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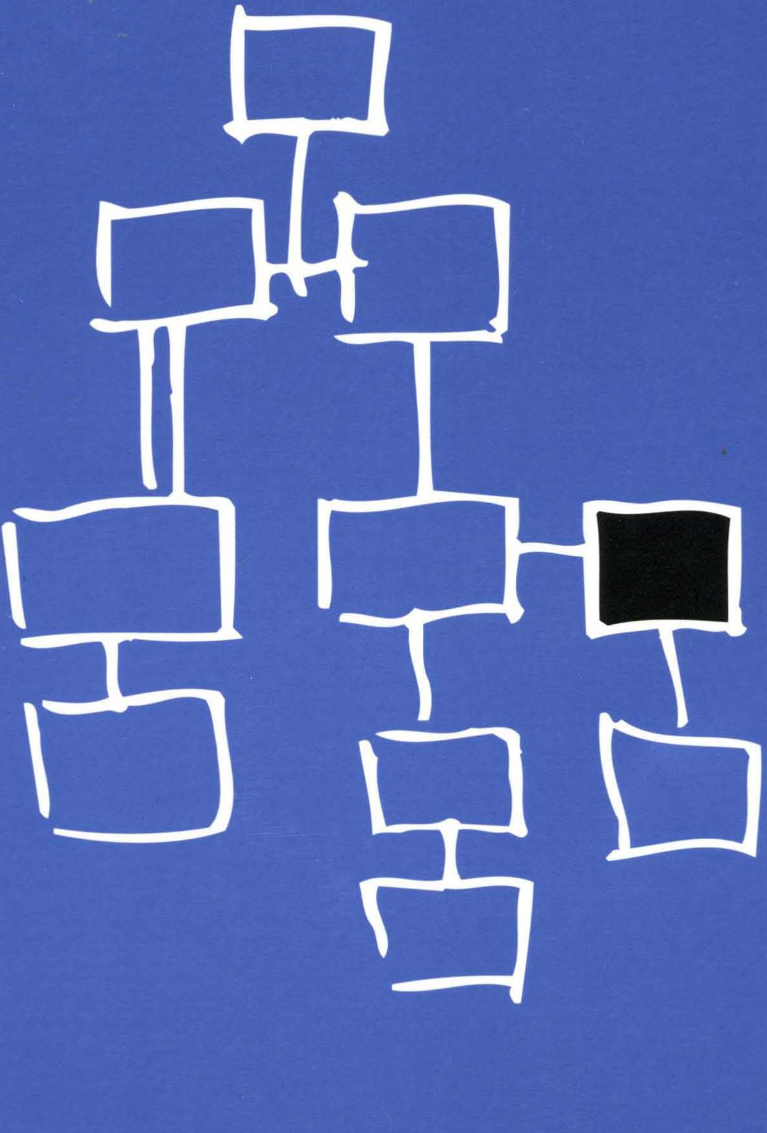
PenPoint™ Architectural Reference
Volume I



PenPoint

PenPoint™

PenPoint™ Architectural Reference

VOLUME I

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GO CORPORATION

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Preface

The *PenPoint Architectural Reference* provides detailed information on the various subsystems of the PenPoint™ operating system. Volume I describes the functions and messages that you use to manipulate classes and describes the fundamental classes used by almost all PenPoint applications. Volume II describes the supplemental classes and functions that provide many different capabilities to PenPoint applications.

Intended Audience

The *PenPoint Architectural Reference* is written for people who are designing and developing applications and services for the PenPoint operating system. We assume that you are familiar with the C language, understand the basic concepts of object-oriented programming, and have read the *PenPoint Application Writing Guide.*

What's Here

The *PenPoint Architectural Reference* is divided into several parts, which are split across two volumes. Volume I contains these parts:

- *Part 1: Class Manager* describes the PenPoint class manager, which supports object-oriented programming in PenPoint.
- *Part 2: PenPoint Application Framework* describes the PenPoint Application Framework, which provides you the tools you use to allow your application to run under the notebook metaphor.
- *Part 3: Windows and Graphics* describes ImagePoint, the imaging system for the PenPoint operating system, and how applications can control the screen (or other output devices).
- *Part 4: UI Toolkit* describes the PenPoint classes that implement many of the common features required by the PenPoint user interface.
- *Part 5: Input and Handwriting Translation* describes the PenPoint input system and programmatic access to the handwriting translation subsystems.

Volume II contains these parts:

- *Part 6: Text Component* describes the PenPoint facilities that allow any application to provide text editing and formatting capabilities to its users.
- *Part 7: File System* describes the PenPoint file system.

- *Part 8: System Services* describes the function calls that applications can use to access kernel functions, such as memory allocation, timer services, process control, and so on.
- *Part 9: Utility Classes* describes a wide variety of classes that save application writers from implementing fundamental things such as, list manipulation, data transfer, and so on.
- *Part 10: Connectivity* describes the classes that applications can use to access remote devices.
- *Part 11: Resources* describes how to read, write, and create PenPoint resource files.
- *Part 12: Installation API* describes PenPoint support for installing applications, services, fonts, dictionaries, handwriting prototypes, and so on.
- *Part 13: Writing PenPoint Services*, describes how to write an installable service.

You can quickly navigate between these sections using their margin tabs. Each volume has its own index. The *PenPoint Development Tools* has a master index for all the manuals in the Software Development Kit.

Other Sources of Information

As mentioned above, the *PenPoint Application Writing Guide* provides a tutorial on writing PenPoint applications. The tutorial is illustrated with several sample applications.

The *PenPoint Development Tools* describes how to run PenPoint on a PC, how to debug programs, and how to use a number of tools to enhance or debug your applications. This volume also contains a Master Index to the five volumes included in the PenPoint SDK.

The *PenPoint API Reference* is a set of "datasheets" that were generated from the PenPoint SDK header files. These datasheets contain information about all the messages defined by the public PenPoint classes. If you own the PenPoint SDK, you can also find the header files in the directory \PENPOINT\SDK\INC.

To learn how to use PenPoint, you should refer to the PenPoint user documentation. The user documentation is included with the PenPoint SDK, and is usually packaged with a PenPoint computer. The user documentation consists of these books:

- *Getting Started with PenPoint*, a primer on how to use PenPoint
- *Using PenPoint*, a detailed book on how to use PenPoint to perform tasks and procedures.

Type Styles in This Book

To emphasize or distinguish particular words or text, we use different fonts.

Computerese

We use fonts to distinguish two different forms of "computerese":

- C language keywords and preprocessor directives, such as `switch`, `case`, `#define`, `#ifdef`, and so on.
- Functions, macros, class names, message names, constants, variables, and structures defined by PenPoint, such as **msgListAddItem**, **clsList**, **stsBadParam**, P_LIST_NEW, and so on.

Although all these PenPoint terms use the same font, you should note that PenPoint has some fixed rules on the capitalization and spelling of messages, functions, constants, and types. By the spelling and capitalization, you can quickly identify the use of a PenPoint term.

- Classes begin with the letters "**cls**"; for example, **clsList**.
- Messages begin with the letters "**msg**"; for example, **msgNew**.
- Status values begin with the letters "**sts**"; for example, **stsOK**.
- Functions are mixed case with an initial upper case letter and trailing parentheses; for example, **OSMemAvailable()**.
- Constants are mixed case with an initial lower case letter; for example, **wsClipChildren**.
- Structures and types are all upper case (with underscores, when needed, to increase comprehension); for example, U32 or LIST_NEW_ONLY.

Code Listings

Code listings and user-PC dialogs appear in a fixed-width font.

```
//
// Allocate, initialize, and record instance data.
//
StsJmp(OSHeapBlockAlloc(osProcessHeapId, SizeOf(*pInst), &pInst), \
        s, Error);
pInst->>placeHolder = -1L;
ObjectWrite(self, ctx, &pInst);
```

Less significant parts of code listings are grayed out to de-emphasize them. You needn't pay so much attention to these lines, although they are part of the listing.

```
ObjCallJmp(msgNewDefaults, clsAppMgr, &new, s, Error);
new.object.uid                  = clsTttApp;
new.object.key                  = 0;
new.cls.pMsg                    = clsTttAppTable;
new.cls.ancestor                = clsApp;
new.cls.size                    = SizeOf(P_TTT_APP_INST);
new.cls.newArgsSize             = SizeOf(APP_NEW);
new.appMgr.flags.stationery     = true;
new.appMgr.flags.accessory      = false;
strcpy(new.appMgr.company, "GO Corporation");
new.appMgr.copyright = "\213 1992 GO Corporation, All Rights Reserved.";
ObjCallJmp(msgNew, clsAppMgr, &new, s, Error);
```

Placeholders

Anything you do *not* have to type in exactly as printed is generally formatted in italics. This includes C variables, suggested filenames in dialogs, and pseudocode in file listings.

Other Text

The documentation uses *italics* for emphasis. When a Part uses a significant term, it is usually emphasized the first time. If you aren't familiar with the term, you can look it up in the Glossary in the *PenPoint Application Writing Guide* or the index of the book.

DOS filenames such as \\BOOT\PENPOINT\APP are in small capitals. PenPoint file names can be upper and lower case, such as \My Disk\\Package Design Letter.

Book names such as *PenPoint Application Writing Guide* are in italics.

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Chapter 1 / Introduction

This chapter provides a brief introduction to the concepts and terminology used in object-oriented programming, and it introduces the PenPoint Class Manager subsystem within that context. The *PenPoint Application Writing Guide* provides additional information on how to use the PenPoint Class Manager.

About Object-Oriented Programming 1.1

This section introduces some of the basic terms used throughout this Part to describe object-oriented programming techniques. If you have no prior experience with object-oriented programming, read the section titled "Getting Started with Classes" in the *PenPoint Application Writing Guide.*

Your PenPoint program uses functional units called **objects**. There are objects that represent windows, scroll bars, lists, text views, etc. Objects communicate with each other by sending and receiving **messages**.

Each object receives messages and responds to them in a particular way. For example, a menu object responds to the message **msgWinShow** by displaying itself on the screen.

An object's behavior is determined by the **class** that it belongs to. A class is a factory for creating objects. The class contains the code that handles the messages received by an object. Thus, **clsMenu** defines the manner in which menu objects respond to **msgWinShow**. The code that the object executes in response to a message is called a **message handler**.

When a class creates an object, that object is said to be an **instance** of the class. The special PenPoint class **clsClass** is a factory for creating objects which are themselves classes. Thus there are two types of objects: **classes** and **instances**. Both can receive and process messages, but only classes can create objects.

A class doesn't have to define all of its behavior from scratch. It can inherit behavior from another class. For example, because a menu object is defined as a type of window, **clsMenu** is defined as a subclass of **clsWin**. This means that **clsMenu** inherits from **clsWin**, and in this case it is **clsWin** which contains most of the code to display a menu on the screen.

In fact the behavior of a class is inherited from all of its **ancestors**. **clsTkTable** is actually a subclass of **clsTableLayout**, which is a subclass of **clsBorder**, which is a subclass of **clsEmbeddedWin**, **clsGWin**, **clsWin**, and **clsObject** (the fundamental class). **clsMenu**, as a subclass of **clsTkTable**, inherits the behavior of all these classes.

When an object receives a message, the class that created the object handles the message. As part of handling the message, the class can choose to pass the message to its ancestor. The ancestor can also pass the message to its ancestor, and so on up the hierarchy of inheritance, up to **clsObject**.

The PenPoint™ operating system has a wide range of built-in classes that generate the instances your application requires: windows, scrollbars, lists, data views, and text objects. The *PenPoint Class Diagram* shows all the built-in PenPoint classes and their hierarchy of inheritance.

If a built-in class doesn't provide quite the functionality that you need, you can create your own class which inherits from it and has additional or modified functionality. For example, your application is a class that you design, which inherits many capabilities from the superclass of applications, **clsApp**. A running instance of your application is an object created by your customized class.

An Overview of This Part 1.2

This part describes the PenPoint Class Manager. In addition, the following manuals in the PenPoint Software Developer's Kit describe the programming environment for PenPoint:

- *PenPoint Application Writer's Guide*
- *UI Design Reference*

After a general examination of object-oriented programming in PenPoint, the functional elements of the Class Manager subsystem are covered. The root classes of the API Class Hierarchy, **clsObject** and **clsClass**, are described along with explanations of how to use them to create the objects that will comprise your application. The chapters of this part cover the following information:

- Chapter 1 (Introduction, this chapter) provides a brief introduction to the Class Manager and an overview of this part of the *PenPoint Architectural Reference.*
- Chapter 2 (Class Manager Concepts) describes the concepts necessary for understanding the PenPoint class manager and classes in general. The sections describe the PenPoint object identifiers, how to send massages to objects, how to create new objects, macros that aid you in passing messages to objects, and properties that objects can have.
- Chapter 3 (Creating a New Class) describes what you have to do to create a new class. The chapter includes descriptions of instance data, method tables, entry points for methods, method parameters, and how to install a class in PenPoint.
- Chapter 4 (Manipulating Objects) describes the facilities provided by the class manager for controlling objects. This chapter includes discussions on copying objects, observing objects, getting information about objects, object properties, destroying objects, and scavenging objects.

Further Literature on Object-Oriented Programming 1.3

This manual attempts to introduce object-oriented programming concepts at the same time it introduces the PenPoint Class Manager and API Class Hierarchy. If you are unfamiliar with object-oriented programming, you should read "Getting Started with Classes" in the *PenPoint Application Writing Guide.* Here is some recommended general reading on object-oriented programming.

- *Object Oriented Programming - An Evolutionary Approach* by Brad J. Cox, Addison-Wesley Publishing Company, Reading, MA, 1986.
- "What's in an Object?" by Dave Thomas, *Byte*, Vol. 14, No. 3, March, 1989.
- *Object-Oriented Programming for the Macintosh* by Kurt J. Schmucker, Hayden Book Company, Hasbrouck Heights, NJ, 1986.
- "What Is Object-Oriented Programming?" by Bjarne Stroustrup (implementer of C++), *IEEE Software*, vol. 5, No. 3, May 1988.

Chapter 2 / Class Manager Concepts

This chapter describes many of the Class Manager features that you will use when writing applications for PenPoint. It covers sending messages, creating objects, destroying objects to free resources, designing a class, and setting object capabilities.

Topics covered in this chapter:

- Identifiers for PenPoint objects
- Sending messages to objects
- How to create a new object
- Other functions that you can use to send messages to objects
- Macros that you can use to send messages to objects
- Object capabilities
- Object keys.

Identifiers 2.1

To create an object or send a message in PenPoint, you must identify the object or the class of the message using a 32-bit unique identifier (**UID**).

There are two types of UIDs: well-known and dynamic. **Well-known UIDs** are defined by you, GO, and other PenPoint developers at compile time. You typically use well-known UIDs to identify classes, but they can also be used to identify shared objects. **Dynamic UIDs** are created by the Class Manager at run time; typically, you use dynamic UIDs to identify objects (instances of classes).

The term "well-known UID" is sometimes shortened to just "well-known."

Well-known UIDs include an administered value. When you define a class, you create a well-known UID that uses this value. All other identifiers related to that class (for example, messages, tags, and status values) use the same administered value. Chapter 4, Manipulating Objects, discusses the macros that you can use to both create these identifiers and extract information from these identifiers.

A well-known UID contains flags that specify the **scope** of the UID, i.e., whether it is known to all tasks in PenPoint (global), known to tasks in a particular process (process global), or known only to the task that uses it (private).

A **global** well-known UID allows all processes in the system to access the *same* object by using the *same* identifier. For example, **clsWin** is a global well-known UID identifying the window class and **theFileSystem** is a global well-known UID identifying the file system object. Any process that refers to **theFileSystem** will reference the same file system object.

A **process-global** well-known UID allows each process in the system to reference *different* objects with a single identifier. This is useful for objects that exist in each process, but that must have the same identifier. For example, **theWorkingDir** is a process-global well-known UID identifying the process working directory. A process that refers to **theWorkingDir** will reference its own working directory object. Other processes that refer to **theWorkingDir** will reference different working directory objects.

A **private** well-known UID belongs to the application developer. For example, a component used only by your application should be identified by a private well-known UID.

Dynamic object UIDs are allocated by the Class Manager during the creation of an instance, and returned to the client for subsequent references. All dynamic UIDs have global scope. After the object referenced by a dynamic UID is freed, that UID may refer to a different dynamic object at a later time.

The scope of an object's UID specifies the maximal possible access to the object. The actual access permitted by the object may be further restricted by the values of the **objCapCall** and **objCapSend** capabilities for the object (described later in this chapter).

Table 2-1
UID Scope and Type

Scope	Object Type	Use
Global	Well-known	Identifying system-wide objects, such as the FileSystem.
Process-Global	Well-known	Identifying per-task objects, such as the WorkingDir.
Private	Well-known	Identifying objects specific to a task, such as an application-specific class.
Global	Dynamic	Identifying objects created by a client.

You use the **MakeWKN**() macro to create well-known UIDs in your source code. For example, the code fragment below creates a value that is assigned to the symbol **clsFileSystem**. When the program creates the class **clsFileSystem**, it uses this value as the class identifier. You refer to this class with the **clsFileSystem** constant in your application code.

```
#define clsFileSystem          MakeWKN(62,1,wknGlobal)
```

In brief, the arguments to **MakeWKN**() specify:

- The administered value
- A version number
- The access for the UID.

Administration of Well-Known UIDs 2.1.1

GO Corporation maintains a register of well-known UIDs to ensure that they are unique. If you do not register a global or process-global well-known UID, your class UIDs and other identifiers might collide with identifiers created by another developer. Because the administered portion of the UID is used in other identifiers (such as messages, status values, and tags), you only need to register one UID per class.

You must contact GO Developer Support in order to obtain unique UID numbers.

PenPoint defines several well-known global and well-known private UIDs that are reserved for development and testing. These UIDs are defined in UID.H and have the symbols **wknGDTa** through **wknGDTk** for the global UIDs and **wknLDTa** throught **wknLDTg** for private UIDs. You must not use these UIDs in code released outside your development organization.

Well-known private UIDs are private to a process. In other words, you can use well-known private UIDs in your application without concern for whether other applications use the same UIDs. You administer them yourself, choosing values that are unique within your application to pass to **MakeWKN**().

Messages 2.1.2

Like objects, messages are also identified by 32-bit constants. Messages identifiers share the administered part of the UID of the class that defines the message. Because message identifiers are associated with their class, you avoid the problem of identifier collisions. This example defines the message **msgWinGetMetrics** that is associated with the class, **clsWin**:

```
#define msgWinGetMetrics     MakeMsg(clsWin, 5)
```

In brief, the arguments to **MakeMsg**() specify: 1) the class to which the message belongs and 2) a message number that is unique for messages that belong to this class. The macro extracts the administered portion of the class identifier and combines it with the message number to create the message identifier. The message number must be between 0 and 254, inclusive. Message number 255 is reserved for use by the Class Manager.

Status Values 2.1.3

A **status value** is a constant value returned by a method when it has completed a message's request. Your application source code uses the Class Manager macro **MakeStatus**() to create status values. The following code fragment defines a status value associated with the root class, **clsObject**:

```
#define stsScopeViolation   MakeStatus(clsObject,5)
```

In brief, the arguments to **MakeStatus**() specify: 1) the class to which the status value belongs and 2) a status number that is unique for status values that belong to this class. The macro combines the administered portion of the class identifier with the status number to create the status value constant. The status number must be between 0 and 255, inclusive.

The sign-bit in the status value indicates whether the status value is an error status or a non-error status. This allows the client code to do a quick check on the value to look for error conditions (without having to match a series of status values). You can create non-error status values with the **MakeWarning()** macro.

```
#define stsAlreadyAdded      MakeWarning(clsObject,2)
```

The Class Manager defines **stsOK** as the usual non-error status that is returned by a message handler.

```
#define stsOK        MakeWarning(0,0)
```

Instead of testing for exact equality with **stsOK**, you should test whether a status is less than **stsOK**. If it is less, an error condition was encountered; if it is greater than or equal, the message handler successfully completed (the message sending macros described in the section on Error-Checking Macros perform this test for you). The message handler may return a status greater than **stsOK** to advise the caller of an interesting condition which is not an error. For example, an enumerator may return **stsTruncatedData** if passed a buffer smaller than the number of items available for enumeration.

Tags 2.1.4

Another useful 32-bit constant is a tag. You use **tags** to identify well-known constants that are used by different modules in your source code. You use tags most commonly to identify option sheets, option cards, and Quick Help strings. This example defines a tag value for an option sheet used by **clsTttView**.

```
#define tagTttViewOptionSheet   MakeTag(clsTttView, 0)
```

In brief, the arguments to **MakeTag()** specify: 1) the class to which the tag belongs and 2) a tag ID that is unique for tags that belong to this class. The macro combines the administered portion of the class identifier with the tag ID to create the tag constant. The tag ID must be between 0 and 255, inclusive.

By using tags, you are guaranteed that an identifier is unique for the set of all classes.

Macros for Working with UIDs 2.1.5

The macros described above (**MakeWKN()**, **MakeStatus()**, **MakeMsg()**, and **MakeTag()**) are defined in the GO.H file. GO.H defines other Class Manager macros that you can use to extract information from UIDs:

TagNum() extracts the tag ID from a tag.

WKNVer() extracts the version number from a well-known UID.

WKNAdmin() extracts the administered value from a well-known UID.

WKNScope() extracts the scope from a well-known UID.

WKNValue() extracts the administrated value and the scope information from a well-known UID.

In addition, CLSMGR.H defines several macros to test the type of a UID:

ObjectIsDynamic() returns **true** if the object is dynamic, otherwise **false**.

ObjectIsWellKnown() returns **true** if the object is a well-known, otherwise **false**.

ObjectIsWKN() is a synonym for **ObjectIsWellKnown()**.

ObjectIsGlobal() returns **true** if the object is global, otherwise **false**.

ObjectIsLocal() returns **true** if the object is local (that is process-global or private well-known), otherwise **false**.

ObjectIsGlobalWKN() returns **true** if the object is a global well-known, otherwise **false**.

ObjectIsProcessGlobalWKN() returns **true** if the object is a process-global well-known, otherwise **false**.

ObjectIsPrivateWKN() returns **true** if the object is a private well-known, otherwise **false**.

Sending Messages 2.2

You send messages to tell the instances to do things: to tell a window to resize itself or to tell a table to send back an item from a certain row and column address. Sending messages to objects is the primary mechanism for control and data flow in PenPoint.

The Class Manager provides a set of C functions and macros that send messages to objects. The functions take arguments that describe the target object, the message being sent, and a pointer to a structure that can contain additional argument data.

The most commonly used function is **ObjectCall()**, whose function prototype follows:

```
STATUS GLOBAL ObjectCall(
    MESSAGE     msg,
    OBJECT      object,
    P_ARGS      pArgs
);
```

msg is the identifier for the message being sent.

object is the identifier for the object to which the message is being sent.

pArgs is the pointer to a structure that contains additional arguments to accompany the message. In some cases this argument is used to convey a 32-bit value, rather than a pointer.

The **ObjectCall()** function passes the parameters to the method that handles the message.

When you read more about how to create a class, in Chapter 3, Creating a New Class, you will understand more about how **ObjectCall()** locates the entry point.

Return Values 2.2.1

When the method completes it returns a STATUS value. The **ObjectCall()** function returns the STATUS value to its caller (your program).

Negative status values indicate errors conditions, positive values indicate non-error conditions. Although some PenPoint classes use status codes to return data in addition to indicating a condition, this technique is discouraged. If you need to return data, it is best to pass it back in the message argument.

Because checking for return values is so common, the Class Manager provides several macros that send a message and check the returned status value. "Using the Message-Sending Macros," later in this chapter, discusses these macros.

Setting Up the Message Argument Structure 2.2.2

The message argument is a pointer to the argument data.

The third argument in the **ObjectCall()** function (and in most message-sending functions) is a pointer to **argument data**. Each message requires a specific argument structure; not all argument structures are the same. The message description in the header files and in the *PenPoint API Reference* specifies the argument structure required by each message.

For example, the **clsTextData** message **msgTextModify** takes as its argument **P_TEXT_BUFFER**, a pointer to a **TEXT_BUFFER** data structure. You can examine the file TXTDATA.H (where **clsTextData** is defined) to find the description of the **TEXT_BUFFER** structure:

```
typedef struct TEXT_BUFFER {
    TEXT_INDEX  first;              // In
    TEXT_INDEX  length;             // In
    TEXT_INDEX  bufLen;             // In
    P_CHAR      buf;                // In:Out via *buf
    TEXT_INDEX  bufUsed;            // Out
} TEXT_BUFFER, *P_TEXT_BUFFER;
```

The PenPoint header files label the members of the argument structures with the words **In**, **Out** or **In:Out**. **In** denotes arguments sent to the called object, but which are not modified. **Out** denotes arguments sent back by the called object. **In:Out** denotes members used to send data in both directions. If a member isn't labelled with one of these words, it is implied to be **In**.

Of course, the argument structure can itself contain pointers to buffers allocated by your program. The receiving object can also copy data to these buffers. In the example above, the **buf** field is a pointer to an array of CHAR values used to store text.

Usually message-sending between objects is done within the same task; passing information between tasks or processes requires slightly more forethought (for example, you must create buffers for data in shared memory).

Example 2-1 shows how to send **msgTextModify** to an instance of **clsTextData**.

Example 2-1

Sending a Message to an Object

One of the things an instance of **clsTextData** does is maintain a text value. Object-oriented programming techniques restrict you from knowing the internal representation of the text data, so you cannot modify it with a simple assignment. Instead, you send the message **msgTextModify** to the **clsTextData** instance, with a pointer to a TEXT_BUFFER as an argument. The TEXT_BUFFER carries the text value that you want the **clsTextData** instance to maintain.

This example shows how to prepare a TEXT_BUFFER argument with the string **"Hello World"** as its text value, and then to send **msgTextModify** to an instance of **clsTextData** with the prepared TEXT_BUFFER as an argument. For simplicity, the example assumes that the **clsTextData** object is defined and created elsewhere.

```
TEXT_BUFFER textBuf;
OBJECT      textDataObject;
STATUS      s;
textBuf.first = 0;      // Modify textDataObject chars starting with first char
textBuf.length = 0; // Insert rather than overwriting existing text
textBuf.buf = "Hello World";           // the new text
textBuf.bufLen = strlen(textBuf.buf);   // length of the new text
s = ObjectCall(msgTextModify, textDataObject, &textBuf);    // send message
```

If the status code returned in **s** is **stsOK**, you can use the **textBuf** structure to examine the values passed back from the message. *Part 6: Text* discusses clsTextData specifics such as these return values.

Creating a New Object 2.3

Thus far we have discussed objects without really discussing how an object is created. This section describes how you create objects.

In brief, to create an object, you:

1 Declare the argument structure for the new object.

2 Send **msgNewDefaults** to the *class* for the object to initialize the argument structure to default values.

3 Modify the default values if required.

4 Create the object by sending **msgNew** to the *class* of the object you want to create, with a *pointer* to the argument structure as an argument.

When **msgNew** completes successfully, the argument structure contains the UID of the newly created object. For purposes of sending messages, the UID is the new object.

New Object Argument Structures 2.3.1

To create an object that belongs to a particular class, you must find the description of the class in either the *PenPoint API Reference* or in the header files. There you will find the argument structure required by **msgNewDefaults** and **msgNew.**

The argument structures for a new object always end with _NEW. For example, the argument structure for a note object (an instance of **clsNote**) is NOTE_NEW. If you look in the header file for **clsNote** (NOTE.H), you will find the type definition for NOTE_NEW:

```
typedef struct NOTE_NEW {
    noteNewFields
} NOTE_NEW, FAR *P_NOTE_NEW;
```

The symbol **noteNewFields** is defined immediately before the NOTE_NEW type definition. :

```
#define noteNewFields        \
    frameNewFields  \
    NOTE_NEW_ONLY           note;
```

clsNote is a subclass of **clsFrame**. The above **#define** says that **noteNewFields** consists of the fields defined by the symbol **frameNewFields**, and a new field called **note**, containing a NOTE_NEW_ONLY structure. That is, the fields of a NOTE_NEW structure are everything that **frameNewFields** is, *plus* a structure containing the added data for a **clsNote** object.

The structure for NOTE_NEW_ONLY is described immediately above the **#define** for **noteNewFields**:

```
typedef struct {
    NOTE_METRICS        metrics;
    P_CHAR              pTitle;
    P_UNKNOWN           pContentEntries;    // used to create the content
    P_TK_TABLE_ENTRY    pCmdBarEntries;     // used to create the command bar
    U32                 spare;              // reserved
} NOTE_NEW_ONLY, *P_NOTE_NEW_ONLY;
```

This structure describes the **clsNote**-specific arguments that pertain to the object created by **msgNew**. The object contains metrics, a pointer to a title string, a pointer to note text, a pointer to the command bar entries, and a spare **U32** for future use by GO Corporation.

More About the NewFields #define 2.3.1.1

The **msgNew** and **msgNewDefaults** argument structure used for a particular class contains structures defined by each of the classes from which the class inherits. The **#define** in the example above defined the symbol **noteNewFields** which contained the symbol **frameNewFields** plus a NOTE_NEW_ONLY structure. This gives **clsNote** all the data structure of its superclass, **clsFrame**, in addition to the **clsNote**-specific data. If you go to the header file for **clsFrame**, you will find that **frameNewFields** is defined as the symbol **shadowNewFields** and a FRAME_NEW_ONLY structure. You can continue to trace this inheritance back to the structure **OBJECT_NEW_ONLY**, which is defined by the fundamental class, **clsObject**.

The *PenPoint API Reference* displays the expanded form of the _NEW structure for each class. The expanded form of NOTE_NEW is:

```
typedef struct NOTE_NEW {
    OBJECT_NEW_ONLY         object;
    WIN_NEW_ONLY                win;
    GWIN_NEW_ONLY           gWin;
    EMBEDDED_WIN_NEW_ONLY   embeddedWin;
    BORDER_NEW_ONLY         border;
    CSTM_LAYOUT_NEW_ONLY    customLayout;
    SHADOW_NEW_ONLY         shadow;
    FRAME_NEW_ONLY          frame;
    NOTE_NEW_ONLY           note;
} NOTE_NEW, far *P_NOTE_NEW;
```

Thus, when you declare a structure using the type NOTE_NEW, the structure contains the NOTE_NEW_ONLY structure and all the structures defined by **clsNote**'s ancestors.

It is important to understand the inheritance of the class from which you are creating an object, because all of the structures defined by the _NEW structure affect the object created by **msgNew**. **msgNewDefaults** sets most of the fields defined by these structures to useful default values.

Using msgNewDefaults 2.3.2

You send **msgNewDefaults** to a class, passing a pointer to the uninitialized _NEW structure, so that the class can set its default values for the argument structure. All classes respond to **msgNewDefaults**. When you define your own classes, you must design them to handle **msgNewDefaults** by setting class-specific structures to useful default values; in particular, you should set the default values of your _NEW_ONLY structure.

The datasheets in the *PenPoint API Reference* and the header file for the class normally list the default values that **msgNewDefaults** assigns to the _NEW structure.

Modifying Argument Data 2.3.3

To obtain some non-default behavior from the new object you are going to create, you must modify some of the default _NEW values that **msgNewDefaults** sets. Furthermore, for some _NEW fields, it is impossible to establish a useful default value; you must set such fields explicitly.

In most cases, the default values are sufficient. The header file or data sheet for a class should document the default values as well as which, if any, of the fields you must set explicitly.

Using msgNew 2.3.4

After you send **msgNewDefaults** to set default values for the _NEW structure (and after modifying those defaults if necessary), you send **msgNew** to the class that creates the object. The argument to **msgNew** is a pointer to the _NEW structure that you have initialized.

Example 2-2 shows how to create a new instance of **clsNote**.

Example 2-2
Creating a New Object

This example shows how to create a new object, in this case an instance of **clsNote**. The example does the following:

1 Sends **msgNewDefaults** to clsNote, with a pointer to a NOTE_NEW structure as an argument, to set the NOTE_NEW structure to default values.

2 Modifies some of the default NOTE_NEW values.

3 Sends **msgNew** to **clsNote**, with the initialized and modified NOTE_NEW structure as an argument, to create a new instance of **clsNote**.

```
NOTE_NEW        noteNew;
TK_TABLE_ENTRY  tkEntry[2];
STATUS          s;
s = ObjectCall(msgNewDefaults, clsNote, &noteNew);
//
noteNew.note.metrics.flags = nfAutoDestroy | nfDefaultAppFlags;
noteNew.note.pContentEntries = tkEntry;
//
s = ObjectCall(msgNew, clsNote, &noteNew);
```

clsNote responds to **msgNew** by manufacturing a new instance of **clsNote**, a note object. The Class Manager assigns a dynamic UID to the new instance, and places this value in **note.object.uid**.

Creating an Object with Default Values 2.3.5

Sometimes there is no reason to change any of the default values that **msgNewDefaults** sets. In these cases, rather than send **msgNewDefaults** followed immediately by **msgNew**, you can use **msgNewWithDefaults**. **msgNewWithDefaults** is a convenient way to get the effect of sending **msgNewDefaults** followed immediately by **msgNew**.

Handling Message Status 2.4

When the message handler for **msgNew** completes, it returns a status value indicating whether clsNote suceeded in creating the new instance. If the message completes successfully, it returns **stsOK**. You can now use the UID value in **note.object.uid** as a target for messages; the UID identifies the new object.

If a message does not complete successfully, it returns a status other than **stsOK**. Your code must be prepared to handle such conditions. Example 2-3 shows the code structure required to handle return values other than **stsOK**.

Example 2-3
Handling the Message Return Status

This example creates a note object as in Example 2-2, then sends **msgNoteShow** to the note object to instruct the note to display itself. The example shows the structure of code to handle errors from **msgNew** and **msgNoteShow**. It does not show ways to handle particular errors, and it assumes that **msgNewDefaults** will not return an error status.

```
NOTE_NEW        noteNew;
TK_TABLE_ENTRY  tkEntry[2];
STATUS          s;
s = ObjectCall(msgNewDefaults, clsNote, &noteNew);
//
noteNew.note.metrics.flags = nfAutoDestroy | nfDefaultAppFlags;
noteNew.note.pContentEntries = tkEntry;
//
s = ObjectCall(msgNew, clsNote, &noteNew);
if (s  stsOK)
    // handle the error.
    // ...
s = ObjectCall(msgNoteShow, noteNew.object.uid, pNull);
if (s  stsOK)
    // handle the error.
    // ...
```

Other Ways to Send Messages 2.5

Thus far we have limited our discussion to the **ObjectCall()** function for sending a message to an object. **ObjectCall()** executes code in the task that calls **ObjectCall()**. If your code sends a message with **ObjectCall()**, your execution thread goes from your code, to the code of the message handler, then back to your code—all executing in your code's task. This is why you normally use **ObjectCall()** to send **msgNew** to create a new object. By using **ObjectCall()**, you cause the instance-creation code to run in your task. Your task owns the object because it was created in your task.

However, the PenPoint™ operating system is multi-tasking. It supports many different tasks; each task gets a share of CPU cycles. Every active document in PenPoint is a separate task (thus embedded documents run in separate tasks from their parent documents). The PenPoint operating system itself uses several tasks. Your own application architecture may involve multiple tasks.

ObjectSend() works like **ObjectCall()** except that the message handler code runs in the task that owns the object rather than in your task. Your task waits for the **ObjectSend()** to return; while awaiting the return, your task will continue to dispatch messages sent to objects owned by your task. This prevents a deadlock condition from arising when you send to an object owned by another task, which in turn sends to an object owned by your task.

ObjectPost() works like **ObjectSend()** in that the message handler code runs in the object's owning task. However, **ObjectPost()** returns immediately, allowing your task to continue its execution. At some later time, the message handler for the posted message executes in the recipient object's task.

ObjectSend() 2.5.1

The multitasking aspect of the PenPoint operating system makes it likely that you will at some time or another wish to send messages to objects that are not in your task. To send a message to an object in another task, you use the **ObjectSend()** function (or one of the related functions described later in this chapter). When you send a message with **ObjectSend()**, the execution thread goes from your code running in your task, to the message handler code running in the object's task, then back to your code running in your task.

There are two common reasons you would want to execute code in a different task:

You want to make use of an object owned by another task. Using **ObjectSend()** is required when the object you want to send the message to is owned by another task and does not have **objCapCall** enabled.

- You want to protect your task from errors. If you use **ObjectCall()** to send a message to an object in another task, buggy code could terminate your task. If you send the same message with **ObjectSend()**, the error occurs in the recipient object's task, leaving your task free to continue after the other task terminates.

When you send a message with **ObjectSend()**, your code's task is suspended while waiting for the message handler to return. Your task resumes operation when the message handler returns.

ObjectSend() does not pass back updated message argument data. If your code requires information from any of the **Out** fields of the argument structure, it should use **ObjectSendUpdate()** (described below).

The function prototype for **ObjectSend()** is:

```
STATUS EXPORTED ObjectSend(
    MESSAGE     msg,
    OBJECT      object,
    P_ARGS      pArgs,          // In only: Not updated
    SIZEOF      lenArgs
);
```

ObjectSend() has one more argument than **ObjectCall()**. In **lenArgs**, you must specify the size, in bytes, of the data indicated by **pArgs**.

ObjectSend() usually copies the argument data to the address space of the task that owns the object (using **lenArgs** to determine how many bytes to copy) and then executes an **ObjectCall()** in that task. When the method returns, **ObjectSend()** returns the status value to the calling task.

If **lenArgs** is zero, the **pArgs** pointer is passed without copying the data to which it points. In this case, the data indicated by **pArgs** must be globally accessible from any task.

If the object is owned by the calling task, the **ObjectSend()** becomes a normal **ObjectCall()**. **pArgs** is not copied, but is used and modified directly.

Functions Related to ObjectSend() 2.5.2

The functions **ObjectSendUpdate()** and **ObjectSendU32()** behave similarly to **ObjectSend()**, but have been modified slightly to handle a different set of arguments or to provide different information.

ObjectSendUpdate() 2.5.2.1

ObjectSendUpdate() works just like **ObjectSend()** except that it copies the modified argument structure (the **lenArgs** bytes that **pArgs** points to) back to your task. This is useful when your task needs to gain access to **Out** fields that the message handler sets. The prototype for **ObjectSendUpdate()** is identical to that of **ObjectSend()**, except that pArgs is **In/Out** rather than just **In**:

```
STATUS EXPORTED ObjectSendUpdate(
    MESSAGE     msg,
    OBJECT      object,
    P_ARGS      pArgs,          // In/Out: Updated
    SIZEOF      lenArgs
);
```

ObjectSendU32() 2.5.2.2

ObjectSendU32() is is the same as **ObjectSend()**, except that it assumes that the **lenArgs** equals zero. **ObjectSendU32()** is slightly more efficient than **ObjectSend()** when you know that the argument structure to which pArgs points is globally accessible. In addition, since the data indicated by **pArgs** must be globally accessible, **ObjectSendU32()** causes the **pArgs** to be updated, providing the caller access to the **Out** fields of the **pArgs**.

The prototype for **ObjectSendU32()** is:

```
STATUS EXPORTED ObjectSendU32(
    MESSAGE     msg,
    OBJECT      object,
    P_ARGS      pArgs           // Out: updated
);
```

ObjectPost() 2.5.3

You use **ObjectPost** when you want to send a message to an object, but you don't want the object to handle the message immediately. The two main reasons for using **ObjectPost()** are:

- You are sending a notification message to observers and aren't concerned about when the object receives it (observers and notification messages are described in Chapter 4, Manipulating Objects).
- You want to destroy an object, but want to allow it to complete its current work before it receives the destruction message.

You can use **ObjectPost()** to send messages to an object in any task, including your own.

ObjectPost() places the message in the input subsystem's input queue and returns immediately. The status value returned by **ObjectPost()** merely indicates whether the message was successfully added to the input queue. The message does not pass back any of the **Out** values in the argument structure to which **pArgs** points.

The PenPoint input subsystem consists of a global input queue that receives messages from device drivers (primarily the pen device driver) and other clients. When a message reaches the front of the input queue, the input subsystem uses **ObjectSend()** to send the message to the destination object. The destination object processes the message in its own low-level message queue. Therefore, any message sent by the input subsystem executes in the object's task, but it doesn't execute until the object's task returns to its top-level dispatch loop.

When the method returns, the status code is returned to the input subsystem, which can then handle the next message at the top of the input queue. In other words, messages in the input queue are handled synchronously; no object receives another message from the input queue until the object has completed its current work. Although messages sent with **ObjectPost()** are not input messages, they are processed synchronously by virtue of being posted to the input queue.

The function prototype for **ObjectPost()** is:

```
STATUS EXPORTED ObjectPost(
    MESSAGE     msg,
    OBJECT      object,
    P_ARGS      pArgs,
    SIZEOF      lenArgs
);
```

ObjectPostU32() 2.5.3.1

A related message-sending function, **ObjectPostU32()**, has the same relationship to **ObjectPost()** that **ObjectSend32()** has to **ObjectSend()**. That is, **ObjectPost32()** works just like **ObjectPost()** except that it assumes a **lenArgs** equal to zero. Therefore, you do not need to specify **lenArgs** in the function call. Also, as with **ObjectSendU32()**, **ObjectPostU32()** does not copy the argument structure to the task of the recipient object, so the data indicated by **pArgs** must be globally accessible. In addition, since the actual handling of the message can be indefinitely delayed, care must be taken to avoid having **pArgs** address memory that becomes invalid before the message handler gets to execute.

The prototype for **ObjectPostU32()** is:

```
STATUS EXPORTED ObjectPostU32(
    MESSAGE     msg,
    OBJECT      object,
    P_ARGS      pArgs
);
```

Using the Message-Sending Macros 2.6

CLSMGR.H defines a number of macros that invoke message-sending functions. The message-sending macros serve two purposes:

- Conditional macros report errors when compiled with the /DDEBUG compilation flag.
- Error-handling macros test the message return value and take special action based on whether the status indicates an error.

DEBUG Warning Macros 2.6.1

CLSMGR.H defines a DEBUG-conditional macro for each message-sending function. When you compile with the /DDEBUG compilation flag, these macros compile to a **...Warning()** form of the associated message-passing function. The **...Warning()** functions print a message to the system error log if the message returns an error status. If you do not specify /DDEBUG, the macros invoke their base functions directly.

The names of the DEBUG-conditional macros are based on the names of the associated message-sending functions. For example, if you compile the **ObjCallWarn()** macro without the /DDEBUG flag, it compiles to the **ObjectCall()** function. If you use the /DDEBUG flag, **ObjCallWarn()** compiles to the **ObjectCallWarning()** function which logs errors. The other DEBUG-conditional macros are named according to the same pattern. For example, **ObjSendWarn()** compiles to **ObjectSend()** or **ObjectSendWarning()**, and **ObjPostWarn()** compiles to **ObjectPost()** or **ObjectPostWarning()**.

Error-Checking Macros 2.6.2

Because most messages return a status value, you need to write code to check return values when you use the message-sending functions. To make your code more readable, CLSMGR.H defines a variety of macros that provide useful shortcuts for sending messages to an object and handling return values.

The error-checking macros take advantage of the DEBUG-conditional macros described in the previous section.

For example, **ObjCallJmp()** is a macro that calls **ObjCallWarn()**, tests the returned status value, and jumps to labelled error-handling code if the status is negative (recall that a negative status indicates an error). Take as an example the following use of **ObjCallJmp()**:

```
ObjCallJmp(msgNoteShow, noteNew.object.uid, pNull, s, error);
```

This calls **ObjCallWarn()** as follows:

```
s = ObjCallWarn(msgNoteShow, noteNew.object.uid, pNull);
```

If the method returns a negative status, **ObjCallJmp()** jumps to the label **error**. The status value is returned in s.

The name of a message-sending macro indicates which message-sending function it invokes. For example, **ObjCallJmp()** invokes **ObjCallWarn()**. The letters (such as **Jmp**) after the name of the function indicate what the macros do. All of the message-sending functions have the following associated macros:

- ...**Jmp**() macros jump to a specified label if the function returned an error code. Use this form to jump to error-handling code before returning. Typical error-handling activities include freeing allocated memory and destroying objects.
- ...**Ret**() macros simply execute **return(s)**, where **s** is the returned status value, when the status is negative.
- ...**OK**() macros return **true** if the function returns a non-negative status code.

ObjectCall() Macros 2.6.3

CLSMGR.H defines two further macros for **ObjectCall()** and **ObjectCallAncestor()** only.

- ...**Failed**() macros return **true** if the function returns a negative status value.
- ...**Chk**() macros also return **true** if the function returns a negative status, but they don't use the DEBUG-conditional macros and therefore never log errors.

Using Keys 2.7

Two fields in the OBJECT_NEW_ONLY structure are useful for controlling access to objects:

key allows you to specify a key value when creating the object. If a client attempts to destroy (or make substantial modifications to) the object, it must use the same key value in its message. If protecting an object isn't particularly important, you can leave the default value (which is **objWKNKey**, defined as `((OBJ_KEY)0)`).

cap argument allows you to establish and restrict the capabilities of the object. Capabilities are described in the next section.

Classes can control access to objects through keys. Several messages that request basic object operations such as **msgDestroy** require the use of a key (unless the capability flags that control these operations are specifically enabled). When you define messages for your own classes, you can require keys for your messages.

A key is a 32-bit value; the class manager stores a key as part of the instance data for an object. When you send a message that requires a key, you send the key in the argument structure for the message. The method that handles the message gets the key value from the argument structure and compares it to the key value in the instance data. If the values match, the class allows the requested operation to take place. If the values do not match, the method returns **stsProtectionViolation**.

The actual key value depends on how you are going to use the object and how you anticipate others might try to affect the object:

- If you want exclusive control over each object, you can use the **rand**() function to create a non-zero key value that is likely to be unique. You must remember this key value in some way.
- If you want any instance of your program to be able to affect objects that it creates, you can create a 32-bit identifier or use some other common value (such as your class's method table identifier).

Capabilities 2.8

In the discussion on setting up the arguments to **msgNew**, we touched briefly on the object capabilities.

Capabilities are a set of flags that control some fundamental properties of objects and classes. Before the class manager actually delivers a message to an object, it checks the object's capabilities. For example, the object capability **objCapCall** indicates whether an object can receive messages sent with the **ObjectCall**() function.

The only way to bypass a capability flag that prevents you from doing something is to use the correct key value for the object with messages that support the use of keys.

The capability flags are enumerated in the definition of OBJ_CAPABILITY in CLSMGR.H. The default capabilities for objects and classes are different.

Table 2-2 lists and briefly describes the capability flags. The sections following the table describe the capabilities in detail.

Table 2-2
Object Capability Flags

Capability	Object Default	Class Default	Description
objCapOwner	true	false	Enables the object to receive msgSetOwner.
objCapFree	true	false	Enables the object to receive msgDestroy.
objCapSend	true	false	Enables the object to receive messages sent with ObjectSend().
objCapCall	false	true	Enables the object to receive messages sent with ObjectCall().
objCapObservable	true	true	Enables the object to receive msgAddObserver and msgRemoveObserver.
objCapInherit	n/a	true	Enables clients to create a new class that inherits from the class.
objCapScavenge	n/a	true	Enables the class to receive msgScavenge.
objCapCreate	false	false	Enables the class to receive msgObjectNew.
objCapCreateNotify	false	false	Directs the class manager to send msgCreated to a new object when it is fully created.
objCapMutate	true	true	Enables the object to receive msgMutate.
objCapProp	true	true	Enables the object to receive properties-related messages.
objCapUnprotected	n/a	false	
objCapNonSwappable	false	false	

Owner Capability 2.8.1

An object is owned by the task that creates it. Sometimes it is useful to be able to change the owner of an object. For example, an object might maintain information required by many clients. If the client that created the object needs to go away for some reason, the client could change ownership of the object to another client that requires the object.

To change the ownership of an object, you send **msgSetOwner** to the object. The **objCapOwner** flag specifies whether the object can receive **msgSetOwner**.

If **objCapOwner** is **true**, anyone can change the ownership of the object; if it is false, the only clients who can change ownership of the object are those that know the key value for the object.

The default value for **objCapOwner** is **true** for objects and **false** for classes.

Freeing Capability 2.8.2

You destroy an object and free its memory by sending **msgDestroy** to the object. The class manager handles **msgDestroy** and checks the object's **objCapFree** capability. If the **objCapFree** is **true**, any client can destroy the object; if it is **false**, only the clients that know the key for the object can destroy it.

The default value for **objCapFree** is **true** for objects, and **false** for classes.

ObjectSend() Capability 2.8.3

The **objCapSend** capability lets an object receive messages sent with the **ObjectSend()** function, which executes the message handler in the task of the recipient object. When **objCapSend** is **true**, the object can receive messages sent with **ObjectSend()**.

The default value for **objCapSend** is **true** for objects, and **false** for classes.

ObjectCall() Capability 2.8.4

The **objCapCall** capability lets an object receive messages sent with the **ObjectCall()** function, which executes the message handler code in the task of the message sender. When **objCapCall** is true, the object can receive messages sent with **ObjectCall()** from tasks other than the object's owning task.

The default value for **objCapCall** is **false** for objects and **true** for classes.

When a task sends a message to an object that it owns, **objCapSend** and **objCapCall** are both assumed to be true. If both **objCapSend** and **objCapCall** are **false**, no task other than the owner of the object can talk to the object.

Observable Capability 2.8.5

For each object, the class manager maintains a list of observers. A client can add itself an object's obsever list by sending **msgAddObserver** to the object; a client can remove itself by sending **msgRemoveObserver**. When an object wants to send a message to its observers, it sends **msgNotifyObservers** to itself and the class manager sends the message specified in the arguments to all of the observers on the observer list. Observer messages are described in more detail in Chapter 4, Manipulating Objects.

The object capability **objCapObservable** specifies whether an object can receive **msgAddObserver** and **msgRemoveObserver**. If **objCapObservable** is **true**, the object can receive both messages. If **false**, the Class Manager returns **stsProtectionViolation** in response to both messages.

The default **objCapObservable** value is **true** for both objects and classes.

Inheritance Capability 2.8.6

You make a class inherit from another by specifying the superclass when you create the subclass. However, there are times when you do not want your class to be subclassed (this is true for some system classes).

The capability **objCapInherit** specifies whether a class can be subclassed or not. If **objCapInherit** is **true** for a class, clients can create subclasses that inherit from that class. If **objCapInherit** is **false** for a class, clients will receive **stsProtectionViolation** when they try to create a subclass of the class.

This capability is meaningful only for classes. The default value for a class is **true**.

Scavenging Capability 2.8.7

When a task terminates, the class manager cleans up all existing classes and their objects in a process called **scavenging**. The Class Manager sends **msgScavenge** to every object that the terminating task owns. The details of scavenging are covered in Chapter 4, Manipulating Objects.

objCapScavenge applies to an entire class, not to individual objects. If a class has **objCapScavenge** set to **true**, its instances will process **msgScavenge** normally. If a class has **objCapScavenge** set to **false**, its instances will return **stsProtectionViolation** in response to **msgScavenge**.

This capability is meaningful only for classes. The default value for a class is **false**.

Creation Capability 2.8.8

A client can ask an object in another task to create a new object by sending **msgObjectNew** to the object. If the object has **objCapCreate** set to **true**, it can receive **msgObjectNew**.

The default value for this capability is **false** for both objects and classes.

Creation Notification 2.8.9

Sometimes an object needs to know when the class manager has created it, before any clients can send messages to the object, so that it can perform some additional work. If **objCapCreateNotify** is set to **true** before sending **msgNew**, the class manager will send **msgCreated** to the object when it is fully created, giving the object an opportunity to respond by performing its additional work.

If you want a specific object to receive notification, you should set **objCapCreateNotify** after sending **msgNewDefaults** and before sending **msgNew**. If you specify **objCapCreateNotify** for a class, the class will receive **msgCreated** when it is fully initialized.

If you want all objects created by a class to receive notification, the class must set **objCapCreateNotify** to **true** when it handles **msgNewDefaults**.

msgCreated is described in Chapter 4, Manipulating Objects.

Mutation Capability 2.8.10

A client can change the class from which an object inherits by sending it **msgMutate**. **msgMutate** is described in full in Chapter 4, Manipulating Objects.

The capability **objCapMutate** specifies whether a class can be mutated or not. If **objCapMutate** is **true** for a class or for an object, clients can send **msgMutate** to the object. If **objCapMutate** is **false**, clients will receive **stsProtectionViolation** when they try to mutate the object.

Properties Capability 2.9

Every object has an associated list of **properties**, data elements attached to the object. Clients set an object's properties with **msgSetProp**, and read them with **msgProp**. If an object's **objCapProp** is set to **true**, any object can send **msgProp** and **msgSetProp** to the object. If **objCapProp** is set to false, clients cannot access the object's properties without the object's key.

The default value for **objCapProp** is **true** for both classes and objects.

Checking Capabilities

2.9.1

To check specific capabilities of a particular object, you send **msgCan** to the object. **msgCan** takes an OBJ_CAPABILITY value that specifies a group of capability flags that you want to check. If the specified combination of capability flags is enabled for the object, **msgCan** returns **stsOK**; otherwise it returns **stsProtectionViolation**. For example, the following code fragment checks an object to determine whether it has both the **objCapObservable** and **objCapSend** capability flags set.

```
OBJ_CAPABILITY      objCaps;
STATUS              s;
OBJECT              someObject;
objCaps = objCapObservable | objCapSend;
s = ObjectSend(msgCan, someObject, objCaps);
if (s = stsOK)
    ...
else
    ...
```

Changing Capabilities

2.9.2

To enable or disable an object's capabilities, you send the message **msgEnable** or **msgDisable** to the object. The messages take a pointer to an OBJ_CAPABILITY_SET structure that contains:

key the key for the object that you want to change.

cap an OBJ_CAPABILITY value that contains the capabilities that you want to enable or disable.

If **key** does not match the key value for the object, the message fails with **stsProtectionViolation**.

Chapter 3 / Creating a New Class

There are two main reasons why you might need to implement a new class:

- You are building a new application. All applications are classes that inherit from **clsApp**, the application class. Application classes are described in detail in *Part Two: Application Framework.*
- You need a class that provides functionality that is not available in any existing classes. Usually you can find a class that has most of the behavior that you require. You can then create a new class that is a subclass of that class, reducing the amount of code you must write and test yourself.

This section describes how to write the skeleton for a new class. It is primarily concerned with the organization of the fundamental parts of a class, how the Class Manager routes messages to a particular method, the parameters involved in invoking a method, and the data maintained for each instance of a class. This section *does not* describe how to actually implement the methods; that aspect of classes is described in the *PenPoint Application Writing Guide.*

Overview 3.1

The next sections describe the different parts that you must create to implement a new class and how the parts interact when you install the class.

The Parts of a Class 3.1.1

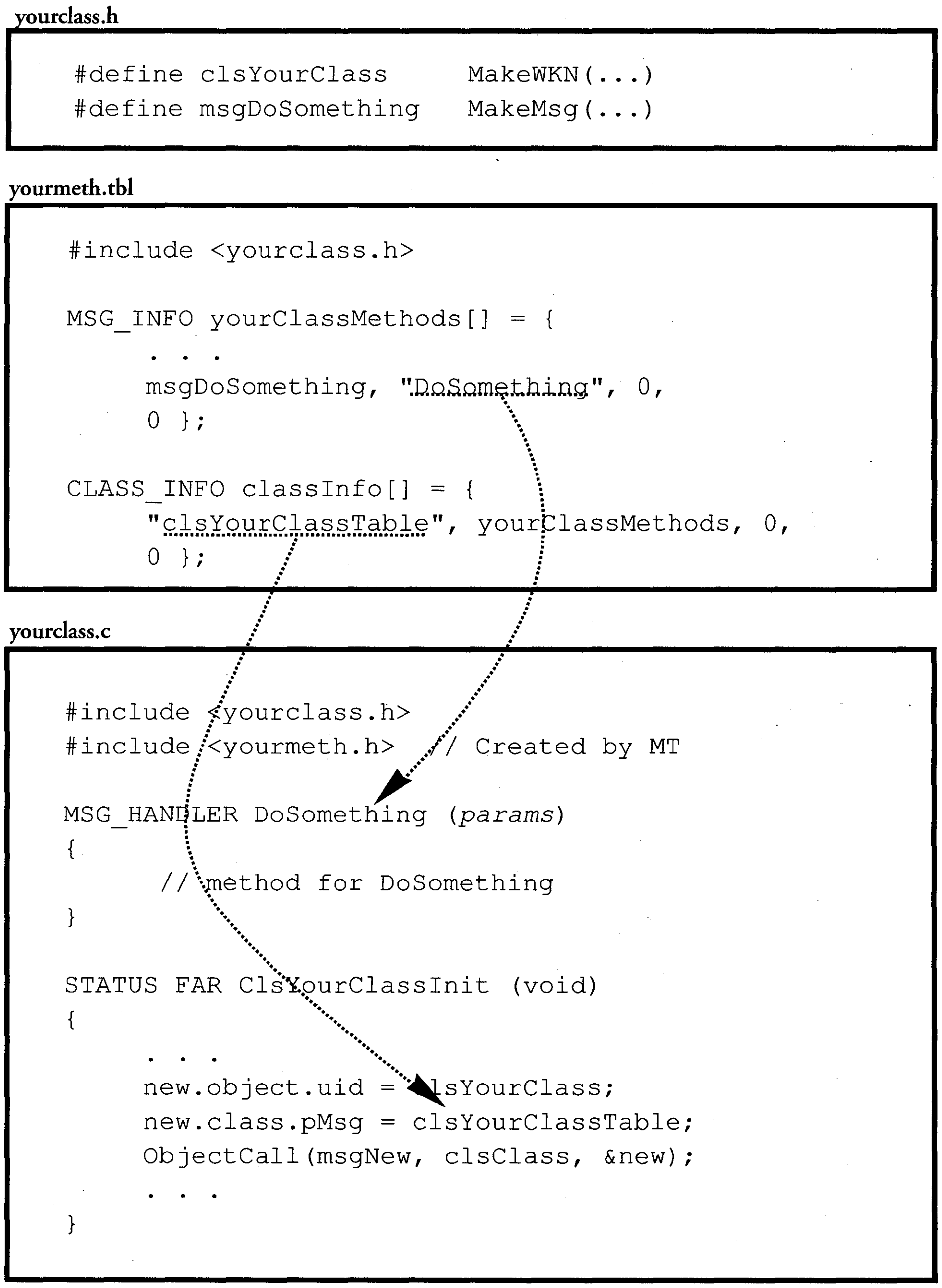
When you create a new class, you must create:

- A header file (.H file) that defines the new messages that your class implements.
- A method table. When the Class Manager sends a message to your class, it uses the method table to locate the method for that message. You compile the method table with the PenPoint method table compiler, shipped with the Software Developer's Kit (SDK) as \PENPOINT\SDK\UTIL\CLSMGR\MT.EXE.
- A C code file that contains a method for each message that your class and its instances will handle. A **method** is a C function that defines the class's behavior for each message. Because methods are the functions with which classes handle incoming messages, you'll sometimes hear methods referred to as **message handlers**.

A message identifier is defined only once (by a single header file), but there can be any number of handlers for that message, written by any class that wants to handle the message. **msgNewDefaults** is the classic example of such a message.

Figure 3-1 shows the parts of a class and how they relate to one another. You can find many source code examples for classes in the SDK directory \PENPOINT\SDK\SAMPLE.

Figure 3-1
Method Table and Class Implementation



yourclass.h

```
#define clsYourClass      MakeWKN(...)
#define msgDoSomething    MakeMsg(...)
```

yourmeth.tbl

```
#include <yourclass.h>

MSG_INFO yourClassMethods[] = {
     . . .
     msgDoSomething, "DoSomething", 0,
     0 };

CLASS_INFO classInfo[] = {
     "clsYourClassTable", yourClassMethods, 0,
     0 };
```

yourclass.c

```
#include <yourclass.h>
#include <yourmeth.h>    // Created by MT

MSG_HANDLER DoSomething (params)
{
      // method for DoSomething
}

STATUS FAR ClsYourClassInit (void)
{
     . . .
     new.object.uid = clsYourClass;
     new.class.pMsg = clsYourClassTable;
     ObjectCall(msgNew, clsClass, &new);
     . . .
}
```

Installation Summary 3.1.2

There are two ways to link a class: you can link a class with an application to create an application executable file, or you can link a class into a DLL file. You use DLL files when multiple clients may want to use your class.

In an application, you create your class by calling a class initialization routine from your application's **main()** routine. In a DLL, you create the class by calling a class initialization routine from the **DLLMain()** routine.

When you have compiled a class into an executable or a DLL, you use the Installed Software section of the PenPoint Settings notebook to copy it to the PenPoint computer. The Settings notebook invokes **main()** or **DLLMain()**, which then calls the class initialization routine.

In your class initialization routine you install your new class by sending **msgNew** to **clsClass** and specifying the new class in the message arguments.

Design Considerations 3.2

When you determine that you need to create a new class, you must also ask yourself several questions about the design of your class. As you read the rest of this chapter, keep these questions in mind:

- Do you want to maintain instance data in the object itself, or do you want to maintain pointers to external instance data?
- Should the class be global? Should it be well known?
- Should you handle messages defined by your ancestors, or should you pass them up to your ancestor?
- When you find that several methods require the same subroutine, do you implement it as a function, or do you implement it as a new message and a new method?

The advantages and disadvantages of these techniques are described throughout the rest of this chapter.

To keep a high level of performance, you should avoid structuring your class so that each message substitutes for a single function call from a procedural model of your class. Passing a message using the Class Manager takes approximately two to three times the amount of time as an equivalent function call.

From an object-oriented point of view, it is a good idea to send messages between objects, but you should structure your messages and objects so that they operate on large chunks of application data.

For example, you might want to create a raster object that controls a screen region, but a raster line should not be an object to which you send messages like **msgDraw**.

Creating Objects 3.3

A client creates an instance of your class by sending **msgNewDefaults** and **msgNew** to your class. However, in passing **msgNew**, the Class Manager handles the message and passes **msgInit** to your class instead. In short, when your class receives **msgInit**, it is being asked to initialize a new instance of itself (the Class Manager has already created the object).

Usually you handle **msgInit** by initializing your instance data (described below) creating objects that an instance of your class requires to do its work. For instance, a graphic editor class maintaining a list of shapes could create an instance of **clsList** when it handles **msgInit**.

Your class must have methods for both **msgNewDefaults** and **msgInit**.

Instance Data 3.4

A class consists of a group of methods; the code for these methods is stored in a shared area of memory. When an instance of a class receives a message, the corresponding method handles the message.

However, each instance has its own, separate instance data. This instance data is actually owned by the Class Manager and is available only to the instance. Each ancestor of an object's class provides part of the instance data for the object. When a class is created, it tells the Class Manager how much space needs to be added to the object for the class to keep its part of the instance data.

Memory Protection 3.4.1

The Class Manager maintains the instance data in memory that is protected from writes by unauthorized clients. Essentially only the Class Manager can write instance data (although you can request the Class Manager to write a specific piece of data for you). This restriction protects clients and subclasses from one another—no program can overwrite another program's instance data.

Allocating Instance Data 3.4.2

When the Class Manager creates a new instance of a class, it allocates a specific amount of memory for the instance data. You specify the size of the instance data when you install your class (by sending **msgNew** to **clsClass**).

Usually you create a structure called something like XXX_INSTANCE_DATA (where XXX is the class name), and use the **sizeof()** function to determine its size. The maximum size for all of the instance data for all of the subclasses of an object is slightly less than 64K.

Accessing Your Instance Data

3.4.3

When the Class Manager invokes a method (a function that you define to handle a message), it passes a pointer to your instance's instance data (**pData**). You can read the instance data and copy it to your local storage, but you cannot write the instance data directly.

To store instance data, you must call the **ObjectWrite()** function. The prototype for the **ObjectWrite()** function is:

```
STATUS EXPORTED0 ObjectWrite(
    OBJECT      self,
    CONTEXT     ctx,
    P_UNKNOWN   pData
);
```

In brief, **self** is the UID of the object whose instance data you wish to access, **ctx** maintains information about the ancestor hierarchy, and **pData** is a pointer to the local copy of the instance data.

Maintaining Dynamic Instance Data

3.4.4

Three PenPoint classes that allocate their own heap block are **clsList**, **clsString**, and **clsTttData**. **clsTttData** is defined in the Tic-Tac-Toe sample application in the \PENPOINT\SDK\SAMPLE\TTT.

If you need variable-sized instance data, you can use **OSHeapBlockAlloc()** to allocate data from your own process heap. You can store a pointer to the heap in your instance data, instead of storing the entire block. This also allows faster write access to your instance data, at the risk that another object in your process might overwrite your data.

On the other hand, the the window system cannot risk data corruption—it stores all of its data in write-protected memory.

Saving and Restoring Instance Data

3.4.5

clsObject defines messages that tell objects to save and restore their instance data. When an object receives **msgSave**, it must file its instance data; when an object receives **msgRestore**, it must restore its instance data.

When an object receives **msgSave**, it uses the pointer to its instance data (**pData**) when it writes its instance data.

Part Two: PenPoint Application Framework describes in detail how objects save and restore their instance data when they receive the **clsObject** messages **msgSave** and **msgRestore**.

Creating a Header File 3.5

The header file for your class should contain **#defines** for all your well-known UIDs, messages, tags, and status values.

You can use the header files (.H files) in \PENPOINT\SDK\INC as an example of how you should write and organize your header files.

For documentation purposes your header files can also list (but shouldn't define) messages that other classes define, but for which your class provides an alternate or enhanced message handler. The actual definitions for those messages will come from the header files that you include at the beginning of your header file.

Ancestor Calls 3.6

When an object receives a message, it has the option of sending the message to its ancestor. As described earlier, the task handling the message remains the same and the object is still the same. The only difference is that the method belongs to the ancestor.

The ancestor call is simply a function call to the method defined by the ancestor. You use the ancestor call functions, because the Class Manager knows your ancestor already. This makes it possible to execute code defined by another class without having to rely on knowledge of the other class's structure.

ObjectCallAncestor() 3.6.1

You use **ObjectCallAncestor**() in a method to send a message to the ancestor of your class. **ObjectCallAncestor**() uses **ctx** to determine the class of the object that called it, finds the ancestor's method for the message, and then calls the method with the **pArgs** value. The function prototype is:

```
STATUS GLOBAL ObjectCallAncestor(
    MESSAGE     msg,
    OBJECT      self,
    P_ARGS      pArgs,
    CONTEXT     ctx
);
```

The arguments to the function are identical to those of **ObjectCall**(), except for the addition of a CONTEXT value.

The Class Manager uses CONTEXT value **ctx** to locate the correct ancestor. Because **ObjectCallAncestor**() is called from a method, you will have received a **ctx** value in your method parameters.

ObjectCallAncestorCtx() 3.6.2

ObjectCallAncestorCtx() is a shorter version of **ObjectCallAncestor**(). It does exactly the same thing as **ObjectCallAncestor**(), but the Class Manager uses the same message and pArgs used to invoke the method. You have to specify only your **ctx**. The function prototype is:

```
STATUS GLOBAL ObjectCallAncestorCtx(
    CONTEXT     ctx
);
```

Example 3-1
Using ObjectCallAncestorCtx()

This example shows how the method for **msgInputEvent** in the Tic-Tac-Toe application uses **ObjectCallAncestorCtx()**. For key events, this method handles **msgInputEvent** itself; for other input events, it uses **ObjectCallAncestorCtx()** to send **msgInputEvent** (along with the **pArgs** for this message handler) to **clsTttView**'s ancestors.

```
/****************************************************************************
    TttViewInputEvent

     msgInputEvent.
****************************************************************************/
#define DbgTttViewInputEvent(x) \
    TttDbgHelper("TttViewInputEvent",tttViewDbgSet,0x1000000,x)
MsgHandlerWithTypes(TttViewInputEvent, P_INPUT_EVENT, PP_TTT_VIEW_INST)
{
    STATUS      s;
    switch (ClsNum(pArgs->>devCode)) {
        case ClsNum(clsKey):
            s = TttViewKeyInput(self, pArgs);
            break;
        default:
            s = ObjectCallAncestorCtx(ctx);
            break;
    }

    return s;
    MsgHandlerParametersNoWarning;
} /* TttViewInputEvent */
```

Creating the Methods 3.7

This section describes how to write a method. While you read through this section, refer to the example code for Tic-Tac-Toe in \PENPOINT\SDK\SAMPLE\TTT in the PenPoint Software Development Kit.

Declaring Entry Points for Methods 3.7.1

When the Class Manager sends a message to an instance, the Class Manager uses the method table to locate the entry point for the procedure that corresponds to the message. The procedure is called a **method** or **message handler** (the terms are synonyms). A single method can handle multiple messages; this allows one method to respond to all messages defined by a class and also avoids unnecessary replication of common code across the handling of several messages.

You must explicitly declare all methods. The Class Manager defines the symbol MSG_HANDLER to identify message handling procedures. MSG_HANDLER and all the macros described in this section are defined in CLSMGR.H. MSG_HANDLER expands to STATUS CDECL. Using the symbol MSG_HANDLER makes your code much easier to read and search.

Message Parameters 3.7.2

When the Class Manager sends a message to your method, it always passes along the same five parameters:

msg the message.

self the UID of the object to which the message was sent.

pArgs the 32-bit value that indicates the client's arguments.

ctx the context, required for calls by the method to **ObjectWrite()** and **ObjectCallAncestor()**.

pData a pointer to your object's instance data.

These parameters are described in the next five sections.

The msg Parameter 3.7.2.1

The **msg** parameter contains the value that identifies the message that you received. This is one of the three parameters specified by the client that sent the message to your object.

You use the **msg** parameter most frequently when you want to send the message to your ancestor from within your method.

You can also use this parameter to do specific processing for messages, especially if you have a wildcard method that needs to do special work for selected messages.

The self Parameter 3.7.2.2

The **self** parameter contains the UID of the object that was originally sent the message. This is the second of the three parameters specified by the client that sent the message to your object.

If an object needs to send a message to itself, the method uses **self** to identify the object executing the method. To forward the message to the object's ancestor class, use **ObjectCallAncestor()**; using **ObjectCall()** results in an infinite loop. Otherwise, use **ObjectCall()** or **ObjectSend()** to provide subclasses a chance to modify the message behavior or to simply notice that the message was sent.

The pArgs Parameter 3.7.2.3

The **pArgs** parameter contains the 32-bit argument value specified by the client. This is the third of the three parameters specified by the client that sent the message to your object.

The **pArgs** parameter is typically a pointer to data, but in some cases is the argument data (for example, when the only data required is a 32-bit value). When you design a method, you must decide what argument data it requires. You use the header file to document what data is required by each message.

The ctx Parameter 3.7.2.4

The **ctx** parameter contains a CONTEXT structure that maintains information about where the current class is in relation to the class hierarchy. The **ctx** parameter is created and maintained by the Class Manager. **ctx** is used primarily by **ObjectCallAncestor()**, **ObjectRead()** and **ObjectWrite()**.

The pData Parameter 3.7.2.5

The **pData** parameter contains a pointer to the instance data for the object.

As described already in the section on instance data, the Class Manager maintains the instance data for each instance separately in write-protected memory.

If you will need to update your instance data, you must copy the instance data to your local memory, update the instance data, then write the instance data back with **ObjectWrite()**.

Method Declaration Macros 3.7.3

Many times when you define a method, you use the same declarations for all or most of the parameters. To free you from declaring all these parameters, and to make your code more readable, the Class Manager defines a number of macros that declare the procedure and its parameters.

Additionally, there are macros to manipulate the instance data pointer **pData** in your methods.

Table 3-1 lists the method macros.

Table 3-1
Method Declaration Macros

Macro	Purpose
MsgHandler()	Declares all parameters.
MsgHandlerArgType()	Allows you to specify a different type for pArgs.
MsgHandlerWithTypes()	Allows you to specify different types for pArgs and pData.
MsgHandlerParametersNoWarning()	Suppresses warning messages about unused parameters.

Using the MsgHandler() Macro 3.7.3.1

You use the **MsgHandler()** macro when you do not need to explicitly define types for the **pArgs** or **pData** parameters when you use them. You might do this when your method simply issues a debug statement and returns (you might have specified **objCallAncestorBefore** or **objCallAncestorAfter** in your method table). The syntax for the **MsgHandler()** macro is:

```
MsgHandler(fn)
```

fn is the name of the message handler. For example:

```
MsgHandler(XferListMsgNewDefaults)                  // Abbrev. parameters
{
    STATUS      s;
    ((P_XFER_LIST_NEW)pArgs)->>object.cap |= objCapCall;
    return stsOK;
    //  Prevent compiler warnings for unused parameters
    MsgHandlerParametersNoWarning;
} /* XferListMsgNewDefaults */
```

Using MsgHandlerArgType() 3.7.3.2

You use the MsgHandlerArgType() macro when you want to explicitly cast the type of the **pArgs** parameter in the method declaration.

The syntax for **MsgHandlerArgType** is:

```
MsgHandlerArgType(fn, pArgsType)
```

fn is the name of the message handler and *pArgsType* is the type to which to cast **pArgs**. *pArgsType* must be a pointer type. In the following code example, the type for **pArgs** is P_XFER_LIST_NEW:

```
MsgHandlerArgType(XferListMsgNewDefaults, P_XFER_LIST_NEW)
{
    STATUS      s;
    pArgs->>object.cap |= objCapCall;
    return stsOK;
    //  Prevent compiler warnings for unused parameters
    MsgHandlerParametersNoWarning;
} /* XferListMsgNewDefaults */
```

Using MsgHandlerWithTypes() 3.7.3.3

You use the MsgHandlerWithTypes() macro when you want to explicitly cast the types of both the **pArgs** and **pData** parameters in the method declaration. The syntax for **MsgHandlerWithTypes()** is:

MsgHandlerWithTypes(*fn*, *pArgsType*, *pDataType*)

fn is the name of the message handler, *pArgsType* is the type for **pArgs**, and *pDataType* is the type for **pData**. Both *pArgsType* and *pDataType* must be pointer types. In this example, the type of **pArgs** is P_OBJ_SAVE and the type of **pData** is PP_TTT_APP_INST:

```
MsgHandlerWithTypes(TttAppSave, P_OBJ_SAVE, PP_TTT_APP_INST)
{
    TTT_APP_FILED_0 filed;
    STATUS          s;
    DbgTttAppSave((""))
...
```

Using MsgHandlerParametersNoWarning() 3.7.3.4

Some C compilers generate warnings when you declare identifiers but don't use them in the function where they are declared. The method macros described in this section declare all five parameters passed by the Class Manager. If you do not reference one of these parameters, the compiler may generate a warning message.

To suppress these messages, include the macro **MsgHandlerParametersNoWarning()** in your method. The macro simply adds references to all of a method's parameters that will satisfy the compiler without generating any unnecessary code.

```
msg, self, pArgs, ctx, pData;
```

By mentioning all the parameters, the macro effectively suppresses the warning messages.

Operations of a Method 3.7.4

The actual processing performed by each method is up to you. You can create objects, send messages to objects, process data, or whatever to accomplish the method's purpose.

Essentially the rest of this volume (the *PenPoint Architectural Reference*) is dedicated to describing the things that you can do from a method.

The *PenPoint Application Writing Guide* explains how to write methods. For examples of methods, see the example code in the \PENPOINT\SDK\SAMPLE directory.

Creating a Method Table 3.8

A method has three options when it receives a message:

- Pass it up the ancestor hierarchy to be processed.
- Perform the requested service.
- Reject the message with no action.

Each class contains a method table responsible for handling all messages sent to instances of that class. Method tables allow you to specify the procedure in your C code that handles each message and whether the Class Manager should send the message up the class hierarchy either before or after your procedure handles the message.

Method Table Overview 3.8.1

When you design a class, you must define the messages that the class will process and what methods will be used during the processing. These definitions are implemented in a **method table** that is compiled as a separate object file and attached at link time. When the class is installed (at cold boot, or by the Settings Notebook) the method table is installed as part of the class into the Class Manager database.

A **method table definition file** (with the extension .TBL) contains the tabular definition for your class's messages and methods. There is an entry in the table for each message that your class will handle. For each message you specify:

- The message token (defined in a header file)
- The method to be executed when an instance of your class receives this message
- A flag field that specifies options for memory or speed optimization, and whether the ancestor of the class should process the message before or after the class does, or not at all.

The table contains entries only for those messages that your class intercepts and processes. If the Class Manager attempts to send a message to an instance of your class and the message is not defined in your method table, the Class Manager automatically sends the message to your class's ancestors. If no class in the ancestry chain is able to handle the message, the message eventually gets to **clsObject**. If **clsObject** cannot handle the message, it returns **stsNotUnderstood** to the sender of the message.

Your method table is not limited to the messages defined by one of your classes. You can create method table entries for any message that an instance of your class might receive (no matter who defines the message). This is known as **overriding** a message.

If you override a message, you must be sure to include in your method table definition file the header file that contains the **#define** for the message. Otherwise, the reference to the message will fail.

You compile the method table with the PenPoint method table compiler (\PENPOINT\SDK\UTIL\CLSMGR\MT.EXE), then you link the resulting method table object file with the object file that defines the methods for the class.

There are five steps to setting up your method tables:

1. Create a method table definition file (a .TBL file).
2. Compile the table with MT.EXE.
3. Define the methods in your class's C code file with the MSG_HANDLER identifier.
4. Add the method table's identifier to your class's **msgNew** initialization method.
5. Compile your class's C code file and link it with the method table.

Figure 3-2 shows the build cycle and file dependencies for an application that includes method tables.

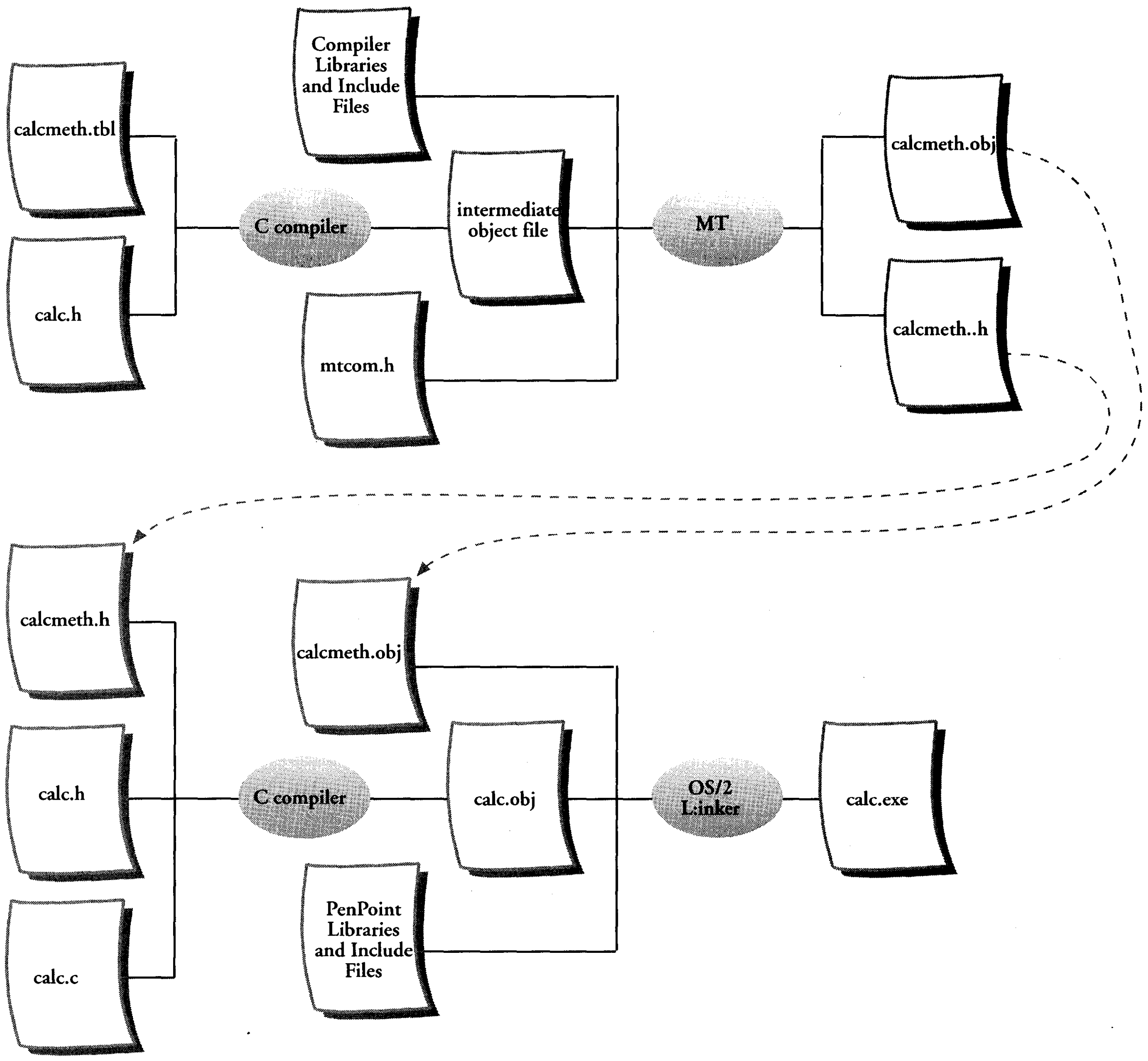
Creating a Method Table Definition File 3.8.2

A method table definition file contains the definitions of at least two arrays:

- A MSG_INFO array that maps message names to method names. Each class has exactly one associated MSG_INFO array.
- A CLASS_INFO array that contains one entry for each class. The CLASS_INFO array associates each MSG_INFO array with a symbol that you use to identify the method table when you install your class (part of the **msgNew** arguments to **clsClass**).

Figure 3-1 shows the relationship between the principle elements in a method table definition file and the source file in which you implement your class. In the figure you can see how the method table defines the message name and the entry point of the method called by the Class Manager. The figure also shows where the method is defined in the C file that implements your class and also shows the method that installs your class.

Figure 3-2
Method Table Files and Build Sequence



The MSG_INFO Array 3.8.2.1

The MSG_INFO array identifies the messages handled by a particular class and specifies for each message the method that handles the message. For each class that you implement in an executable file, you must define one MSG_INFO array. Thus, if you defined three classes in a single executable file, the method table definition file must have three MSG_INFO arrays.

You can see a number of examples of method tables in the sample application directories under \PENPOINT\SDK\SAMPLE. Here is an abbreviated example of the MSG_INFO array for **clsTttData** from TTTTBL.TBL:

```
MSG_INFO clsTttDataMethods[] = {
    msgNewDefaults,           "TttDataNewDefaults",   objCallAncestorBefore,
    msgInit,                  "TttDataInit",          objCallAncestorBefore,
    msgFree,                  "TttDataFree",          objCallAncestorAfter,
    msgTttDataGetMetrics,     "TttDataGetMetrics",        0,
    msgTttDataSetMetrics,     "TttDataSetMetrics",        0,
    msgTttDataSetSquare,      "TttDataSetSquare",     0,
    msgTttDataRead,           "TttDataRead",          0,
    msgUndoItem,                  "TttDataUndoItem",      0,
    0
};
```

The identifiers MSG_INFO and **objCallAncestorBefore** are defined in CLSMGR.H.

Each entry in the array has 3 fields:

- The message name.
- The name of the method for the message. The method name identifies the entry point for the method. The method name must be in quotes.
- One or more options flags.

Table 3-2 lists the option flags and their meanings. The options flags can be OR'd together. Some options may not make much sense when combined. For example, it it is impossible to optimize memory usage with the save space option and at the same time optimize performance with the save time option.

Table 3-2
MSG_INFO Option Flags

Option Flag	Meaning
objCallAncestorBefore	Call the object's ancestor before calling the method.
objCallAncestorAfter	Call the object's ancestor after calling the method.
objClassMessage	Handle the message when sent to the class.
objSaveSpace	Optimize this entry for space. This option is not implemented.
objSaveTime	Optimize this entry for time.

If you do not use any of these options, you must specify 0 as a placeholder in the array.

CLASS_INFO Array 3.8.2.2

The CLASS_INFO array specifies which MSG_INFO array belongs to which class. In a method table definition file there is only one CLASS_INFO array.

This example shows the CLASS_INFO array from TTTTBL.TBL:

```
CLASS_INFO classInfo[] = {
    "clsTttViewTable",  clsTttViewMethods,  0,
    "clsTttDataTable",  clsTttDataMethods,  0,
    "clsTttAppTable",   clsTttAppMethods,   0,
    0
};
```

Each entry in the CLASS_INFO array has 3 fields:

- a method table name that you will use when you install the class
- The name of a MSG_INFO struct defined in this method table definition file
- An options flag.

The options flag is reserved for future use; put a 0 in this field as a placeholder.

Method Table Wildcards 3.8.2.3

The MSG_INFO array can contain wildcard message names. Wildcards match any message within a given set of messages and call the associated method.

There are two types of wildcards:

- those that match all messages defined for a given class
- those that match all messages sent to instances of a given class (essentially you use this as a match-all-others in your MSG_INFO array)

A single MSG_INFO array can contain either type of wildcard, or both types. For example, a MSG_INFO array might contain both a wildcard that matched all messages for *one* of the classes that it handles and, at the end of the MSG_INFO array, a wildcard for all messages sent to instances of the class for which the MSG_INFO array is defined.

To create a wildcard that matches all messages for a class, you must use the **MakeMsg()** macro to create a message that uses your class (as usual) and has the special message number **objWildCard**. For example, to create a wildcard (**fooWildCard**) that matches all messages of **clsFoo**, you would use:

```
#define fooWildCard MakeMsg(clsFoo, objWildCard)
```

To use the class wildcard, insert the message in the MSG_INFO array:

```
#define fooWildCard MakeMsg(clsFoo, objWildCard).
MSG_INFO foo = {
    fooWildCard, "HandleAllFooMsgs", 0,
    0
}
```

To match messages sent to objects created by a class, add a line to the end of the MSG_INFO array that uses **objWildCard** as the message name and specifies a method as usual. For example:

```
MSG_INFO foo = {
    msgNew, "HandleMsgNew", 0,
    ...
    objWildCard, "HandleAllOtherMsgs", 0,
    0
}
```

Compiling a Method Table 3.8.3

To compile a method table you need

- The C compiler (including DOS4GW.EXE)
- The method table compiler, MT.EXE.

The method table compiler is delivered with the PenPoint SDK in the directory \PENPOINT\SDK\UTIL\MT.

Running MT 3.8.3.1

Usually you compile your method table simply by running the method table compiler, MT.EXE. Before you run the method table compiler, you must make sure that MT.EXE is in your local directory or your path includes the directory that contains MT.EXE.

The run command for the method table compiler has the following syntax:

```
MT infile
```

If the input file has a .C or .TBL extension, the method table compiler:

- Compiles your method table with the C compiler, which results in an intermediate object file
- Processes the resulting object file to produce the method table object file and corresponding header file.

Compiling Method Tables With Wildcards 3.8.3.2

When you compile method tables that use wildcards, the method table compiler uses the assembler.

You must specify a path that includes the assembler during the compile phase for method tables if you use wildcards. The simplest strategy is to put the assembler in the same directory as the compiler executable files.

MT Output Files 3.8.3.3

The method table compiler produces a header file and an object file. These files have the same name as the .TBL file, but with the extensions .H and .OBJ, respectively. If you already have a file with the same name and the extension .H, the method table compiler will overwrite it. For example, FOO.TBL will generate FOO.H and overwrite any previous version of FOO.H.

The header file contains the declarations for each of the methods. You must **#include** this file in the sources that define the methods for your class.

The object file contains the method table code used by the Class Manager when it routes a message to an instance of your class.

Compiling in Two Steps 3.8.3.4

Although the method table compiler will run the C compiler for you, if you run MT from MAKE, you may run out of memory. If this happens, you should compile your method table in two steps:

1. Use the C compiler to compile your method table.
2. Run MT on the resulting intermediate object file to create the method table object and header files. If MT does not detect a .C or .TBL extension, it does not run the C compiler.

Installing a Class in PenPoint 3.9

The way that you compile and link your class affects the way in which PenPoint finds the routine used to install your class. You can compile and link your classes one of two ways:

- If your class is part of an application and will not be used by any other clients, you can link your class with your application to create an application executable file.
- If your class might be used by a number of clients (including your application), you can link your class separately to create a DLL file.

Your class must contain some code that sends **msgNew** to **clsClass** to install your class. If the class is part of your application executable file, you install your class when you install your application (that is, in **main()** when process equals 0).

If the class is in a DLL file, you install the class from the **DLLMain()** routine. If your application requires a class in a DLL file, it can name the DLL file in the application installation .DLC file. For more information on DLL and .DLC files, see *PenPoint Application Writing Guide.*

The Class Initialization Routine 3.9.1

The purpose of the class initialization routine is to send **msgNew** to **clsClass**. **clsClass** is a special class that exists solely to install new classes.

Before you send **msgNew** to **clsClass**, you must create, initialize, and modify a CLASS_NEW structure that describes the new class. You initialize the CLASS_NEW structure by sending **msgNewDefaults** to **clsClass**.

The CLASS_NEW structure contains an OBJECT_NEW_ONLY structure (**object**) and a CLASS_NEW_ONLY structure (**cls**). The OBJECT_NEW_ONLY structure contains:

uid the well-known UID that you will use for this class.

key a key value for the class.

cap the capabilities for the class.

The CLASS_NEW_ONLY structure contains:

pMsg a pointer to the method table for your class. The method table name is the first field in the CLASS_INFO entry that you created in your method table definition file. If this is an abstract class (one that defines messages but has no methods), you can specify **pNull.**

ancestor the UID of the class that is the immediate ancestor of this class.

size The size of the instance data for instances of this class. The size of instance data must be less than 64K bytes. If the size is not 0, you should usually have methods for **msgSave** and **msgRestore** to handling filing of the instance data.

The instance data can be be a pointer to a heap where the data is stored. Pointers are useful when you do not know what the exact size of the data for a given instance will be.

newArgsSize The size of the _NEW structure used to create instances of this class. It is usually set by **SizeOf**(..._NEW).

When you send **msgNew** to **clsClass**, the message returns a status value. If the Class Manager creates the class successfully, **msgNew** returns **stsOK** and the **object.uid** field contains the UID of the new class.

Example 3-2
Creating a New Class

This example from \PENPOINT\SDK\SAMPLE\TTT\TTTDATA.C shows how the routine **ClsTttDataInit()** creates the class **clsTttData.** TTTPRIV.H **#defines** the token **clsTttData,** and TTTTBL.TBL establishes **clsTttDataTable** as the identifier for **clsTttData**'s method table.

```
/****************************************************************************
    ClsTttDataInit
    Install the class.
****************************************************************************/
STATUS PASCAL
ClsTttDataInit (void)
{
    CLASS_NEW       new;
    STATUS          s;
    ObjCallJmp(msgNewDefaults, clsClass, &new, s, Error);
    new.object.uid          = clsTttData;
    new.object.key          = 0;
    new.cls.pMsg            = clsTttDataTable;
    new.cls.ancestor        = clsObject;
    new.cls.size            = SizeOf(P_TTT_DATA_INST);
    new.cls.newArgsSize = SizeOf(TTT_DATA_NEW);
    ObjCallJmp(msgNew, clsClass, &new, s, Error);
    return stsOK;
Error:
    return s;
} /* ClsTttDataInit */
```

Chapter 4 / Manipulating Objects

When you have created an object you tell it to do things by passing messages to it. Most of these messages are defined by the class that created the object.

Additionally, the PenPoint™ Class Manager provides a number of messages that provide class manager support for those objects. These messages fall into four categories:

- Copying objects.
- Observing objects and object notification.
- Getting object status information.
- Destroying objects.

Copying Objects 4.1

Perhaps the most important object manipulation is the ability to copy objects. The PenPoint Class Manager provides a low-level facility to copy objects. When copying an object, all objects owned by the object are copied at the same time.

Copying objects can be done by either the client that owns the original object or the client that will receive the copied object. The original owner and the receiver do not have to be in the same process.

The object copy facility is used by many parts of the PenPoint operating system. For instance, the embedded window move/copy protocol uses object copy to copy objects from one window to another.

While there are two messages used in copying objects, **msgCopy** and **msgCopyRestore**, clients only need to send **msgCopy** to the object to be copied. When **clsObject** handles **msgCopy** it sends **msgCopyRestore** to the destination object. Clients should almost never have to send **msgCopyRestore**.

Using msgCopy 4.1.1

To copy an object, send **msgCopy** to the object. The object being copied must be able to file itself, that is, it must respond to **msgSave** and **msgRestore.**

msgCopy takes a pointer to an OBJ_COPY structure. The **requestor** field specifies the UID of the object that will receive the copied object. If **requestor** is in a different process from the client sending **msgCopy**, the **requestor** must have **objCapCall** set on.

When you send **msgCopy** to an object, **clsObject** creates a temporary resource file and sends **msgSave** to the object. After the object saves itself, **clsObject** sends **msgCopyRestore** to the object that you specified in **requestor**.

When an object receives **msgCopyRestore**, it passes the message to its ancestor. When **clsObject** receives **msgCopyRestore**, it creates the new object that is the copy and sends it **msgRestore**.

After the **requestor** restores the object, **msgCopy** closes and destroys the temporary file and passes back the UID of the new object in the **object** field of the OBJ_COPY structure.

Observing Objects 4.2

All objects can maintain a list of observers. An observer is an object that wants to be notified when the observed object changes state.

The class manager creates and maintains the list of observers for each object.

Table 4-1 lists the observer messages that are described in the sections following the table. All of these messages are defined in CLSMGR.H.

Table 4-1
Observer Messages

Message	pArgs	Description
msgAddObserver	OBJECT	Adds an observer to the end of the object's observer list.
msgAddObserverAt	P_OBJ_OBSERVER_POS	Adds an observer at the specified position in the observer list.
msgRemoveObserver	OBJECT	Removes an observer from the object's observer list.
msgNotifyObservers	P_OBJ_NOTIFY_OBSERVERS	Sends a message to the observers.
msgPostObservers	P_OBJ_NOTIFY_OBSERVERS	Posts a message to the observers.
msgEnumObservers	P_OBJ_ENUM_OBSERVERS	Passes back the observer list.
msgGetObserver	P_OBJ_OBSERVER_POS	Passes back the observer at the specified position in the observer list.
msgNumObservers	P_U16	Passes back the number of observers for this object.
		Observer Notification
msgAdded	OBJECT	Sent to the observer when it is added to an object's observer list.
msgRemoved	OBJECT	Sent to the observer when it is removed from an object's observer list.
msgChanged	OBJECT	Generic message that can be used to notify observers that a change has occurred.

Adding an Observer 4.2.1

If you want to observe an object, you send **msgAddObserver** to the object that you are interested in. The only argument for the message is the UID of the object that will receive notifications; usually this is **self** (your object). To add an observer to a specific location in an observer list, use **msgAddObserverAt** (described below).

For example, to receive notification messages when the list of volumes in the file system changes, send **msgAddObserver** to **theFileSystem**.

```
ObjCallRet(msgAddObserver, theFileSystem, self, s);
```

When the message completes successfully, it returns **stsOK**. The class manager adds the observer to the end of the object's observer list and sends **msgAdded** to the object that sent **msgAddObserver**.

If the object's capability **objCapObservable** is false, the object cannot be observed; the class manager returns **stsProtectionViolation**.

Adding an Observer with Position 4.2.2

Normally the class manager adds an observer to the end of an object's observer list. If you want your object to be the first one that receives notification, you can add yourself to the beginning of the observer list.

To add an observer to a specific position within the object's observer list, send **msgAddObserverAt** to the object. The message takes an OBJ_OBSERVER_POS structure that contains:

observer the UID of the object that will receive notifications. Usually this is self.

position an integer that specifies the absolute position within the observer list for the object. The value 0 adds the observer to the beginning of the list. The value **maxU16** adds the observer to the end of the list.

When the message completes successfully, it returns **stsOK**. When the class manager adds the observer to the object's observer list, it sends **msgAdded** to the object that sent **msgAddObserver** or **msgAddObserverAt**.

Removing an Observer 4.2.3

If you no longer wish to observe an object, you can send **msgRemoveObserver** to that object. Like **msgAddObserver**, the only argument to the message is the UID of the object that was to receive notifications.

```
ObjCallRet(msgRemoveObserver, theFileSystem, self, s);
```

When the message completes successfully, it returns **stsOK**. When the class manager removes the observer from the object's observer list, it sends **msgRemoved** to the object that sent **msgRemoveObserver**.

Getting Observers from a List 4.2.4

The class manager defines three messages that you can use to get information about an object's observer list. You can send these messages to another object to get information about that object's observer list, or you can send these messages to self to get information about your own observer list.

Getting the Observer List 4.2.4.1

To get the entire observer list for an object, send **msgEnumObservers** to that object. The message takes a pointer to an OBJ_ENUM_OBSERVERS structure that contains:

max a U16 value that specifies the size of your **pObservers** array.

count a U16 value that specifies the number of observers that you expect to receive. If this number is greater than **max**, the class manager will allocate more memory for the observer list. You can tell the class manager to give you all of the observers in its list (if necessary) by specifying **maxU16** for **count**.

pObservers a pointer to the array of OBJECTs that will receive the list of observers.

next a U16 value that specifies the position of the first observer to get. If this value is 0, start at the beginning of the list.

When the message completes successfully, it returns **stsOK** and the OBJ_ENUM_OBSERVERS structure contains:

count the number of valid entries in **pObservers**.

pObservers a pointer to the array of observers. If the class manager had to allocate memory for the list, this pointer may not be the same value that was passed in. If the pointer value is changed, you must free the new **pObservers** array when you are done with it.

next if count was less than **max**, the position of the next entry in the observer list. You can use this value in a subsequent **msgEnumObservers** to continue enumerating where you left off. To get all observers, continue the enumeration until **msgEnumObservers** returns **stsEndOfData**.

Getting an Observer by Position 4.2.4.2

To get the UID of a specific observer for an object, send **msgGetObserver** to that object. The message takes a pointer to an OBJ_OBSERVER_POS structure that contains a U16 value that specifies the position in the observer list (**position**).

If the message returns successfully, it returns **stsOK** and passes back the OBJ_OBSERVER_POS structure in which the **observer** field contains the UID of the object at **position**.

Getting the Number of Observers 4.2.4.3

To get the number of observers for an object, send **msgNumObservers** to that object. The only argument for the message is a pointer to a U16 value.

When the message completes successfully, it returns **stsOK** and copies the number of objects in the observer list to the U16 value specified in the message arguments.

Notifying Observers 4.3

When an object needs to send a notification message to its observers it uses **ObjectCall()** to send itself **msgNotifyObservers**. The message takes a pointer to an OBJ_NOTIFY_OBSERVERS structure that contains:

msg the message to send to observers.

pArgs the arguments for the message.

lenSend the length of the arguments, in bytes.

The class manager handles **msgNotifyObservers**. It extracts the message and pArgs from the OBJ_NOTIFY_OBSERVERS structure and sends the message to all objects in the observer list.

If you don't want to define your own message to send to observers, you can use the generic message, **msgChanged**. The only argument for the message is an OBJECT value, which you usually use to pass the UID of the object that sent the notification.

Posting to Observers 4.3.1

If you want to defer delivery of your notification message so that the receiver handles it when its input queue is empty, you can use **msgPostObservers** rather than **msgNotifyObservers**.

The message taks a pointer to an OBJ_NOTIFY_OBSERVERS structure, just like **msgNotifyObservers**.

The status code returned from **msgNotifyObservers** merely indicates that the message was posted successfully, it does not indicate the completion status of the message.

Example of Observer Notification 4.3.2

The following sample from TTTDATA.C shows a utility routine used by the Tic-Tac-Toe application when it needs to notify observers.

Example 4-1
Notifying Observers

```
/****************************************************************************
    TttDataNotifyObservers

    Sends notifications.
****************************************************************************/
#define DbgTttDataNotifyObservers(x) \
    TttDbgHelper("TttDataNotifyObservers",tttDataDbgSet,0x1,x)
STATIC STATUS PASCAL
TttDataNotifyObservers(
    OBJECT                  self,
    P_ARGS                  pArgs)
{
    OBJ_NOTIFY_OBSERVERS    nobs;
    STATUS                  s;
    DbgTttDataNotifyObservers((""))
    nobs.msg = msgTttDataChanged;
    nobs.pArgs = pArgs;
    nobs.lenSend = SizeOf(TTT_DATA_CHANGED);
    ObjCallJmp(msgNotifyObservers, self, &nobs, s, Error);
    DbgTttDataNotifyObservers(("return stsOK"))
    return stsOK;
Error:
    DbgTttDataNotifyObservers(("Error; return 0x%lx",s))
    return s;
} /* TttDataNotifyObservers */
```

Getting Object and Class Information 4.4

These messages allow you to:

- Get information about objects and classes
- Confirm an object's inheritance
- Check the validity of an object or class.

These messages are useful in critical-path areas where a failed message transmission will crash the application. Table 4-2 lists the object and class information messages.

The table is divided into two sections: the first section contains messages that you pass directly to the object or class in question; these messages are only useful for information about objects and classes within your task. The second section contains messages that you pass to **clsObject**; the **pArgs** for these messages specify the object or class you are interested in. You use these messages to find information out about any object or class in the system.

Table 4-2
Object and Class Information Messages

Message	pArgs	Description
		Direct
msgIsA	CLASS	Tests if the object's class inherits from the class.
msgAncestorIsA	CLASS	Tests if self inherits from the class.
msgClass	P_CLASS	Passes back the class of the object.
msgOwner	P_OS_TASK_ID	Passes back the task that owns this object.
msgAncestor	P_CLASS	Passes back the ancestor of the class.
msgVersion	pNull	Returns the version of the object.
		Indirect
msgObjectIsA	P_OBJ_IS_A	Using the object and the class in the pArgs. Tests if the object's class inherits from the class.
msgObjectAncestorIsA	P_OBJ_ANCESTOR_IS_A	Tests if the descendant class inherits from the ancestor.
msgObjectClass	P_OBJ_CLASS	Passes back the class for the object in pArgs.
msgObjectOwner	P_OBJ_OWNER	Passes back the owning task for the object in pArgs.
msgObjectValid	OBJECT	Tests that the object in pArgs exists.
msgObjectVersion	OBJECT	Returns the version of the object in pArgs.

Confirming an Object's Class 4.4.1

To test that an object is an instance of a particular class, send **msgIsA** to the object or send **msgObjectIsA** to **clsObject**. The only argument to **msgIsA** is a class UID. **msgObjectIsA** takes a pointer to a OBJ_IS_A structure that contains:

object	the UID of the object that you want to check.
objClass	the UID of the class to which you think **object** belongs.

If the object is an instance of the specified class, either message returns **stsOK**.

Confirming an Object's Ancestor 4.4.2

To test that a class inherits from a particular class, send **msgAncestorIsA** to the class or send **msgObjectAncestorIsA** to **clsObject**. The only argument to **msgAncestorIsA** is a class UID. **msgObjectAncestorIsA** takes a pointer to an OBJ_ANCESTOR_IS_A structure that contains:

descendant the UID of the class that you want to check.

ancestor the UID of the class that you think is the ancestor of **class**.

If the class inherits from the specified class, either message returns **stsOK**.

Getting an Object's Class 4.4.3

To get the class that created an object, send **msgClass** to the object or send **msgObjectClass** to **clsObject**. The only argument to **msgClass** is a pointer to a CLASS value. **msgObjectClass** takes a pointer to an OBJ_CLASS structure that contains the UID of the object that you want to check (**object**).

If either message completes successfully, it returns **stsOK**. **msgClass** copies the UID of the class to the CLASS value indicated by **pArgs**; **msgObjectClass** passes back the UID of the class in the **objClass** field of the OBJ_CLASS structure.

Getting the Owner of an Object 4.4.4

To get the owner of an object, send **msgOwner** to an object or send **msgObjectOwner** to **clsObject**. The only argument to **msgOwner** is a pointer to an OS_TASK_ID value. **msgObjectOwner** takes a pointer to an OBJ_OWNER structure that contains the UID of the object about which you need information (**object**).

If either message completes successfully, it returns **stsOK** and copies the owner identification to the OS_TASK_ID value indicated by **pArgs**.

Getting a Class's Class 4.4.5

To get the immediate ancestor of a particular class, send **msgAncestor** to the class. The only argument to the message is a pointer to a CLASS value.

If the message completes successfully, it returns **stsOK** and copies the UID of the class to the CLASS value indicated by **pArgs**.

You can only send this message to a class.

Checking an Object for Validity 4.4.6

To check whether an object is valid (that is, whether it still is known to the class manager), send **msgObjectValid** to **clsClass**. The only argument for the message is the UID of the object that you are checking. There is no local form of this message.

If the object exists, the message returns **stsOK**. If the object does not exist, the message returns **stsBadObject**. If the object has an invalid ancestor, the message returns **stsBadAncestor**.

Checking an Object's Version Number 4.4.7

The UID for a well-known object contains a version number. You can check this version number before you send a message to a class, that way you can be sure that you are using the correct version of the class.

To get an object's version number, send **msgVersion** or **msgObjectVersion** to **clsObject**. The only argument for either message is the UID of the object for which you want the version number.

If the object exists and has a version number, the message returns the version number (instead of **stsOK**).

Version numbers are only meaningful for well-known objects; if you send this message to a dynamic object, it returns **stsScopeViolation**.

If the argument value did not specify an existing object, the message returns **stsBadObject**.

Getting Notification of Object Creation 4.4.8

If you set the capability **objCapCreateNotify** to **true** before passing **msgNew**, the class manager will send **msgCreated** to the object when it is fully initialized. The message passes a _NEW structure for the object being created.

Properties 4.5

Properties allow objects to use additional storage space administered by the class manager. Properties are useful if your objects need transient additional storage. By using properties, you don't have to waste four bytes of instance data for a pointer that is only occasionally used; you just create the property when you need it. Properties also allow other clients to attach information to an object.

Each object maintains its own property list. Since all clients of an object share the object's property list, you need a unique name for each property you add to an object. You generate unique property names with the **MakeTag()** macro, using an administered value that belongs to you and your own choice of tag ID.

Creating a Property 4.5.1

To create a property for an object, you send **msgSetProp** to that object. The message takes a pointer to an OBJ_PROP structure that contains:

key	a key value.
propId	a tag to identify the property.
pData	a pointer to the data to be copied to the property.
length	the number of bytes to be copied to the property.

To clear a property, you send **msgSetProp** to the object with **pData** set to NULL, and **length** set to 0.

Retrieving Properties 4.5.2

To get a copy of the data in a property, send **msgProp** to **self**. The message takes a pointer to an OBJ_PROP structure that contains:

propId	the tag for the property.
pData	a pointer to a local buffer that will receive the property data.
length	the size of the buffer indicated by **pData**..

If the property does not exist, the **length** value passed back is 0.

Object Destruction 4.6

Because an object may be depend on objects that depend on it, the Class Manager defines a protocol that involves several steps to destroy an object. This provides plenty of opportunity for objects to veto their destruction or to notify all related objects that they are going away.

There are two aspects to destroying an object:

- The client that wants to destroy the object sends **msgDestroy** to the object.
- The class manager then sends a series of freeing messages to the object to be destroyed.

Destroying an Object 4.6.1

To destroy an object, you send it **msgDestroy**. The message takes an OBJ_KEY value that specifies the key used to create the object.

Do not send **msgFree** to an object; only the Class Manager should send **msgFree**.

The class manager handles **msgDestroy** and sends a series of freeing messages to the object being destroyed. If the object eventually destroys itself, **msgDestroy** returns **stsOK**.

It is often necessary to use **ObjectPost()** instead of **ObjectCall()** with **msgDestroy**. For example, if an instance of **clsButton** sends your object **msgButtonNotify**, and your method uses **ObjectCall()** to send **msgDestroy** to that button, the button will fault after your method returns to it because its instance data will have been freed. In general, you cannot use **ObjectCall()** to send **msgDestroy** to any object (or any window subtree containing an object) that is notifying you of some interesting event.

Handling Object Free Protocol 4.6.2

When you send **msgDestroy** to an object, the class manager sends these messages to the object being destroyed:

1 **msgFreeOK**, which gives the object the opportunity to veto its destruction.

2. **msgFreeing**, which tells the object that it is time to clean up and remove itself from observer lists.
3. **msgFree**, which tells the object to destroy its data structures.

After the object handles **msgFreeing**, the class manager also sends **msgFreePending** to all observers of the object.

In each of these steps, the object should pass the message to its ancestor with **ObjectCallAncestor()**. This gives all the ancestor classes the chance to veto, to clean up, and destroy data structures.

The object being destroyed should not handle **msgDestroy** directly.

The following sections describe the freeing messages in more detail.

Handling msgFreeOK 4.6.2.1

When you receive **msgFreeOK**, the message passes the OBJ_KEY value used by the client that sent **msgDestroy**. You should verify that it is OK to destroy the object. If it is not OK, return **stsVetoed**.

If it is OK to destroy the object, pass **msgFreeOK** to your ancestor; often sending the message to your ancestor is all you have to do. When the message reaches **clsObject**, it checks the capability **objCapFree**. If no key is necessary, it returns **stsOK**. If the capability is false and the object's key matches the **pArgs**, **clsObject** returns **stsOK**. Otherwise **clsObject** returns **stsProtectionViolation**.

If your ancestor returns **stsOK**, return **stsOK**. If your ancestor returns an error status value, return the error value.

You must not assume that just because you returned **stsOK** to **msgFreeOK** that the object will, in fact, be destroyed—some other sub-class could veto the destruction of the object.

If **msgFreeOK** returns to the class manager with **stsOK**, the class manager continues with the protocol. Otherwise, the class manager returns from **msgDestroy** to its caller with the status value that you returned.

Handling msgFreeing 4.6.2.2

When you receive **msgFreeing**, it means that all ancestor classes agreed that the object can be destroyed. Most classes ignore **msgFreeing**.

Your handler for **msgFreeing** should clean up its data in preparation for destruction of the object (such as removing itself from notification lists). When you have finished your work, pass **msgFreeing** to your ancestor.

When your ancestor returns, return its status value to your caller.

Handling msgFreePending 4.6.2.3

Before the class manager sends **msgFree** to the object, it sends **msgFreePending** to the object's observers. In effect, **msgFreePending** is the class manager's notification to observers that the object is about to go away.

When an observer receives **msgFreePending**, the observed object is still valid and will respond to messages. An observer might take this opportunity to query the state of the object one last time.

Most classes that observe objects will respond to **msgFreePending**, if only to note that they had better not rely on the existence of the observed object.

As with all observer notifications in PenPoint, the class manager ignores the status returned from **msgFreePending**.

Handling msgFree 4.6.2.4

msgFree is the last step in the destruction of an object. Most classes should handle **msgFree**. When you receive **msgFree**, you must destroy objects and destroy and deallocate data structures.

The last thing that you do with **msgFree** is pass it to your ancestor. You usually call ancestor before you do anything else, but when you pass **msgFree** to your ancestor, you won't see another message again.

When **msgFree** reaches **clsObject**, **clsObject** finishes the destruction by invalidating the object and releasing resources allocated to that object.

Handling Failures During msgInit and msgRestore 4.6.3

msgInit and **msgRestore** are **clsObject** messages used to intialize instances of objects and to restore instances after they have been saved.

An object must be in prepared to handle **msgDestroy** after **msgInit** or **msgRestore** returns. If the Class Manager receives anything other than **stsOK** from **msgInit** or **msgRestore**, it will turn around and send **msgDestroy** to the object.

When you leave your handler for **msgInit** or **msgRestore**, the object must be prepared so that **msgDestroy** can destroy the object. This must be true even if the allocations of this class or one of the ancestor classes failed.

To give **msgDestroy** something to destroy, the handler for **msgInit** and **msgRestore** should do something like the following, in order. Obviously there are several different coding styles that achieve the same effect.

```
MyHandler(...)
{
    StsJmp(ObjectCallAncestor(msgInit or msgRestore, ...), s, ErrorExit);
    StsJmp(AllocateMyInstanceData(...), s, ErrorExit);
    ObjectWrite(my instance data);
    return stsOK;
ErrorExit:
    ObjectWrite(some default instance data, perhaps NULL)
    return s;
}
```

Scavenging 4.7

When a task is terminated, the Class Manager destroys all objects owned by that task on a class-by-class basis. This process of destroying objects is called scavenging. Clients cannot scavenge; only the Class Manager can start scavenging.

Mutating Objects 4.8

Occasionally you might need to override the behavior of an existing object by changing the object's ancestor. This is a risky thing to do and should be avoided if possible; it is not intended for general use. However, there are times when overriding behavior is unavoidable. At these times, you can send **msgMutate** to the object.

The message takes a pointer to an OBJ_MUTATE structure, which contains:

newClass	the CLASS of the new ancestor for the object.
key	a key, if **objCapMutate** is **false**.

The size of the instance data for the original ancestor and the new ancestor must be equal. If the size of the new and old instance data is not equal, the message fails with **stsSizeLimit**.

If the message completes successfully, it returns **stsOK**. If the **newAncestor** class is not valid, the message returns **stsBadAncestor**.

Part 2 / PenPoint Application Framework

Chapter 5 / Introduction

Part 2: Application Framework describes the PenPoint Application Framework and its associated classes.

The PenPoint Application Framework encompasses a number of topics, including the file system, file organization, running processes, and screen displays.

Because this part covers some complicated topics, there is bound to be some confusion about the terms used here.

An application is the executable file that you (the software designer) create to run on the PenPoint™ operating system. The application specifies how its documents will respond to user actions and other messages.

The PenPoint Application Framework is a collection of classes that the PenPoint operating system uses to run applications.

An application class is a PenPoint class that contains the code and initialization data used to create documents. When the user installs your application (your executable code), the PenPoint Application Framework creates the application class for your application.

A Notebook is an application written by GO that provides the user interface for the application framework and, along with the Section application, maintains the document hierarchy. The Notebook sends PenPoint Application Framework messages to documents to create, open, close, and destroy documents.

A document is a set of objects and data created by an application class that is able to interact with the user and the PenPoint Application Framework. When closed, a document consists of a series of files and directories in the file system; when active, a document consists of a system process, an number of objects (including an instance of the application class), in addition to the files and directories in the file system.

An instance of an application class, or an application object is an instance of an application class that provides a document with an interface to the PenPoint Application Framework.

An embedded document is a document that is contained within another document. Embedded documents are not shown in the Notebook Table of Contents.

An open document is a document that is currently displayed on the screen.

Overview 5.1

The PenPoint operating system and its Notebook metaphor differ greatly from other operating systems. In other operating systems, the user issues a command or clicks on an icon to run a particular program. The user must also specify which data file to open. When finished with a task, the user must save the data to some location before quitting, or risk loss of information.

In PenPoint, the user turns to the page that contains the desired document. PenPoint knows where the document's data is stored and which application to run. When the user turns to another page, PenPoint knows exactly where to store the modified data.

In short, each page in the Notebook contains a document; an open document is a running application.

To support this level of user friendliness, applications must interact much more with the operating system than with traditional operating systems. The PenPoint Application Framework provides the tools for this interaction.

The Notebook is actually a specialized application that is started when you boot the PenPoint computer. The Notebook uses the PenPoint Application Framework, just as any other application.

Much of the PenPoint Application Framework consists of messages defined by several classes. When your application receives some of these messages, it must perform specific processing actions; when it receives other messages, your application must pass the messages to its ancestor.

Application Framework Classes 5.2

The PenPoint Application Framework consists of seven basic classes:

- Application manager class
- Application class
- Embedded window class
- Mark class
- View class
- Resource file class
- Application directory class

In addition to these classes, the PenPoint Application Framework makes extensive use of the class manager's utility classes, described in *Part 9: Utility Classes.*

Application Class (clsApp) 5.2.1

- Manages program startup, shutdown, checkpointing, and backup.
- Manages the application hierarchy.
- Controls application embedding.
- Is a descendant of clsObject.
- Creates views and objects.
- Informs its views and objects when and where to file.

Application Manager (clsAppMgr) 5.2.2

- Instances of clsAppMgr maintain information about each application class.
- Each application class creates an application manager instance that knows about that application.
- Is a descendant of clsClass.

Application Monitor (clsAppMonitor) 5.2.3

- Drives application installation and deinstallation
- Reactivates applications on warm boot.

Embedded Window (clsEmbeddedWin) 5.2.4

- Controls view embedding.
- Provides move and copy behavior for components.
- Is a descendant of clsWin.

Marks (clsMark) 5.2.5

- Provides a mechanism to refer to a data item within a component.
- Provides a mechanism for traversing embedded documents.

View (clsView) 5.2.6

- Manages the user interface.
- Displays data for an object.
- Controls view embedding.
- Is a descendant of clsEmbeddedWin.
- Observes its objects.

Observed Object (Any Class Manager Class) 5.2.7

- Manages a list of observers.
- Communicates state changes and other events to its observers.
- Any object can be observed.
- Is the mechanism used by viewed objects to notify their views of changes.

Resource File Handle (clsResFile) 5.2.8

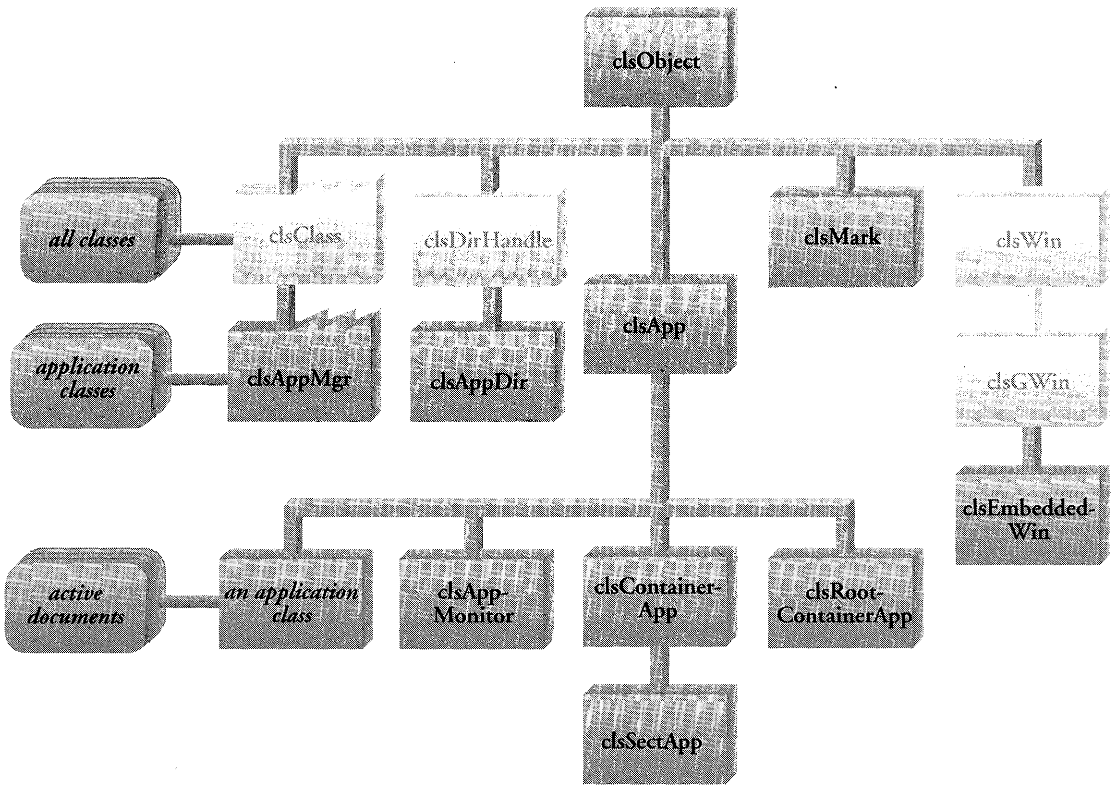
- Manages the structured reading and writing of objects to a file.
- Can re-create objects and their classes when their data is read in.
- Is a descendant of clsFileHandle.
- Used by many application classes to store or re-create their objects to and from the file system.
- Used by viewed objects during file writing to file their multiple views.

Application Directory Handle (clsAppDirHandle) 5.2.9

- Represents a document in the document hierarchy.
- Manages application directories.
- Provides a working directory in which applications can checkpoint their data.
- Is a descendant of clsDirHandle.
- Used by applications to communicate with child (embedded) documents.

The PenPoint Application Framework classes are related in the class hierarchy shown in Figure 5-1.

Figure 5-1
PenPoint Application Framework Classes Hierarchy



Application Writer's Overview

5.3

The most elementary PenPoint application doesn't do anything. It lets the PenPoint Application Framework do all the work by allowing **clsApp** to handle all PenPoint Application Framework messages. You can see this in the two sample programs, Empty Application and Template Application, described in the *PenPoint Application Writing Guide*. The sources for these applications are in \PENPOINT\SDK\SAMPLE.

As your program increases in sophistication, your application has to handle more and more PenPoint Application Framework messages. This quick-start section lists the PenPoint Application Framework messages that most applications have to handle and describes briefly how to handle them. The messages are:

main() is actually a function.

main()
msgInit
msgAppInit
msgAppOpen
msgAppClose
msgFree
msgSave
msgRestore

main() 5.3.1

The function **main**() is the entry point to your application. An application executable file must have a **main**() function.

main() has two primary purposes:

- Installing your application class.
- Starting the dispatch loop for each document that uses your application.

The **processCount** parameter to **main**() indicates how many other processes are currently running this application program. When **processCount** is 0, the application is being installed, so you call a routine to install your application class and then call **AppMonitorMain**(), a PenPoint function that starts the application monitor for your application class.

When **processCount** is greater than 0, the user is opening a document that uses your application, so you call **AppMain**(), a PenPoint function that creates an instance of your application class, passes it messages to initialize its data, and enters a dispatch loop to receive messages.

msgInit 5.3.2

Your application's method table should call ancestor before handling **msgInit.** In response to **msgInit, clsApp** allocates storage for your application's instance data in protected memory.

When your application receives **msgInit**, it should initialize its instance data and use the function **ObjectWrite** to save the initialized instance data to protected memory.

msgAppInit 5.3.3

Your application's method table should call the application's ancestor before handling **msgAppInit**. In response to **msgAppInit, clsApp** creates an object resource file and main window for the application.

When your application receives **msgAppInit**, it creates objects that it will use to store permanent data for the document (as opposed to window and control objects that it displays on screen).

msgAppOpen 5.3.4

Your application's method table should call the application's ancestor *after* handling **msgAppOpen**.

When your application receives **msgAppOpen**, it creates windows to display data and any other control objects and returns.

In response to **msgAppOpen, clsApp** then inserts the document's frame into the main window, which displays the document on screen.

msgAppClose 5.3.5

Your application's method table should call the application's ancestor before handling **msgAppClose**. In response to **msgAppClose**, **clsApp** extracts the frame from the main window.

When your application receives **msgAppClose**, it destroys its windows and control objects.

msgSave 5.3.6

Your application's method table should call the application's ancestor before handling **msgSave**. In response to **msgSave**, your application's ancestors save data and objects that they created. **clsApp** saves your main window, any data objects observed by views, and, optionally, its client window.

When your application receives **msgSave**, it should:

- Write data that isn't maintained in objects to the resource file.
- Save any permanent objects.

msgRestore 5.3.7

Your application's method table should call the application's ancestor before handling **msgRestore**. In response to **msgRestore**, your application's ancestors restore data and objects that they saved earlier. **clsApp** restores your main window and its client window.

When your application receives **msgRestore**, it should restore any data that it saved in **msgSave**.

msgFree 5.3.8

Your application's method table should call the application's ancestor *after* handling **msgFree**.

When your application receives **msgFree**, it should destroy any permanent objects that it created and frees any allocated memory. (The application receives **msgSave** before it receives **msgFree**.)

In response to **msgFree**, your application's ancestors destroy objects and free memory that they allocated.

Organization of Part 2 5.4

Part 2 is divided into two sub-parts. Chapters 5 through 11 present the PenPoint Application Framework concepts. Chapters 12 through 20 describe each of the classes used by the PenPoint Application Framework and their significant messages.

Chapter 5, Introduction, provides an introduction to the PenPoint Application Framework and describes the organization of Part 2.

Chapter 6, Application Environment Concepts, describes the PenPoint environment that supports applications and explains why the PenPoint Application Framework is necessary.

Chapter 7, Application Concepts, describes the applications and their parts. This chapter also provides a brief description of the classes that make up the PenPoint Application Framework.

Chapter 8, Life Cycles, describes the life cycles of application classes and documents. The life cycles are presented from both the user perspective and the application perspective.

Chapter 9, Embedded Documents, describes the concepts related to embedded windows and embedded applications.

Chapter 10, Mark Concepts, describes the concepts used when examining applications with embedded documents.

Chapter 11, Printing, describes what you have to do to print.

The remaining chapters discuss the individual classes used by the PenPoint Application Framework.

Chapter 12, The Application Manager Class, describes the messages defined by **clsAppMgr**.

Chapter 13, The Application Monitor Class, describes the messages defined by **clsAppMonitor**.

Chapter 14, The Application Class, describes the messages defined by **clsApp**.

Chapter 15, The View Class, describes the messages defined by **clsView**.

Chapter 16, The Application Directory Handle Class, describes the messages defined by **clsAppDir**.

Chapter 17, Container Application Classes, describes the two classes that implement containers (sections) and root containers (the Notebook).

Chapter 18, Embedded Windows Class, describes the messages defined by **clsEmbeddedWin**.

Chapter 19, Application Windows Class, describes the messages defined by **clsAppWin**.

Chapter 20, The Mark Class, describes the messages defined by **clsMark**.

Other Sources of Information 5.5

Part 2 should be read in conjunction with the *PenPoint Application Writing Guide*. While Part 2 describes what the PenPoint Application Framework does for you, the *PenPoint Application Writing Guide* describes how you *use* the PenPoint Application Framework when you write an application.

Chapter 6 / Application Environment Concepts

The PenPoint Application Framework provides the environment in which all PenPoint applications run. It is not a user interface shell or window system that applications choose to use. If you want your application to fit into the Notebook metaphor and interact correctly with other applications, it must use the PenPoint Application Framework. Programs that run under the PenPoint™ operating system must use the PenPoint Application Framework; there is no other way to start a program in PenPoint.

Your PenPoint application will not run unless it uses the PenPoint Application Framework.

The PenPoint operating system uses the PenPoint Application Framework extensively to implement its Notebook user interface. The *PenPoint Application Writing Guide* explains how your applications fit into an application hierarchy, which includes the pages and section tabs of a Notebook. The *PenPoint Application Writing Guide* also provides a good introduction to the ideas behind the PenPoint Application Framework.

The PenPoint Application Framework provides a foundation on which you build PenPoint applications. It is implemented as a collection of PenPoint classes that you must use in order to write an application.

The following sections discuss aspects of applications and how they relate to the PenPoint Application Framework:

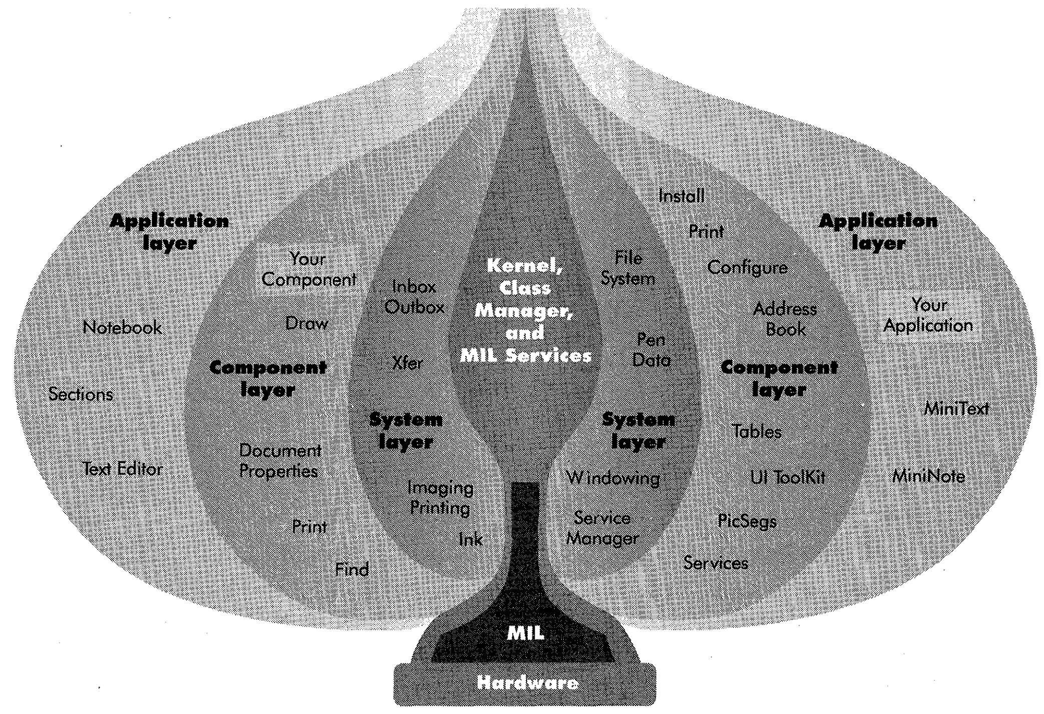
- Relationships between applications and components.
- Embedded applications.
- Saving and restoring application data.
- Saved documents and application directories.
- Missing application classes.

Applications and Components

6.1

Figure 6-1 shows the hierarchy of PenPoint software.

Figure 6-1
PenPoint Software Hierarchy



An **application** is a PenPoint class that defines how its active documents will interact with the user or other devices to perform some useful work. To fit in the PenPoint Notebook environment, an application must also define how its active documents perform housekeeping operations, such as startup, shutdown, filing, and message dispatching provided by the PenPoint Application Framework.

Components are classes that perform more specialized tasks: the file system, windows, buttons, graphics, tables, text, lists, and many other classes. Your application is responsible for orchestrating component behavior, including creation, visual positioning, filing, and destruction. A well-designed PenPoint application will take advantage of components wherever possible.

Components save you from having to write your own routines to perform these tasks. However, if a component doesn't provide the functionality that you need, you can either subclass an existing component class or create an entirely new component class. You can document and publish your new component class so that other application writers can take advantage of it.

In contrast with applications and components, **services** are PenPoint programs that do not have a user interface, but do useful work in response to requests from applications and components. Typical examples of services are MIL devices (device drivers), database engines, or E-Mail backends. If you are contemplating a

PenPoint program that performs this type of task, you should read *Part 13: Writing PenPoint Services* of the *PenPoint Architectural Reference.*

Embedding Documents 6.2

Just as someone might fill a page of a paper notebook with text, a diagram, and some notes and figures, PenPoint users should be able to intermix different applications. The Notebook user interface makes this easy: the user just creates a new document inside an existing document, or moves or copies one document into another.

To support this style of interaction, the PenPoint Application Framework provides facilities for applications and components to **embed** inside of other applications and components without detailed knowledge about what is being embedded. Write your applications so that the user can embed another well-behaved application within it.

When you create a new application class, you specify whether the application allows embedded documents. Embedded documents allow an embedded window and its parent application to negotiate how much space the embedded document can use. For more information on embedded windows, see Chapter 9, Embedded Documents.

The PenPoint Application Framework classes allow applications and components to accept or reject embedding requests, determine the size and position of the embedded objects, and tell the embedded objects when to file their data.

Application Data 6.3

Your application is responsible for maintaining, displaying, and filing its application data.

Saving and Restoring Data 6.3.1

Each object is responsible for saving and restoring its own data. This is a key point of the PenPoint operating system.

clsObject and **clsResFile** define messages that tell objects when to save and restore their data. Your application must be prepared to receive these messages and act on them. Your application can maintain its own data, in which case it is responsible for performing the necessary read and write operations. However, if your application stores its data in objects, it simply tells the handle for the resource file to send, save, or restore messages to the objects.

Component classes (such as lists, tables, and text) file their own data. For specialized types of data, you must write your own component class that can save and restore its data. You need only write the component class once and you can use it many times.

Observing Objects 6.3.2

Most applications go beyond creating descendants of **clsObject** and structure their data into **observable** objects, which they then observe. The Class Manager allows an object to keep track of other objects that are interested in that object, and to send them messages when it changes. Such a style of interaction makes it easier for applications to support multiple views of the same data: the data is maintained by an observable object that notifies multiple views when the data changes.

Displaying Data 6.3.3

Usually, your application maintains its data as separate objects. Each object is responsible for filing its own data. Your application can use views to display the data.

As mentioned in the *PenPoint Application Writing Guide*, a **view** is a specialized descendent of **clsWin** that displays a data object in its window. The data object sends a message to the view when its data changes; the view takes care of redisplaying the data. An application can associate more than one view with the same data object.

Using views to display data objects automatically sends filing messages to its data objects. Your application doesn't have to bother sending the filing messages to the viewed objects. (However, the objects must be able to handle the filing messages.)

With careful design, your application data should know nothing about the form of your application's user interface, nor whether your application is on screen, nor even if your application has a user interface at all. The data objects simply respond to messages on behalf of external agents.

Saved Documents 6.4

Each document has its own directory in the file system. The PenPoint Application Framework helps to coordinate the location of each application directory.

The Notebook Table of Contents displays the list of documents. To the user, it looks like each of the documents is ready and available. When the user turns to a page, the document is visible; when the user turns to another page, another document is visible. The user doesn't realize that when a document is visible on screen, its application is running; when the document is not on screen, usually its application is not running and its data is saved in memory.

Actually, the Notebook Table of Contents displays a list of document directories in the file system. Each directory contains a resource file for the document's instance data and an attribute that indicates the application that created the document.

When the user turns to a particular document, the PenPoint Application Framework creates a process running an instance of the application and tells that process to read in the document's data from the resource file. When the user turns away from the page, the PenPoint Application Framework tells the document to save its instance data and terminates the process.

This is how documents survive while the power is off; documents are active only while they are on the screen. When a document is not visible on the screen, its data is safely stored in the file system.

When a document runs in **hot mode** it closes its windows on a page turn, but the process does not terminate.

Chapter 7 / Application Concepts

This chapter describes PenPoint applications and how they relate to the PenPoint™ Application Framework and the Notebook. It does not discuss how to send or respond to Penpoint Application Framework messages (that is covered in Chapter 8).

The following topics are covered in this chapter:

- How application classes differ from other classes.
- How application classes relate to application instances.
- How a document is represented on the screen, in the file system, and as a process in the PenPoint operating system.
- The parts that make up an application.

The chapter concludes with a table that summarizes the purposes and relationships of the PenPoint Application Framework classes.

What is a PenPoint Application? 7.1

In its simplest form, a PenPoint application is an executable file that can create and maintain documents in the PenPoint computer.

An application contains a routine to create an application class, and methods that handle messages sent to instances of an application class. The application class is an instance of **clsAppMgr**.

When the user installs the application, the application invokes the routine to create the application class. An installed application class is an active process in the PenPoint computer.

When the user creates a document, the Notebook responds by creating an instance of the appropriate application class. When active, a document is also a process in the PenPoint computer. In most cases when a document is active, it is displayed on screen. There are times, such as printing, when a document is active but not on screen.

When the user taps or writes on the document, the methods defined in the application class perform the work for the document.

Simple Classes and Application Classes 7.2

In *Part 1: The Class Manager*, we saw how classes generate instances of themselves. Clients use instances of a class to describe particular sets of data. For example, a client can request **clsList** to create two list objects; in each of those lists, the client maintains separate sets of data.

Similarly, an **application class** generates **application instances**. Each application instance describes the set of data that makes up a document. When the user turns to a document in the Notebook, the PenPoint Application Framework creates an application instance that manages that document. In fact, when we use the term **document**, we are referring to both the application instance and the data that make up that document.

When you write an application, you are actually defining a new application class. The PenPoint Application Framework uses your application class to create new documents. When the user installs an application, the PenPoint Application Framework works with your application to create an application class. When the PenPoint Application Framework sends **msgNew** to your application class, it creates a document.

A Look at Simple Classes 7.2.1

Before we continue our discussion of application classes, let's take a look at classes and their relationship to **clsClass**.

All classes and instances in the PenPoint operating system are objects, represented by a 32-bit UID (unique identifier). An object is an instance of a particular class. When you send **msgNew** to a class, the class creates a new object. When you send **msgNew** to **clsClass**, the new object created by **clsClass** is a new class.

clsClass is a special class whose sole purpose is to create and destroy classes. Because **clsClass** cannot create itself, PenPoint creates **clsClass** at boot time. **clsClass** inherits from **clsObject**.

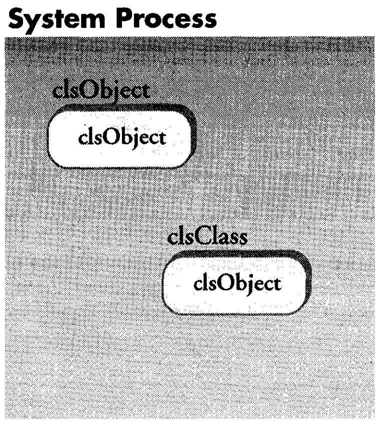
One of the arguments in **msgNew** to **clsClass** specifies the ancestor of the new class. The new class **inherits** the behavior of its ancestor class.

When an instance of a class receives a message, it can handle the message or it can pass the message to its ancestor. The ancestor can handle the message or pass the message to *its* ancestor, and so on, up to **clsObject**. **clsObject** is another special class, which is the great ancestor of all classes, including **clsClass**. Because **clsClass** inherits from **clsObject**, **clsClass** cannot create **clsObject**. Therefore PenPoint creates **clsObject** at boot time.

Figure 7-1 shows **clsClass** and **clsObject** in the context of the system process. In this and following drawings, the objects are depicted as lozenges. The label above the object identifies the specific object. The bottom-most class listed inside an object tells what class created the object (and therefore tells you what the object is). Thus, in the figure, both **clsObject** and **clsClass** are instances of **clsObject**.

This paragraph provides a key to the next series of figures.

Figure 7-1
Predefined Classes



Labeling the box that contains **clsObject** and **clsClass** a "system process" is a gross simplification; the PenPoint operating system uses several processes.

This example from the Tic-Tac-Toe sample application shows a client creating a new class called **clsTttData.**

```
CLASS_NEW       new;
STATUS          s;
ObjCallJmp(msgNewDefaults, clsClass, &new, s, Error);
new.object.uid          = clsTttData;
new.object.key          = 0;
new.cls.pMsg            = clsTttDataTable;
new.cls.ancestor        = clsObject;
new.cls.size            = SizeOf(P_TTT_DATA_INST);
new.cls.newArgsSize = SizeOf(TTT_DATA_NEW);
ObjCallJmp(msgNew, clsClass, &new, s, Error);
```

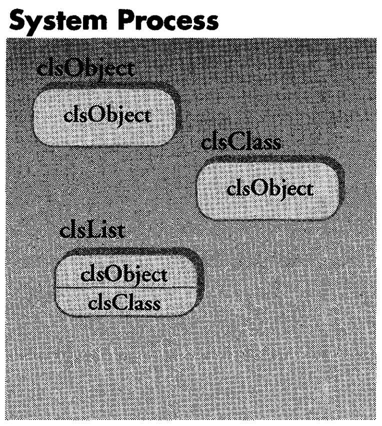
When you send **msgNew** to a class, the class allocates space for the instance that it is about to create, and sends **msgNew** to its ancestor. Eventually, **clsObject** receives **msgNew**, creates a new object, assigns it a UID, and returns.

In this example, the client sends **msgNew** to a class, creating an instance of that class.

```
TTT_DATA_NEW        tttDataNew;
    // Create the TttData object
    ObjCallJmp(msgNewDefaults, clsTttData, &tttDataNew, s, Error);
    // no defaults to override
    ObjCallJmp(msgNew, clsTttData, &tttDataNew, s, Error);

    // get the UID of the new TttData object
    pArgs->view.dataObject = tttDataNew.object.uid;
```

Figure 7-2 shows a simple example class (**clsList**). As you can see, the object labeled "**clsList**" is an instance of **clsClass** and inherits from **clsObject.** When a client sends a message to **clsList**, the messages are handled by methods defined by **clsClass.** If **clsClass** cannot handle a message, it can pass the message to its ancestor, **clsObject.**

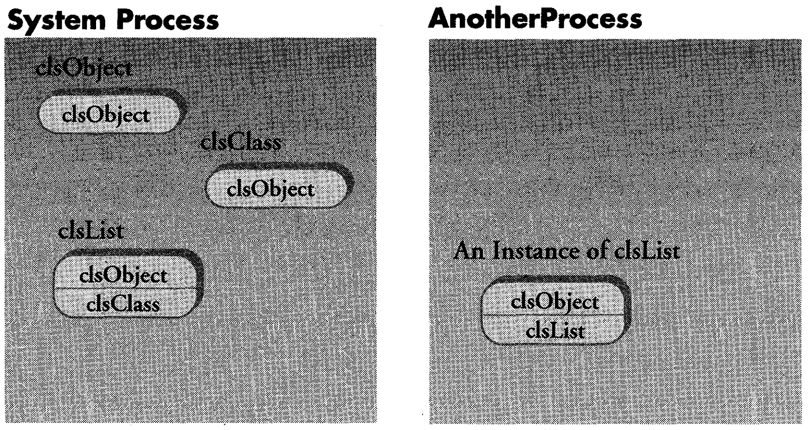
Figure 7-2
A Simple Class



When a client sends **msgNew** to **clsList**, the method defined by **clsClass** creates a new object that is an instance of **clsList**. The new object responds to messages defined by **clsList** and those defined by its ancestor, **clsObject**.

Figure 7-3 shows an instance of **clsList**.

Figure 7-3
An Instance of a Simple Class



Metaclasses 7.2.2

An application class is simply an extension of what we have discussed so far. At this point, we know that:

- **clsClass** creates new classes.
- Classes create instances of themselves (objects).
- Objects handle messages by performing methods defined by their class.
- If the class cannot handle a message, it can allow its ancestor to handle the message.

Most classes are instances of **clsClass**. Each class has a small amount of instance data (describing the location of the method table for the class, how much room to allocate for instances of the class, and so on). This common information is used by all instances of the class, but because it is stored in a single location, it is extremely space efficient.

Other classes can benefit from being able to store common information in a single location. Unfortunately, the structure used by **clsClass** is specific only to **clsClass**. It isn't possible for classes to add to the structure.

Metaclasses are an extremely powerful tool for extending the abilities of existing classes.

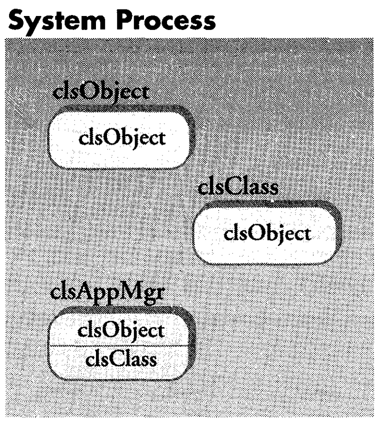
However, it is possible to define additional instance data by creating a new class that inherits from **clsClass**. A class that inherits from **clsClass** is called a **metaclass**. Because the class inherits from **clsClass**, it can create new classes. These new classes can all use common instance data that is defined specifically for the metaclass.

Space efficiency is important to application classes. Each application class contains a large amount of information that is used by each instance of the application class, yet would be wasteful to copy over and over again. This information includes the application name, icon, and initial size and position.

For application classes, PenPoint defines the metaclass **clsAppMgr**. An application class is installed by creating an instance of **clsAppMgr**. An instance of **clsAppMgr** contains instance data that includes the name, icon, and initial size and position for instances of the application class.

Figure 7-4 shows the system classes, as described above, with the addition of **clsAppMgr**.

Figure 7-4
Predefined Classes with clsAppMgr



We can add to our list above:

- **clsAppMgr** creates new application classes.
- Application classes create instances of themselves (documents).

Application Classes

7.2.3

While the metaclass **clsAppMgr** enables an application class to maintain instance data used by all of its instances, the only thing that **clsAppMgr** actually *does* is to create application classes.

Applications have to perform many, many actions in response to the PenPoint Application Framework messages. All of the standard behavior for applications is defined by the application class, **clsApp**.

All application classes are descendents of **clsApp**.

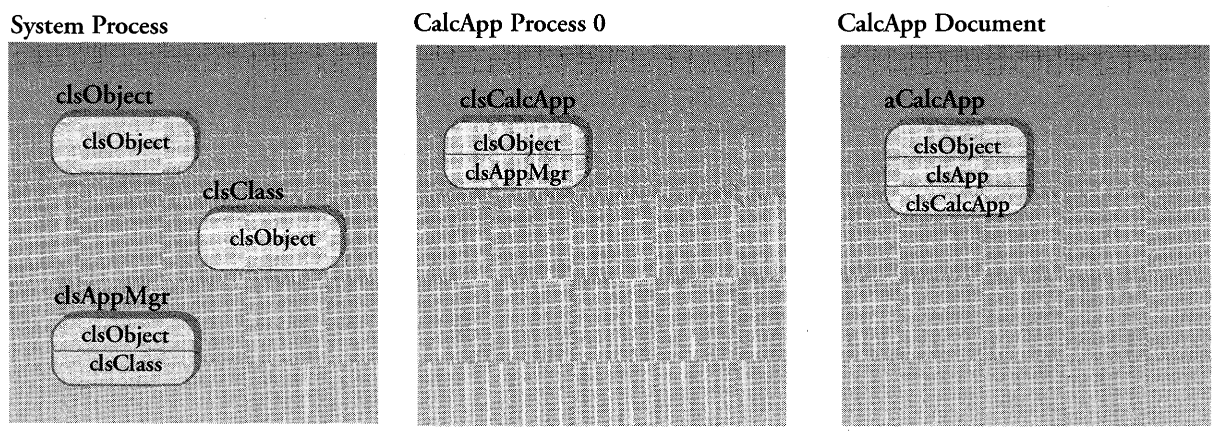
Because applications inherit from **clsApp**, they can allow **clsApp** to handle most PenPoint Application Framework messages, rather than handle the messages themselves. This frees you, the application developer, from coding mundane tasks and allows you to spend time writing the actual behavior of your application.

This example shows a client sending **msgNew** to **clsAppMgr** to create the Tic-Tac-Toe application class.

```
APP_MGR_NEW new;
STATUS      s;
ObjCallJmp(msgNewDefaults, clsAppMgr, &new, s, Error);
new.object.uid                 = clsTttApp;
new.object.key                 = 0;
new.cls.pMsg                   = clsTttAppTable;
new.cls.ancestor               = clsApp;
new.cls.size                   = SizeOf(P_TTT_APP_INST);
new.cls.newArgsSize            = SizeOf(APP_NEW);
new.appMgr.flags.stationery    = true;
new.appMgr.flags.accessory     = false;
strcpy(new.appMgr.company, "GO Corporation");
```

Figure 7-5 shows an application class (**clsCalcApp**). In the figure, you can see the process that contains the application class (**CalcApp** Process 0), and the process that contains the active document (**CalcApp** Document). Process 0 contains **clsCalcApp**, which is an instance of **clsAppMgr**, and inherits from **clsApp**. The document process contains **aCalcApp**, which is an instance of **clsCalcApp**.

Figure 7-5
Inheritance of an Application Class



In summary:

- An instance is an object.
- **clsObject** is an object; it has no ancestors.
- **clsClass** is an instance of **clsObject** that inherits behavior from **clsObject**.
- **clsAppMgr** is an instance of **clsClass** that inherits behavior from **clsClass** and **clsObject**.
- **clsApp** is an instance of **clsAppMgr** that also inherits behavior from **clsObject**.
- A class is an instance of **clsClass** that inherits behavior from the class specified by its creator (and all of that class's ancestors).
- An application class is an instance of **clsAppMgr** that also inherits behavior from **clsApp** and **clsObject**.
- A document is an instance of an application class; it inherits behavior from its application class, **clsApp**, and **clsObject**.

The Document 7.3

The concepts presented here apply to active documents (usually an active document is visible on the screen). Later, we will discuss what happens to documents that are inactive.

An active document has four aspects:

- It can display its information on screen.
- It has its own directory in the file system.
- It is a process.
- It is an object that receives messages from the PenPoint Application Framework.

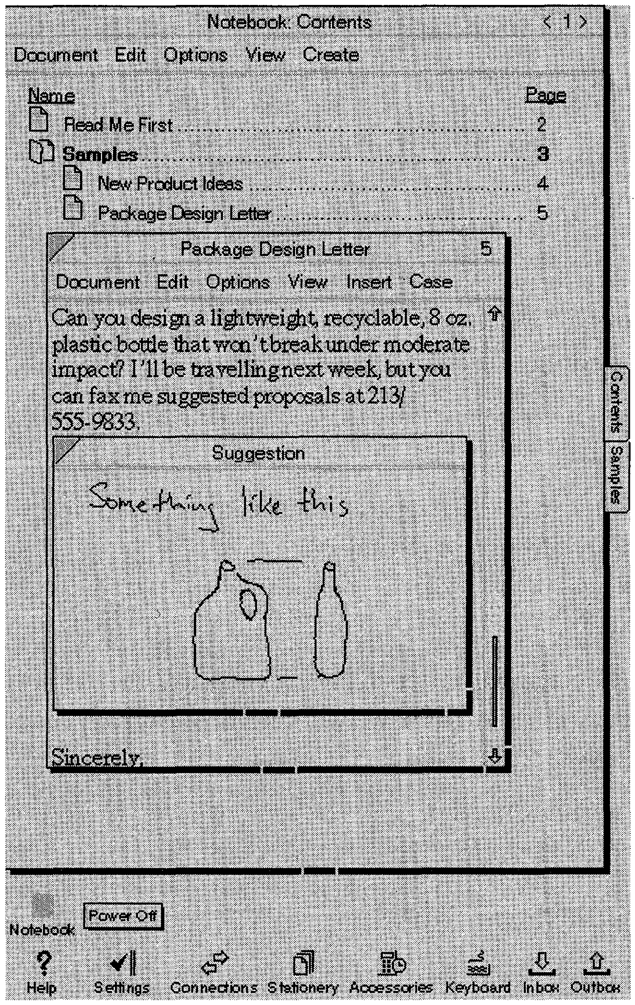
These aspects are related. However, because they are difficult to address simultaneously, the next four sections describe them individually.

Information on Screen 7.3.1

Figure 7-6 shows a typical screen with four documents visible. The documents are:

- The Notebook.
- The Notebook Table of Contents.
- A MiniText document called "Package Design Letter."
- A MiniNote document called "Suggestion."

Figure 7-6
Application Hierarchy: Screen Perspective



Notebook: Contents < 1 >

Document Edit Options View Create

Name	Page
Read Me First	2
Samples	**3**
New Product Ideas	4
Package Design Letter	5

Package Design Letter 5

Document Edit Options View Insert Case

Can you design a lightweight, recyclable, 8 oz. plastic bottle that won't break under moderate impact? I'll be travelling next week, but you can fax me suggested proposals at 213/ 555-9833.

Suggestion

Something like this

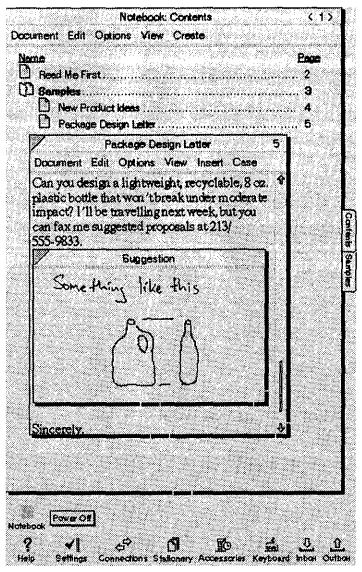
Sincerely,

The File System and Documents 7.3.2

The PenPoint file system has a hierarchical organization, much like MS-DOS. Each volume has a root directory; directory entries can point to files or other directories.

Figure 7-7 illustrates part of the file system organization for the screen shown in Figure 7-6.

Figure 7-7
Application Hierarchy: File System Perspective



Name	Page
Read Me First	2
Samples	3
New Product Ideas	4
Package Design Letter	5

Can you design a lightweight, recyclable, 8 oz. plastic bottle that won't break under moderate impact? I'll be travelling next week, but you can fax me suggested proposals at 213/ 555-9833.

Sincerely,

```
Book Shelf
├doc.res
├docstate.res
└NB
    ├doc.res
    ├docstate.res
    └Notebook Contents
        ├doc.res
        ├docstate.res
        ├Browstat
        ├Read Me First
        │  ├doc.res
        │  └docstate.res
        ├Samples
        │   ├doc.res
        │   ├docstate.res
        │   ├Browstat
        │   ├New Product Ideas
        │   │  └etc...
        │   └Package Design Letter
        │       ├doc.res
        │       ├docstate.res
        │       └Suggestion
        │          ├doc.res
        │          └docstate.res
        └etc...
```

The Notebook uses the file system to organize its documents in parallel with the organization of the table of contents.

- Each document in the Notebook has its own directory. This directory contains the object resource file (DOCSTATE.RES) that holds the document's instance data and a document resource file (DOC.RES) that holds resources used by the document.
- Sections are a type of document; thus each section in the Notebook has its own directory.
- If a document is contained in a section, the document's directory is a subdirectory of that section's directory.
- If a document has an embedded document, the embedded document's directory is a subdirectory of its enclosing document's directory.
- The Notebook Table of Contents is a big section that contains all the other documents and sections.

The Document as a Process 7.3.3

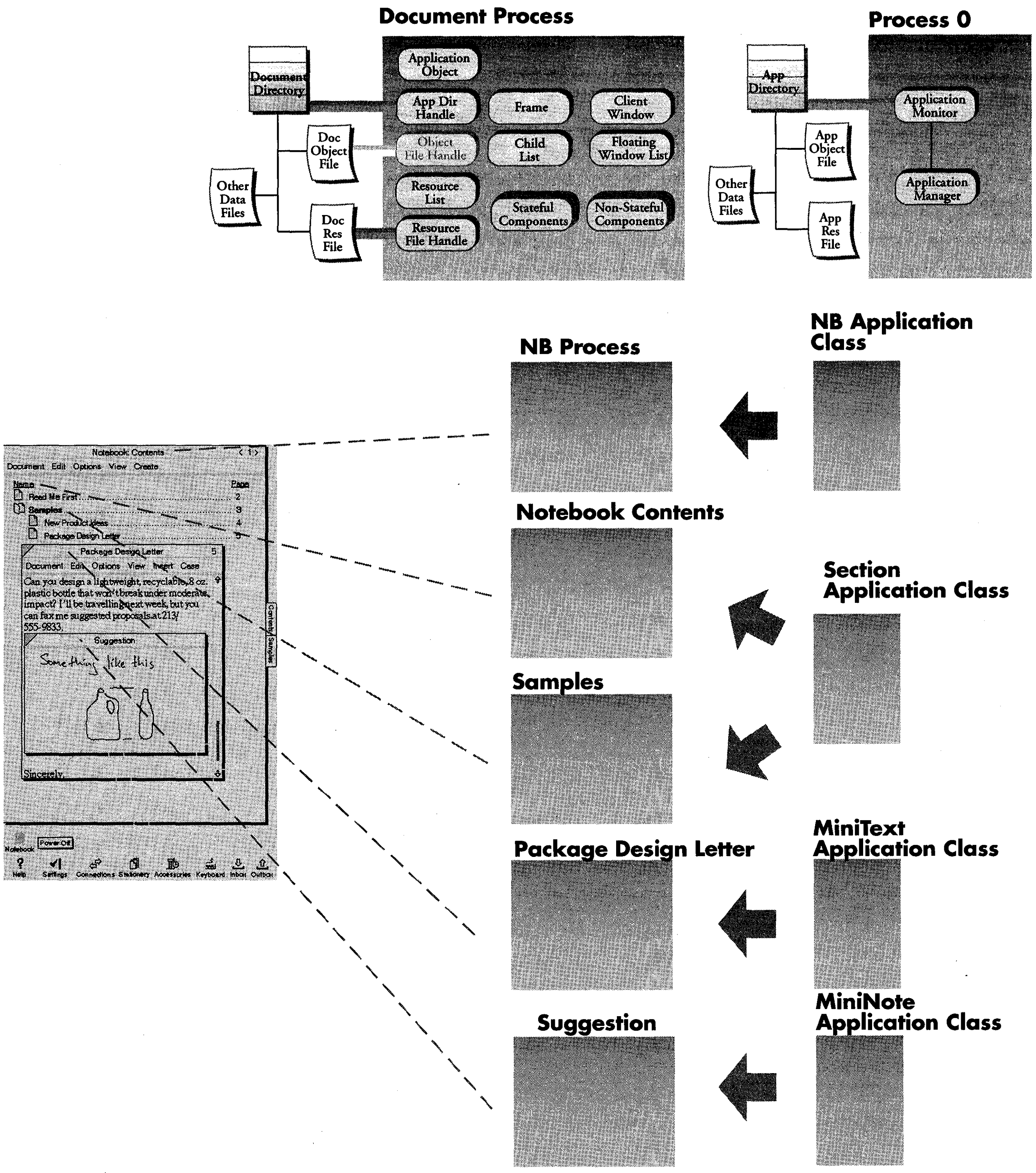
An open document is a running application. An active document is also a process in a PenPoint computer.

When a document is displayed on the screen, it has an active process. When a document is not displayed on screen, it usually does not have a process. Much of the work performed by the PenPoint Application Framework involves creating the process, making it an application object capable of receiving messages, and—when the user turns away—destroying the process and saving its data.

The class manager maintains a database that associates the application process with a UID, which identifies the process as an application object that can receive messages.

Figure 7-8 illustrates the processes running for the screen shown in Figure 7-7. Each of the boxes represent a running process. These processes are described in greater detail in "The Parts of a Document," later in this chapter. Note that the figure also shows the application class processes. Each application class is a process that runs to create instances of itself.

Figure 7-8
Application Hierarchy: Process Perspective



Can you design a lightweight, recyclable, 8 oz. plastic bottle that won't break under moderate impact? I'll be travelling next week, but you can fax me suggested proposals at 213/ 555-9833.

Sincerely,

The Document as an Object 7.3.4

An open document is also an instance of a particular application class, and a descendent of **clsApp**. The document object is shown in Figure 7-8.

The document responds to messages defined by its application class. Because the document object inherits from **clsApp**, it also responds to **clsApp** messages.

The Parts of a Document 7.4

The preceeding discussion of applications and documents presented a number of concepts and described how the document related to the rest of the PenPoint operating system, but it didn't tell you much about what a document is (and what you must provide when you write an application).

A document consists of these components:

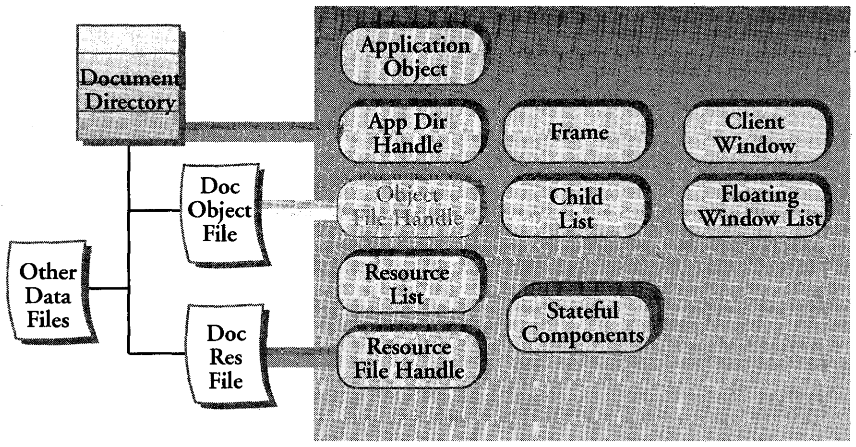
- The application code. The application code is the executable file and DLLs that you create. When loaded in PenPoint, it is loaded into a portion of memory allocated specifically for applications (it isn't stored in the RAM file system).
- A process. As described earlier, an active document is a process created by the PenPoint Application Framework. The process has a queue for messages, an entry point (**main()**), and an **AppMain()** routine.
- An application object, or an instance of an application class. The document object has a UID that can receive messages from the PenPoint Application Framework. The document object is the core of the document. It performs work for the document, creates any child objects that the document uses, and assigns work to the child objects.
- Component objects. Your application creates these objects from component classes and uses them to perform tasks and store data. You can write classes for your own component objects or you can use component classes that exist already (such as those provided by GO).
- A main window. A main window is a special window created by the PenPoint Application Framework for a document that contains a document's main window, a title bar, a page number, a menu bar, horizontal and vertical scroll bars, and other controls. Windows are described in *Part 3: Windows and Graphics*; frames are described in *Part 4: UI Toolkit.*
- A client window. A client window displays a document's data. In PenPoint, rather than have each object display its own data, you create window objects that display the data object (called **views**). This separation frees the data objects from having to repaint themselves, and allows the UI Toolkit to perform most of the work.
- Other window objects.

- A directory. When the user first taps on the Create menu to create a document, the Notebook creates a directory in the file system. A directory attribute indicates the application class that the document uses.

  Later, when the user turns to the document, the Notebook uses the PenPoint Application Framework to start an instance of that application class.
- Resourcetl files. A document uses a resource file to store its instance data. Other resource files can contain replaceable objects and data used by the document. When the user turns away from a document, the only things that remain are the directory and the resource files (and the application code and DLLs).

Figure 7-9 illustrates the parts of a document process. On the left side of the figure are the document directory and the files in that directory (the object file, the resource file, and other data files). As in previous figures in this chapter, the box on the right represents the document process and the lozenges represent the individual objects within the process.

Figure 7-9
Parts of a Document Process



Chapter 8 / Life Cycles

The previous chapters discussed the concepts of where applications exist and what they consist of. This chapter describes the life cycles for an application class and a document.

At this stage, the discussion will begin to concentrate more on what you (the application developer) must do and what the PenPoint™ Application Framework does for you.

The following topics are covered in this chapter:

- Life cycle of an application class.
- The purpose of **main** in application installation.
- The purpose of **clsAppMgr** messages in application installation and deinstallation.
- Life cycle of a document.
- The purpose of **main** in document activation.
- The purpose of **clsAppMgr** and **clsApp** messages in document activation and termination.

Application Class Life Cycle

This section describes the life cycle for an application class. As described in Chapter 7, an application class is an instance of **clsAppMgr** that creates documents.

Figure 8-1 shows the states of an application class; Table 8-1 describes the states shown in the figure.

Figure 8-1
Application Class State Diagram

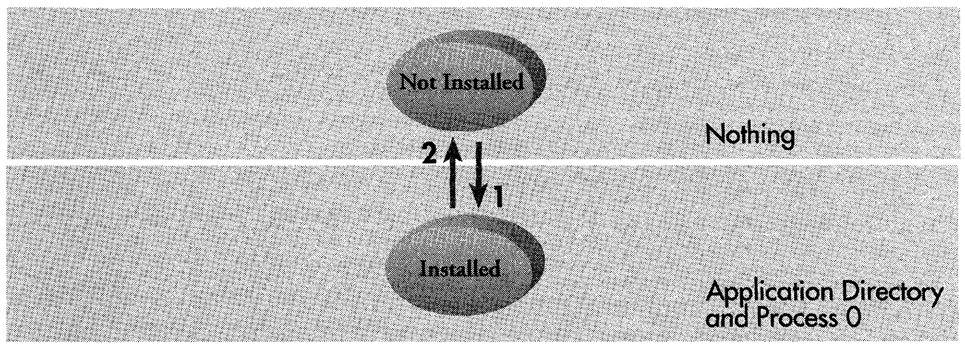


Table 8-1
Application Class States

State	Description
Not Installed	The application is totally unknown to PenPoint. The user cannot create or turn to documents for the application, because the application class does not exist.
Installed	The application appears on the Create menu. The user can create and turn to documents for the application.

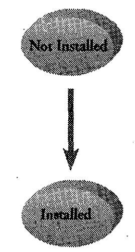
The following sections describe application installation in broad strokes. Application installation is described in more detail in *Part 13: Installation API.*

The transitions in Figure 8-1 are labeled. The user actions that cause these transitions begin when the user turns to the Connections notebook in applications view and performs the following actions:

1 Checks the Install check box in the applications view of the Connections notebook. The PenPoint operating system loads the application .EXE file from disk into the loader database, and creates the application class.

2 Clears the Install check box to deinstall the application. The PenPoint operating system deletes the application class and removes the .EXE file from memory.

Installing an Application 8.1.1



The most important part of installing an application is creating the application class. Although most of your application contains methods (functions) that handle messages that documents can receive, your application is also responsible for sending **msgNew** to **clsAppMgr** to create a new application class.

When the user installs your application, the application installer loads the application executable file from a user-specified volume to the PenPoint computer. The object code isn't stored in the file system; rather, PenPoint stores the object code in an area of protected memory known as the **loader database.**

main in Application Installation 8.1.1.1

You create **main** and the application class initialization routine.

The installer calls the kernel function **OSProgramInstantiate()** to create a process using your application and transfers control to your application's main routine, which is the process's entry point. **main** calls an application class initialization routine, which establishes space for the class instance data and declares the ancestor for instances of the class (usually **clsApp**).

main is the entry point for all application processes. **OSProgramInstantiate()** passes three parameters to **main, argc, argv,** and **appProcess,** which is a U16 that contains a process number. **OSProgramInstantiate()** assigns the process a process number of 0, because there are no other processes running this application code (at this time).

If **main** finds that the process number equals 0, it calls initialization routines for the application class and any other classes used by the application class. Finally, it calls **AppMonitorMain()**, which starts the application monitor for the application class.

If **main** finds that the process number is greater than 0, the application calls **AppMain**, a routine provided by PenPoint, which creates a document for that application.

This example shows the **main** routine used by the Tic-Tac-Toe application:

```
void CDECL
main(
    int         argc,
    char *      argv[],
    U16         processCount)
{
    if (processCount == 0) {
        TttSymbolsInit();
        StsWarn(ClsTttAppInit());
        StsWarn(ClsTttViewInit());
        StsWarn(ClsTttDataInit());
        AppMonitorMain(clsTttApp, objNull);
    }   else {
        AppMain();
    }
    // Suppress compiler's "unused parameter" warnings
    Unused(argc); Unused(argv);
} /* main */
```

Application Class Initialization Routine

8.1.1.2

You must write the application class initialization routine.

When **main** finds that the process number is 0, it calls the initialization routine for that application class (and initializes any other classes required by the application).

The initialization routine for the application class creates an instance of **clsAppMgr**, which is the application class object.

The routine declares an APP_MGR_NEW structure, initializes it (by sending **msgNewDefaults** to **clsAppMgr**), modifies some of the arguments, and then sends **msgNew** to **clsAppMgr**.

This example shows the applications class initialization routine for the Tic-Tac-Toe application.

```
/****************************************************************************
    ClsTttAppInit

    Install the application.
****************************************************************************/
STATUS PASCAL
ClsTttAppInit (void)
{
    APP_MGR_NEW new;
    STATUS      s;
    ObjCallJmp(msgNewDefaults, clsAppMgr, &new, s, Error);
    new.object.uid                  = clsTttApp;
    new.object.key                  = 0;
    new.cls.pMsg                    = clsTttAppTable;
    new.cls.ancestor                = clsApp;
    new.cls.size                    = SizeOf(P_TTT_APP_INST);
    new.cls.newArgsSize             = SizeOf(APP_NEW);
    new.appMgr.flags.stationery     = true;
    new.appMgr.flags.accessory      = false;
    strcpy(new.appMgr.company, "GO Corporation");
    // 213 (octal) is the "circle-c" copyright symbol
    new.appMgr.copyright = "\213 1992 GO Corporation, All Rights Reserved.";
    ObjCallJmp(msgNew, clsAppMgr, &new, s, Error);
    return stsOK;
Error:
    return s;
}
```

The message arguments specify the application class's well-known UID and ancestor (which for applications is almost always **clsApp**), the name of the application, its initial state (whether it is a floating document, whether it runs in hot mode, and so on), the size of its instance data, and the ID of its method table.

If **new.appMgr.defaultDocName** contains **pNull**, the PenPoint Application Framework will look for the default document name in **tagAppMgrDefaultDocName** in the resource file APP.RES. This allows you to localize your default document names by having different resource files (and thus a different **tagAppMgrDefaultDocName**) for different languages or locales.

Because the application class uses a process, it can have a full-scale environment, just like an application instance. This environment includes a floating window list and initialized local copies of **theProcessResList** and **theUndoManager**. Using this environment, your process 0 can actually provide its own user interface, if necessary for altering application-global settings. However, most of the time this overhead is unnecessary. When you don't need a full enviroment for process 0, set the **fullEnvironment** flag to false.

At this point, the process can send messages, but it has no object that can receive messages.

clsAppMgr creates the new object by sending **msgInit** to its ancestor, **clsClass**. **clsClass** creates an application class object (an instance of **clsAppMgr**) for process 0. The new application class can now receive messages as well as send them.

clsClass then sends **msgInit** to the new instance of **clsAppMgr** (the application class object). In response to **msgInit**, the application class sends **msgInit** to its ancestor (**clsClass**) and then allocates and initializes its instance data.

PenPoint provides the method for handling **msgInit** received by an application class (because it is an instance of **clsAppMgr**).

When **msgInit** returns from **clsClass**, **clsAppMgr** initializes the instance data that your application class will use to create instances of itself (documents). The instance data includes your application name, your company's name, your icon, the initial size and location for floating documents (if floating), whether it is a hot mode application or not, and whether the user can create instances of it or not. (Some applications, such as device drivers, should not be user-creatable.)

The new class object is an instance of **clsAppMgr**. Thus, any messages received by your application class are handled first by the methods defined in **clsAppMgr**.

AppMonitorMain() in Installation

8.1.1.3

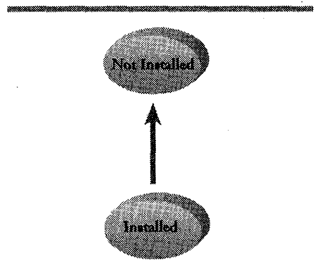
The last step that **main** executes in installing an application class is to create an application monitor in your application class.

The application monitor is an object in your application class that helps to maintain installation information about the application, including the UID of the application manager object and the location of the application's home.

You create the application monitor by calling **AppMonitorMain()**. The application monitor is described in Chapter 13, The Application Monitor Class.

Deinstalling an Application

8.1.2



To remove an application from the PenPoint computer, the user deinstalls the application.

Deinstalling an application removes the program from the loader database and removes the application directory and the application's attributes from the file system. To use the application again, the user must reinstall the program, its resources, and all other files.

msgFree in Deinstallation

8.1.2.1

When the user deinstalls your application, the installer program sends **msgFree** to your application class, which destroys the application class object.

PenPoint provides the method for **msgFree** in deinstallation.

clsAppMgr's routine to handle **msgFree** first calls ancestor to free itself, then it removes itself from the list of installed applications, and broadcasts its deinstallation to all observers of **clsApp**.

Document Life Cycle

This section describes the life cycle for a document.

Figure 8-2 shows the states of a document; Table 8-2 describes the states shown in Figure 8-2.

Figure 8-2
Document State Diagram

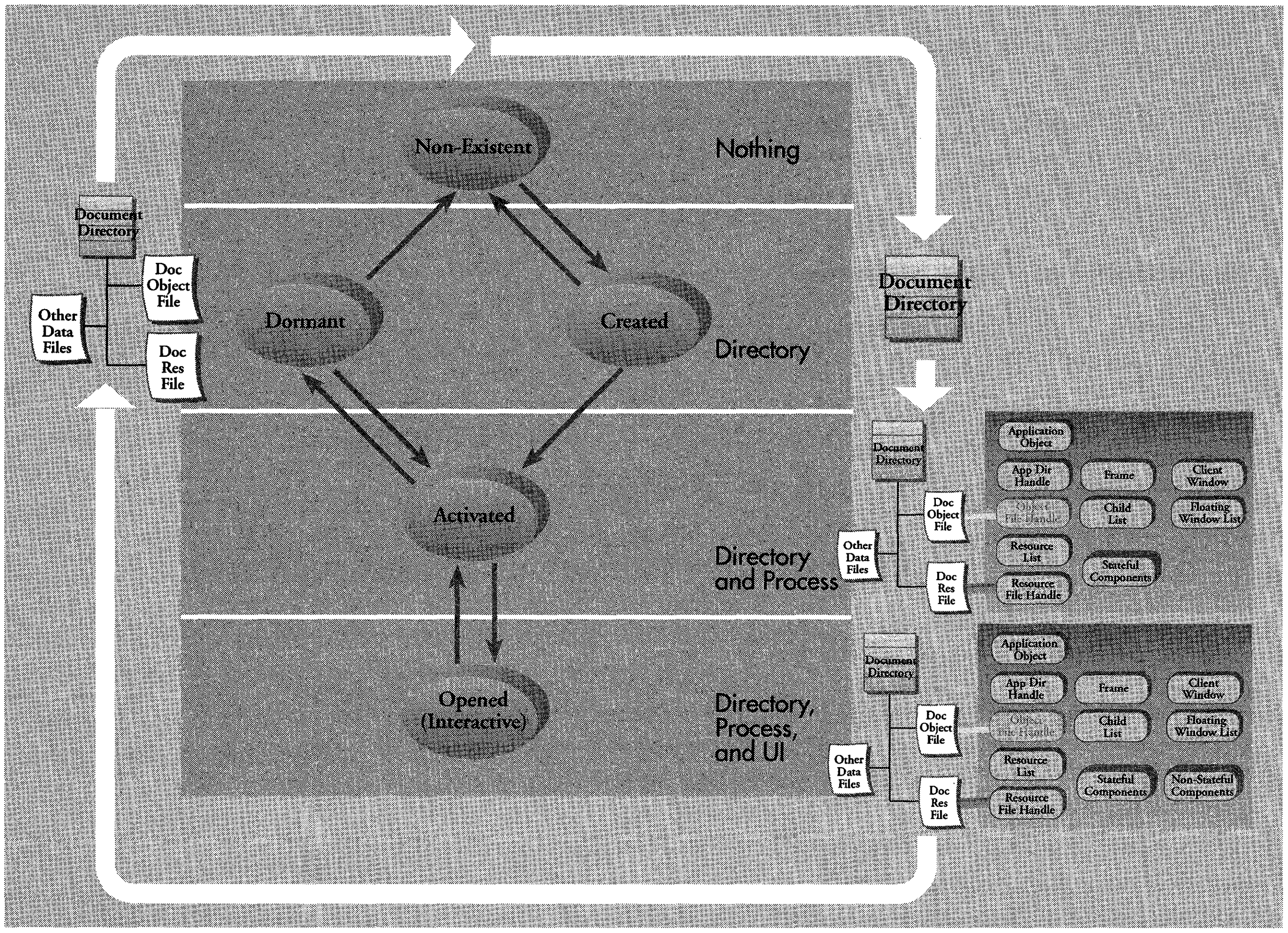


Table 8-2
Document States

State	Description
Non-Existent	The document does not exist, nor does it have a directory. There is no resource file for the document.
Created	A directory exists for the document.
Activated	A process exists, the process contains a document object, and the application data has been either initialized or restored.
Opened	The document is displayed on the screen.
Dormant	A directory exists for the document, the application data is stored in a resource file, but there is no process and no document object.

Created and dormant states are similar, because in those states there is a directory, but there is no process. However, in the created state there is no resource file; in dormant, there is.

The transitions shown in in Figure 8-2 are labeled. The user actions that cause these transitions are:

1 The user taps on the Create menu and chooses this application. The PenPoint Application Framework creates a directory for the document.

2 The user deletes the document before turning to the document. The PenPoint Application Framework deletes the document directory.

3 The user turns to the page containing the document. The PenPoint Application Framework starts the document process, creates a document object in the process, and initializes the document's data. If the document displays itself on screen, processing continues with transition 4.

Normally, transition 4 occurs immediately after transition 3 or transition 7 without additional user action. This transition can also occur when the user turns to a document running in hot mode or returns to a document that has an active selection.

4 The PenPoint Application Framework creates the document's main window and its views, and displays the document on screen.

5 The user turns to another page. The PenPoint Application Framework removes the document from the screen and destroys its view objects. If the user didn't have anything selected and the document is not in hot mode, processing continues with transition 6.

6 If the user didn't have anything selected, this step continues from transition 5. This transition is also made if the user had something selected and then tapped anywhere on another page. The PenPoint Application Framework saves the document's data and shuts down the process.

7 The user turned back to the document. The PenPoint Application Framework starts a new application process and reads the document data from the resource file. Usually when the document reaches the activated state, it continues on transition 4 to the opened state.

8 The user deleted the document. The PenPoint Application Framework deletes the resource file and removes the document directory.

The following sections describe how the PenPoint Application Framework works to create, save, and destroy instances of your document.

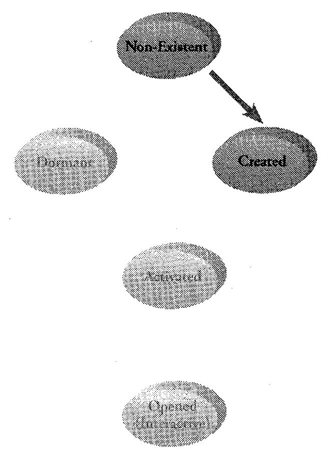
Creating a Document

8.2.1

PenPoint provides **msgAppMgrCreate**.

When the user taps on the **Create** menu or chooses an item on the Stationery menu, the Notebook sends **msgAppMgrCopy** to your application class. **msgAppMgrCopy** creates a new subdirectory in the directory specified in the message. The message also stamps the directory with an attribute that indicates the application class that will use this directory.

At this point, the page exists in the Notebook Table of Contents, but does not contain any data, nor does any process exist for the document. The user might turn to the document immediately or might continue working on the current document.



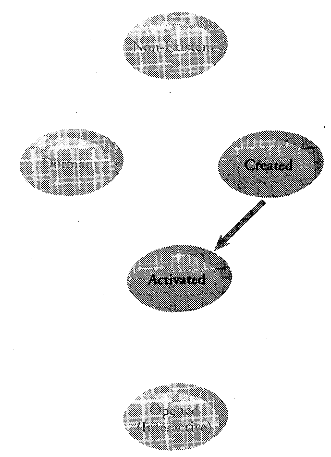
Activating a Document

8.2.2

PenPoint provides **msgAppMgrActivate**.

When the user turns the page to a document, the Notebook locates the directory that corresponds to that document and finds the directory attribute that identifies the document's application class. The Notebook then sends **msgAppMgrActivate** to the application class.

Although this discussion centers on the Notebook, any application can start any other application in just the same way, that is, by sending **msgAppMgrActivate** to an application class. **msgAppMgrActivate** spawns a new process by calling **OSProgramInstantiate**().



Because there is at least one other process running the same application code (the application class), **OSProgramInstantiate**() increments the last process number that it generated and passes the new process number to that new process.

The process number merely distinguishes this process from other processes running the same application code. It does not indicate the number of times that the document has been reactivated, nor does it indicate the number of processes simultaneously running the application code.

main in Activation

8.2.2.1

The entry point for the new process is **main**(). **msgAppMgrActivate** transfers control to the new process at **main**(). Because the process number is greater than zero, **main** transfers control to **AppMain**(). In **AppMain**(), the process waits to receive something.

If the application has process-private classes, it creates and initializes the classes with separate initialization routines before calling **AppMain**().

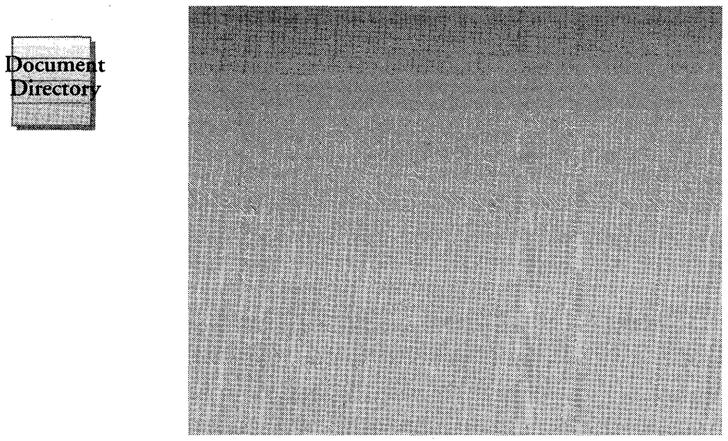
You write **main()** and the class initialization routines; PenPoint provides **AppMain()**.

This **main**() comes from the Tic-Tac-Toe application (TTTAPP.C).

```
void CDECL
main(
    int         argc,
    char *      argv[],
    U16         processCount)
{
    if (processCount == 0) {
        TttSymbolsInit();
        StsWarn(ClsTttAppInit());
        StsWarn(ClsTttViewInit());
        StsWarn(ClsTttDataInit());
        AppMonitorMain(clsTttApp, objNull);
    }   else {
        AppMain();
    }
    // Suppress compiler's "unused parameter" warnings
    Unused(argc); Unused(argv);
} /* main */
```

At this point, the document consists of the items shown in Figure 8-3. The document directory exists and there is a process for the document.

Figure 8-3
New Document Process



msgAppMgrActivate in Activation 8.2.2.2

In the meantime, the **msgAppMgrActivate** that was sent by the Notebook builds a **pArgs** structure for **msgNew** and sends it to the new document process, using one of the kernel's ITC (inter-task communication) messages. (The process does not yet contain a document object to receive messages. That is why **msgAppMgrActivate** uses an ITC message.) The new process (which we last left waiting in **AppMain**), receives the **pArgs** and uses them to send a **msgNew** to your application class, using the arguments received in the ITC message.

Your application class handles **msgNew** by calling its ancestor, **clsClass**, which creates a document object (an instance of your application class) in the new process, and sends **msgInit** to the new object.

Because your application class is an instance of **clsAppMgr**, **clsAppMgr** defines the method for handling **msgNew**.

msgInit in Activation 8.2.2.3

Your application's method table for **msgInit** directs the class manager to pass the message to your ancestor (**clsApp**) before passing it to your method.

When **clsApp** receives **msgInit**, it opens the document's directory in the file system, allocates memory for the document's instance data, zeros the allocated memory, performs some housekeeping, updates its own instance data, and returns.

When your document receives **msgInit**, it initializes its instance data and saves the instance data in protected memory by calling **ObjectWrite()**, and then returns.

You must define a method for **msgInit** *in your application.*

The instance data and application directory handle are both examples of activate-to-terminate objects that do not have **state**. That is, they do not need to be saved when the document terminates.

When your application initializes the instance data, the data is local to the method. However the instance data maintained by the class manager is in protected memory. To update the protected instance data with the local copy, call the function **ObjectWrite()**. **ObjectWrite()** stores the instance data in protected memory, where it will stay until the process is terminated.

This example shows the method for **msgInit** used by the Tic-Tac-Toe application.

```
/****************************************************************************
    TttAppInit

    Initialize instance data of new object.
    Note: clsmgr has already initialized instance data to zeros.
****************************************************************************/
#define DbgTttAppInit(x) \
    TttDbgHelper("TttAppInit",tttAppDbgSet,0x2,x)
MsgHandler(TttAppInit)
{
    P_TTT_APP_INST  pInst;
    STATUS          s;
    DbgTttAppInit((""))
    //
    // Initialize for error recovery.
    //
    pInst = pNull;
    //
    // Allocate, initialize, and record instance data.
    //
    StsJmp(OSHeapBlockAlloc(osProcessHeapId, SizeOf(*pInst), &pInst), \
            s, Error);
    pInst->placeHolder = -1L;
    ObjectWrite(self, ctx, &pInst);
    DbgTttAppInit(("returns stsOK"))
    return stsOK;
    MsgHandlerParametersNoWarning;
Error:
    if (pInst) {
        OSHeapBlockFree(pInst);
    }
    DbgTttAppInit(("Error; returns 0x%lx",s))
    return s;
} /* TttAppInit */
```

msgAppActivate and msgAppInit

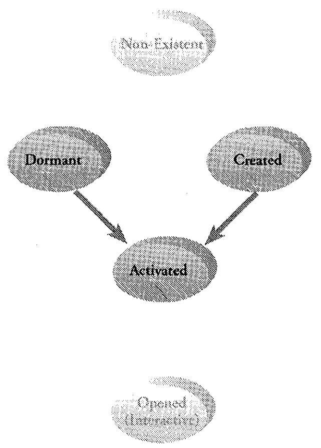
8.2.2.4

When the **msgNew** sent by **AppMain()** returns, **AppMain()** sends **msgAppActivate** to the document. You shouldn't define a method for **msgAppActivate**; let **clsApp** handle it.

Reminder If you don't list a message in your method table, the class manager automatically sends it to your ancestor.

You must write a method for **msgAppInit**. If your document has instance data or creates objects, you must also write methods for **msgSave** and **msgRestore**.

If this is the first time the document has been opened, **msgAppActivate** sends **msgAppInit** and **msgAppSave** to the document; if the document has been opened before, **msgAppActivate** sends **msgAppRestore** to the document.



- Your application's method table should call ancestor (**clsApp**) before handling **msgAppInit**. **clsApp** creates the resource file and creates the main window. When the message returns from **clsApp**, your method should create and initialize any objects that both have instance data and that you need to save. For example, if your application uses an instance of **clsText**, it should create it and load any initial text at this time.
- Your application's method table should call ancestor before handling **msgAppSave**. This will result in the document receiving **msgSave**. The method for **msgSave** should save the document's instance data and any **stateful** objects to the resource file. **msgSave** is described later.
- Your application's method table should call ancestor before handling **msgAppRestore**. This will result in the document receiving **msgRestore**. The method for **msgRestore** should restore the document's instance data and any stateful objects from the resource file. **msgAppRestore** and **msgRestore** are described later.

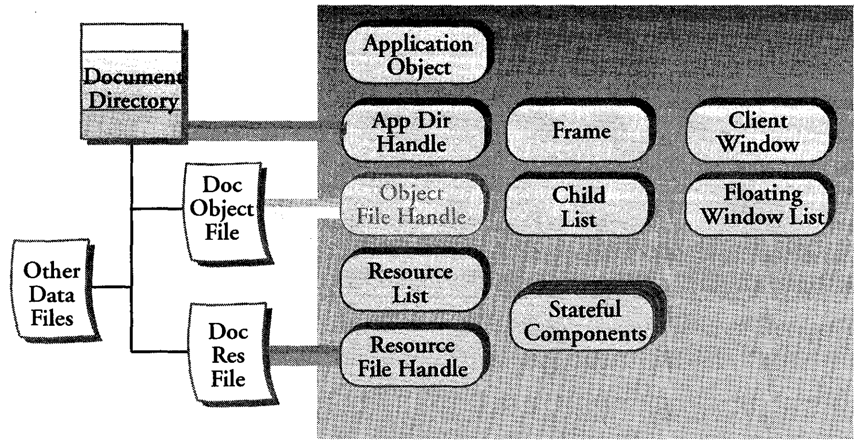
This example shows the method for **msgAppInit** for the Tic-Tac-Toe application.

```
/****************************************************************************
    TttAppAppInit

    Respond to msgAppInit.  Perform one-time app life-cyle initializations.
****************************************************************************/
#define DbgTttAppAppInit(x) \
    TttDbgHelper("TttAppAppInit",tttAppDbgSet,0x20,x)
MsgHandlerWithTypes(TttAppAppInit, P_ARGS, PP_TTT_APP_INST)
{
    APP_METRICS     am;
    TTT_VIEW_NEW    tttViewNew;
    BOOLEAN         responsibleForView;
    BOOLEAN         responsibleForScrollWin;
    OBJECT          dataObject;
    OBJECT          scrollWin;
    STATUS          s;
    DbgTttAppAppInit((""))
    //
    // Initialize for error recovery.
    //
    tttViewNew.object.uid = objNull;
    scrollWin = objNull;
    responsibleForView = false;
    responsibleForScrollWin = false;
    //
    // Create and initialize view.  This creates and initializes
    // data object as well.
    //
    ObjCallJmp(msgNewDefaults, clsTttView, &tttViewNew, s, Error);
    ObjCallJmp(msgNew, clsTttView, &tttViewNew, s, Error);
    responsibleForView = true;
    //
    // Check for stationery.
    //
    ObjCallJmp(msgViewGetDataObject, tttViewNew.object.uid, \
            &dataObject, s, Error);
    StsJmp(TttAppCheckStationery(dataObject), s, Error);
    //
    // Create and initialize scrollWin.
    //
    StsJmp(TttUtilCreateScrollWin(tttViewNew.object.uid, &scrollWin), \
            s, Error);
    responsibleForScrollWin = true;
    responsibleForView = false;
    //
    // Make the scrollWin be the frame's client win.
    //
    ObjCallJmp(msgAppGetMetrics, self, &am, s, Error);
    ObjCallJmp(msgFrameSetClientWin, am.mainWin, (P_ARGS)scrollWin, s, Error);
    responsibleForScrollWin = false;
    DbgTttAppAppInit(("returns stsOK"))
    return stsOK;
    MsgHandlerParametersNoWarning;
Error:
    if (responsibleForView AND tttViewNew.object.uid) {
        ObjCallWarn(msgDestroy, tttViewNew.object.uid, pNull);
    }
    if (responsibleForScrollWin AND scrollWin) {
        ObjCallWarn(msgDestroy, scrollWin, pNull);
    }
    DbgTttAppAppInit(("Error; returns 0x%lx",s))
    return s;
} /* TttAppAppInit */
```

clsApp also activates any embedded documents in the document being activated, sets its priority, and returns.

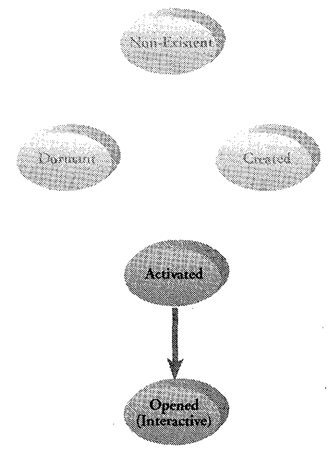
Figure 8-4 shows the document at this point. The document process now contains a number of the objects necessary for the document to be active in the PenPoint Application Framework, however it doesn't have any instances of non-stateful components (such as views on data and user interface control objects).

Figure 8-4
Document with Objects and Frame



When **msgAppActivate** returns, **AppMain()** opens the document by sending **msgAppOpen** to the new document.

Opening a Document 8.2.3



Usually, when the user turns to your document, processing continues immediately from transition 3 or transition 7, as shown in Figure 8-2.

However, as noted before, documents that run in hot mode or have an active selection might remain in the activated state and make transition 4 when the user turns back to the document.

msgAppOpen 8.2.3.1

When your document receives **msgAppOpen** from **AppMain()**, it creates windows to display data and other control objects. Most of the windows that your document creates here are decribed in either *Part 3: Windows and Graphics* or *Part 4: UI Toolkit* of the *PenPoint Architectural Reference.*

Your method table entry for **msgAppOpen** should call ancestor after your method handles the message. In response to **msgAppOpen**, **clsApp** displays the document on screen by sending **msgWinInsert** to the document's main window.

At this point, the user can interact with the document.

This example shows the method for **msgAppOpen** used by the Tic-Tac-Toe application.

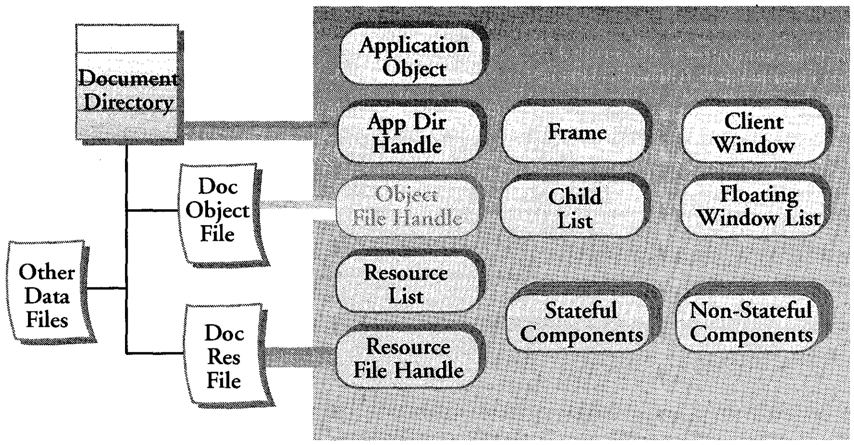
You must write a method for **msgAppOpen**.

```
/****************************************************************************
    TttAppOpen

    Respond to msgAppOpen.
    It's important that the ancestor be called AFTER all the frame
    manipulations in this routine because the ancestor takes care of any
    layout that is necessary.
****************************************************************************/
#define DbgTttAppOpen(x) \
    TttDbgHelper("TttAppOpen",tttAppDbgSet,0x40,x)
//
// Really a P_TK_TABLE_ENTRY
//
extern P_UNKNOWN tttMenuBar;
MsgHandlerWithTypes(TttAppOpen, P_ARGS, PP_TTT_APP_INST)
{
    APP_METRICS      am;
    OBJECT           menu;
    BOOLEAN          menuAdded;
    STATUS           s;

    DbgTttAppOpen((""))

    //
    // Initialize for error recovery.
    //
    menu = objNull;
    menuAdded = false;

    //
    // Get app and frame metrics.
    //
    ObjCallJmp(msgAppGetMetrics, self, &am, s, Error);

    //
    // Create and add menu bar.
    //
    StsJmp(TttUtilCreateMenu(am.mainWin, self, tttMenuBar, &menu), s, Error);
    DbgTttAppOpen(("menu=0x%lx",menu));
    ObjCallJmp(msgAppCreateMenuBar, self, &menu, s, Error);
    StsJmp(TttUtilAdjustMenu(menu), s, Error);
    ObjCallJmp(msgFrameSetMenuBar, am.mainWin, (P_ARGS)menu, s, Error);
    menuAdded = true;

    DbgTttAppOpen(("returns stsOK"))
    return stsOK;
    MsgHandlerParametersNoWarning;

Error:
    if (menuAdded) {
        ObjCallWarn(msgFrameDestroyMenuBar, am.mainWin, pNull);
    } else if (menu) {
        ObjCallWarn(msgDestroy, menu, pNull);
    }
    DbgTttAppOpen(("Error; return 0x%lx",s))
    return s;
} /* TttAppOpen */
```

When **msgAppOpen** returns, **AppMain()** sends **msgAppDispatch** to the document. This makes the document eligible to receive other messages.

Figure 8-5 shows the fully opened document process, complete with non-stateful objects.

Figure 8-5
Opened Document

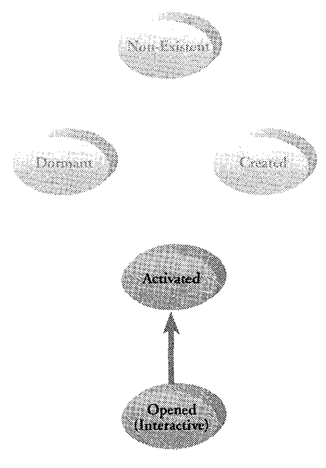


Closing a Document

8.2.4

When the user turns away from the document, the Notebook sends **msgAppClose** to the document, which causes it to remove itself from the screen.

If the document wasn't running in hot mode or didn't have a selection, the Notebook also sends **msgFree** to the document, which causes the document to save its instance data and destroy its objects.



msgAppClose

8.2.4.1

Your method for **msgAppClose** must remove your application from the screen by setting the client window pointer to nil and freeing the window. The method for **msgAppClose** should also destroy any non-stateful window objects.

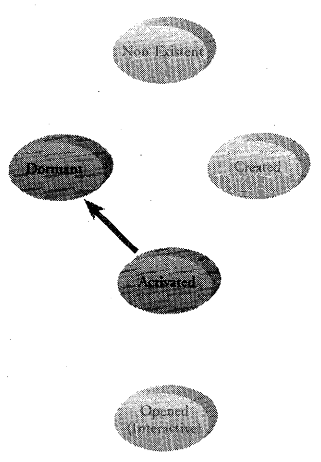
You must write a method for **msgAppClose**.

If the document has an active selection in one of the windows, that window object must be preserved.

This code example shows the method for **msgAppClose** used by the Tic-Tac-Toe application.

```
/****************************************************************************
    TttAppClose

    Respond to msgAppClose.
    Be sure that the ancestor is called FIRST. The ancestor extracts the
    frame, and we want the frame extracted before performing surgery on
    it.
****************************************************************************/
#define DbgTttAppClose(x) \
    TttDbgHelper("TttAppClose",tttAppDbgSet,0x80,x)
MsgHandlerWithTypes(TttAppClose, P_ARGS, PP_TTT_APP_INST)
{
    APP_METRICS     am;
    STATUS          s;
    DbgTttAppClose((""))
    //
    // Get the frame.  Extract the menu bar from the frame.  Then
    // free the menu bar.
    //
    ObjCallJmp(msgAppGetMetrics, self, &am, s, Error);
    ObjCallJmp(msgFrameDestroyMenuBar, am.mainWin, pNull, s, Error);
    DbgTttAppClose(("returns stsOK"))
    return stsOK;
    MsgHandlerParametersNoWarning;
Error:
    DbgTttAppClose(("Error; return 0x%lx",s))
    return s;
} /* TttAppClose */
```

Terminating a Document 8.2.5



Usually, when the Notebook closes a document, it also terminates the document process (unless there is a window with an active selection or the document is running in hot mode).

If there was a window with an active selection and the user taps elsewhere in the Notebook, the selection is lost and termination continues.

The Notebook does not terminate a hot-mode document until the user deletes it.

The Notebook terminates a document by sending it **msgFree**.

msgFree 8.2.5.1

You must write a method to handle **msgFree**.

When your application receives **msgFree**, it should free any objects that it has created and release any data allocated from heap.

Your application's method table should call ancestor after handling **msgFree**. When **clsApp** receives **msgFree**, it sends **msgAppSave** to self (the document). Your application should not handle **msgAppSave**. If you omit **msgAppSave** from the method table, the class manager will send it to **clsApp**.

When **clsApp** receives **msgAppSave**, it performs the following tasks:

1 Tells the embedded documents to save themselves (by self-sending **msgAppSaveChildren** to each one).

2 Sends **msgNew** to **clsResFile** to create a handle on the document state resource file in the document's directory. Note that when **clsApp** sends **msgNew** to **clsResFile**, it specifies "truncate-on-open," that is, delete all information in the file. From this point, until all objects have saved their information in the file, a drastic failure (such as loss of power or a crash) in the computer could cause a loss of data.

   If data integrity is important, your application could copy its resource file when it receives **msgAppSave** (provided it knows the name of the resource file).

   When **clsResFile** receives **msgNew**, it writes a resource file header to the file.

3 Sends **msgResWriteObject** to the resource file handle and specifies **self** as the object to file. When the resource file handle receives **msgResWriteObject**, it:

   Writes a resource file header that identifies the object.

   Sends **msgSave** to the document. Your application's responsibilities for **msgSave** are described below.

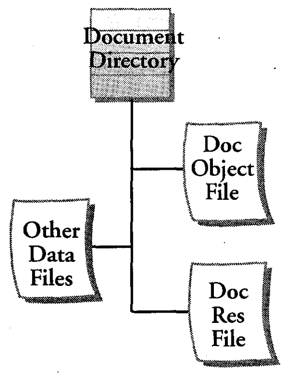
   When **msgSave** completes, the resource manager updates the number of bytes written to the resource file and returns **stsOK** for **msgResWriteObject**.

4 When **msgResWriteObject** returns, **clsApp** closes the resource file.

5 Finally, clsApp sends **msgAppTerminateProcess** to your document. Allow your ancestor to handle this message, which terminates the document process.

When the document process terminates, the only thing that remains is the directory in the file system, the resource file in the directory, and the resource files for the document (plus any other files created by your document). Figure 8-6 shows what remains of the document.

Figure 8-6
Document after Termination



This example shows the method used by the Tic-Tac-Toe application to handle **msgFree**.

```
/****************************************************************************
    TttAppFree
    Respond to msgFree.
    Note:  Always return stsOK, even if a problem occurs.  This is
    (1) because there's nothing useful to do if a problem occurs anyhow
    and (2) because the ancestor is called after this function if and
    only if stsOK is returned, and it's important that the ancestor
    get called.
****************************************************************************/
#define DbgTttAppFree(x) \
    TttDbgHelper("TttAppFree",tttAppDbgSet,0x4,x)
MsgHandlerWithTypes(TttAppFree, P_ARGS, PP_TTT_APP_INST)
{
    DbgTttAppFree((""))
    OSHeapBlockFree(*pData);
    DbgTttAppFree(("returns stsOK"))
    return stsOK;
    MsgHandlerParametersNoWarning;
} /* TttAppFree */
```

msgSave

8.2.5.2

You must write a method to handle ***msgSave****.*

msgSave passes an OBJ_SAVE structure, which contains a handle on the file where you must store your data.

Your application's method table should call ancestor before handling **msgSave**. **msgSave** initiates the following process:

1. When **clsApp** receives **msgSave**, it does a **ObjectCallAncestor** to file its instance data.
2. When **ObjectCallAncestor** returns, **clsApp** sends **msgResWriteObject** to the resource file handle with the document's main window as the object.
3. **clsWin** files any of its child objects that have **wsSendFile** set.
4. **clsFrame** files its client view, if the view has **wsSendFile** set.
5. The view receives **msgSave** and saves its instance data (the UID of its data object).
6. The view sends **msgResPutObject** or **msgResWriteObject** to its data object.

This files your window data and its client window. Because views file their corresponding data objects, your document doesn't have to save these objects.

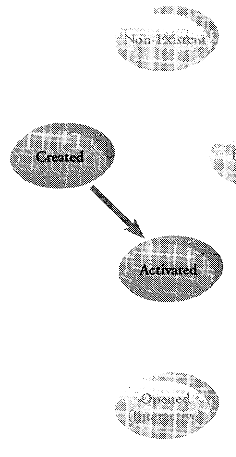
When your application receives **msgSave**, it should save its instance data by sending **msgStreamWrite** to the resource file handle; the **pArgs** indicate the data to save.

Finally, your application should save its stateful objects by sending **msgResWriteObject** or **msgResPutObject** to the resource file handle; the **pArgs** indicate the object to save. These resource file messages then send **msgSave** to the specified object.

This example shows the method for **msgSave** used by the Tic-Tac-Toe application.

```
/****************************************************************************
    TttAppSave
    Save self to a file.
****************************************************************************/
#define DbgTttAppSave(x) \
    TttDbgHelper("TttAppSave",tttAppDbgSet,0x8,x)
MsgHandlerWithTypes(TttAppSave, P_OBJ_SAVE, PP_TTT_APP_INST)
{
    TTT_APP_FILED_0 filed;
    STATUS          s;
    DbgTttAppSave((""))
    StsJmp(TttUtilWriteVersion(pArgs->file, CURRENT_VERSION), s, Error);
    TttAppFiledData0FromInstData(*pData, &filed);
    StsJmp(TttUtilWrite(pArgs->file, SizeOf(filed), &filed), s, Error);
    DbgTttAppSave(("returns stsOK"))
    return stsOK;
    MsgHandlerParametersNoWarning;
Error:
    DbgTttAppSave(("Error; return 0x%lx",s))
    return s;
} /* TttAppSave */
```

Reactivating a Document 8.2.6



If the user turns back to the document, the notebook sends **msgAppMgrActivate** to your application class. Processing is just the same as in document activation. However, instead of sending **msgAppInit** to self, **clsApp** responds to **msgAppActivate** by self-sending **msgAppRestore**.

Your application shouldn't handle **msgAppRestore**. Omit the message from your method table so that the class manager will pass it to your application's ancestor, **clsApp**.

When **clsApp** receives **msgAppRestore**, it starts the cascade of events that causes all objects in a document to load themselves:

1. One of the **msgAppRestore** arguments is a directory handle. When **clsApp** receives **msgAppRestore**, it looks in the directory for a resource file. When it finds the resource file, it opens it by sending **msgNew** to **clsResFile**.
2. When **clsResFile** receives **msgNew**, it opens the file. If the resource file index is saved in the file, **clsResFile** reads it in. If the index does not exist, **clsResFile** creates one.
3. When the **msgNew** returns, **clsApp** sends **msgResReadObject** to the resource file handle, specifying self as the object to restore. **msgResReadObject** sends **msgRestore** to the document.
4. As described below, your application's method table passes **msgRestore** to its ancestor first, which causes windows and client views with **wsSendFile** set to receive **msgRestore**. The object then reads its state information and uses **msgResGetObject** to re-create its objects.

5 **clsApp** determines the name of the directory and resource file, creates a file handle on the resource file, and sends **msgResReadObject** to the resource file handle. The **pArgs** for **msgResReadObject** indicates self is the object to read.

msgRestore

8.2.6.1

You must write the method to handle **msgRestore**.

msgResReadObject sends **msgRestore** to self (the document); the **pArgs** includes the handle on the resource file.

Your application's method table should pass **msgRestore** to its ancestor before handling it, which causes the main window to read its instance data. The main window also tells all its subwindows to read their objects back in. (This is similar to how the main window uses **msgSave** to save all of its subwindows.)

When your application receives **msgRestore**, it should read its instance data from the resource file (by sending **msgStreamRead** to the resource file handle) and should restore its stateful objects (by sending **msgResReadObject** to the resource file handle).

When your application reads the instance data, the data is local to the method. To write that local copy to protected memory, you must call **ObjectWrite**().

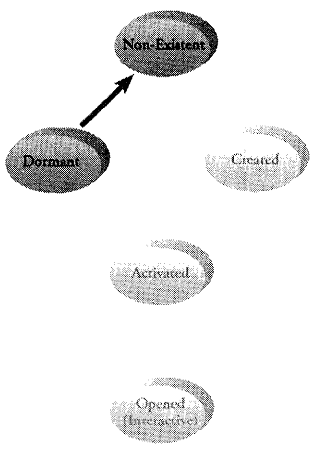
This example shows the method for **msgRestore** used by Tic-Tac-Toe.

```
/****************************************************************************
    TttAppRestore

    Restore self from a file.
    Note: clsmgr has already initialized instance data to zeros.
****************************************************************************/
#define DbgTttAppRestore(x) \
    TttDbgHelper("TttAppRestore",tttAppDbgSet,0x10,x)
MsgHandlerWithTypes(TttAppRestore, P_OBJ_RESTORE, PP_TTT_APP_INST)
{
    P_TTT_APP_INST      pInst;
    TTT_APP_FILED_0 filed;
    STATUS              s;
    TTT_VERSION         version;
    DbgTttAppRestore((""))
    //
    // Initialize for error recovery.
    //
    pInst = pNull;
    //
    // Read version, then read filed data. (Currently there's only
    // only one legitimate file format, so no checking of the version
    // need be done.)
    //
    // The allocate instance data and convert filed data.
    //
    StsJmp(TttUtilReadVersion(pArgs->file, MIN_VERSION, MAX_VERSION, \
            &version), s, Error);
    StsJmp(TttUtilRead(pArgs->file, SizeOf(filed), &filed), s, Error);
    StsJmp(OSHeapBlockAlloc(osProcessHeapId, SizeOf(*pInst), &pInst), \
            s, Error);
    TttAppInstDataFromFiledData0(&filed, pInst);
```

```
        ObjectWrite(self, ctx, &pInst);
        DbgTttAppRestore(("returns stsOK"))
        return stsOK;
        MsgHandlerParametersNoWarning;
    Error:
        if (pInst) {
            OSHeapBlockFree(pInst);
        }
        DbgTttAppRestore(("Error; returns 0x%lx",s))
        return s;
    } /* TttAppRestore */
```

Deleting a Document

8.2.7



When the user deletes a document from the Notebook, the Notebook sends **msgAppMgrDelete** to the application class, indicating the directory of the document to be deleted.

msgAppMgrDelete searches the document's directory for embedded documents. For each embedded document, **msgAppMgrDelete** sends **msgFree** to each embedded document (if it exists), terminates the document processes (if it exists), and deletes the document's directory.

Chapter 9 / Embedded Documents

One of the features that differentiates the PenPoint™ operating system from many other operating systems is that components can contain other components. Both the containing component and the contained component can have views on their data. The contained component with a view on its data is called an **embedded window**.

Chapter 9 covers these topics:

- Embedded window marks.
- Descendants of **clsEmbeddedWin**.
- Moving and copying between embedded windows.
- Creating and destroying embedded windows.
- Moving or copying to an embedded window.
- Handling child embedded windows.
- Selecting an embedded window.

Embedded Window Concepts 9.1

Embedded windows are described by **clsEmbeddedWin**, which is a descendant of clsGWin.

As **clsApp** provides the default behavior for applications (save, restore, open, close), **clsEmbeddedWin** provides default behavior for views (move, copy, reference).

There are many examples of embedded windows in the PenPoint operating system:

- Any view is actually an embedded window. Thus, text views are embedded windows.
- Each line in the table of contents is a view.
- Reference (goto) buttons are embedded windows that contain an additional mark on another document.

Note Reference buttons are called "goto" buttons in the PenPoint header files.

The user can move or copy information directly from any other view to an embedded window (because all views descend from the embedded window class).

In move or copy operations, the source and destination components must agree on the data exchange method and the destination component must be able to present *the* data in a reasonable way. Is it easy to imagine a user moving data from a text view into a spreadsheet view (perhaps as a label), but it is harder to conceive of a user copying a spreadsheet formula into a drawing view.

To enable the components to agree on a data exchange method and to provide a context for moving or copying the data, **clsEmbeddedWin** provides default behavior for the **move**, **copy**, **insert reference button**, and other gestures.

Marking Support 9.1.1

The embedded window marks also provide support for application marking. When a marking operation finds an embedded window, it must report its find to the mark driver and then return to that location. **clsMark** uses the embedded window marks to save its locations.

Descendants of clsEmbeddedWin 9.1.2

Among the descendants of **clsEmbeddedWin** are **clsGotoButton**, **clsView**, and **clsAppWin**.

- **clsGotoButton** implements the reference (goto) buttons.
- **clsView** is an abstract class that defines messages used to display an object's data. The descendants of **clsView** include **clsTextView** and **clsBrowView**. This is how text views or the browser responds to move and copy gestures.
- **clsAppWin** provides the interface for embedded applications. If you embed an application, you must create a **clsAppWin** object.

The difference between **clsEmbeddedWin** and **clsAppWin** is that an embedded window allows you to embed a component in a document (such as a reference button), whereas an application window allows you to embed an application in a document (such as a graph application within a text document). When you embed an application, it affects the file system directory tree because an embedded application maintains its data in a subdirectory of the containing application.

Moving or Copying Between Embedded Windows 9.2

One of the most important features of **clsEmbeddedWin** is its implementation of the move and copy protocol.

The user can select data in a document (or an entire document) and move or copy that data to another document that allows embedding. This section describes the messages that are exchanged when copying or moving data from one object to another.

Throughout this discussion, remember that both the source and destination inherit from **clsEmbeddedWin**. When your class inherits from **clsEmbeddedWin**, instances of your class can be either a source or a destination.

Separate Messages 9.2.1

The messages used by **clsEmbeddedWin** are usually sent to self. If, when the message is sent to self, the object that received the message cannot (or chooses not) to handle the message, it can allow its ancestor to handle the message. Eventually the message is handled by **clsEmbeddedWin**, which provides default behavior for move and copy operations.

Usually, a class specifies that a message can be sent to its ancestor in the method table for the class. However, classes can also call ancestor from their methods.

At first impression, it seems that the messages defined by **clsEmbeddedWin** could be combined to make them more efficient. However, many of the tasks are separated so that the messages can be sent to self, again allowing classes that inherit from **clsEmbeddedWin** to implement their own behavior for each message.

By defining a separate message for each of the tasks, **clsEmbeddedWin** also separates two types of translations that occur when the user makes a gesture:

- The translation from gestures to semantics.
- The translation from semantics to implementation.

Future PenPoint or third-party products can then replace either or both of these translations with their own sets of gestures, semantics, or implementations.

Why Use the Move and Copy Protocol? 9.2.2

The move and copy protocol enables **clsEmbeddedWin** to provide default behavior for moving or copying many types of data. The source could be: a character, a word, a value, a sentence, a spreadsheet column, a file, a reference button, or even an entire document. The destination can be a location in: a text document, a spreadsheet, a directory, or a table of contents.

The advantage to always using the move and copy protocol is that you can intercept messages where you want your application to do the work, and you allow your ancestor to handle the messages when you want **clsEmbeddedWin** to do the work. When moving a reference button, you allow **clsEmbeddedWin** to do all the work. However, when moving your own data, you might let **clsEmbeddedWin** handle the move or copy icon, but you might want to do the actual move or copy of data.

Usually, objects use the transfer protocol defined by **clsTransfer**, which is documented in *Part 9: Utility Classes.*

The Move and Copy Protocol 9.3

There are nine essential steps for moving or copying data:

1. The user selects the data and requests a move or copy operation.
2. The source determines what was selected.
3. The source allows the user to indicate the destination.
4. The source tells the destination object to move or copy the selection.
5. The destination determines the type of data that the source has selected and tells the source to send the data.
6. The source determines whether it can move or copy data to the destination.

7 The source determines the file system location of the destination.

8 The source moves or copies the data.

9 The destination determines exactly where to put the data.

The following discussion of the move and copy protocol simply describes the messages used to implement the protocol. The next section describes a move operation that actually uses the messages.

Requesting a Move or Copy 9.3.1

After making a selection, the user can start a move or copy in two ways:

- By making a gesture (press or tap and press) on the selection.
- By choosing Move or Copy on the Edit menu.

If the user holds the pen to the selection, the owner of the selection receives a **msgPenHoldTimeout** input event. If the tap count is 0, the user wants to move the selection; the selection owner sends **msgSelBeginMove** to self. If the tap count is 1, the user wants to copy it; the selection owner sends **msgSelBeginCopy** to self.

If the user chooses Move or Copy from the Edit menu:

- **clsApp** sends **msgAppMoveSel** or **msgAppCopySel** to self.
- Your application allows its ancestor (**clsApp**) to handle the message.
- **clsApp** receives the message and sends **msgSelBeginMove** or **msgSelBeginCopy** to the owner of the selection.

Identify the Selection 9.3.2

When your application receives **msgSelBeginMove** or **msgSelBeginCopy** (either from self or from the standard application menu), it is in move or copy mode.

The class that handles the message should identify the current selection by:

- Locating the x-y position of the selection and the bounds of the selection.
- Storing the x-y and bounds in an EMBEDDED_WIN_BEGIN_MOVE_COPY structure.
- Sending **msgEmbeddedWinBeginMove** or **msgEmbeddedWinBeginCopy** to self.

clsEmbeddedWin uses the bounds of the selection to determine the type of move or copy icon to use. If the bounds are non-zero, the icon is a marquee around the selected area; otherwise **clsEmbeddedWin** uses a default move or copy icon.

Let the User Indicate the Destination 9.3.3

When the source receives **msgEmbeddedWinBeginMove** or **msgEmbedded-WinBeginCopy**, it must provide a way for the user to indicate the destination (UID of the object that will receive the data and the x-y coordinates on screen). **clsEmbeddedWin** does this by providing the move or copy icon.

Tell the Destination to Move or Copy 9.3.4

When the user indicates the destination, the class that prompted the user sends **msgSelMoveSelection** or **msgSelCopySelection** to the destination.

The source does not necessarily have to be the object that sends **msgSelMoveSelection** or **msgSelCopySelection**. If a destination object is able to determine where the user wants to place the data, it can send one of these messages to self.

For example, if your application maintains an insertion point and supports a Paste command, the Paste command could send **msgSelMoveSelection** or **msgSelCopySelection** to self, specifying the location of the insertion point as the x-y location.

Determining the Data Type 9.3.5

When the destination receives **msgSelMoveSelection** or **msgSelCopySelection**, it should send **msgXferList** to the source to determine the transfer type. At this point, the embedded window move and copy protocol uses the transfer protocol documented in Chapter 5, Class Transfer, in *Part 9: The Utility Classes.*

The object that handles **msgXferList** must add its transfer types to the list in the messages arguments and send the message to its ancestor (so that the ancestor classes can add their transfer types).

When the destination receives the completed list, it looks for compatible transfer types. (If the data transfer types sent back by the source are unknown by the destination, the object at the destination should call ancestor. Its ancestor can send **msgXferList** to the source again and examine the returned list for compatible transfer types.)

When the destination finds an acceptable transfer type, it determines what protocol it will use for the move or copy operation.

If the transfer type was defined by **clsXfer** (for instance, **xferString**) the destination sends **msgXferGet** to the source. **msgXferGet** is the next step in the **clsXfer** protocol.

If the transfer type was **clsEmbeddedWin**, the destination sends **msgEmbeddedWinMove** or **msgEmbeddedWinCopy** to the source. **msgEmbeddedWinCopy** is the next step in the **clsEmbeddedWin** protocol.

clsEmbeddedWin and **clsXfer** are the two principle move or copy protocols used by objects. There can be many other transfer types. However, it is up to the implementors of the source and destination objects to understand and participate in any other protocol.

OK the Move or Copy 9.3.6

Continuing with the description of the **clsEmbeddedWin** protocol, when the owner of the source receives **msgEmbeddedWinMove** or **msgEmbeddedWinCopy**, it determines whether it can perform the move or copy by sending **msgEmbeddedWinMoveCopyOK** to self.

The owner of the source receives **msgEmbeddedWinMoveCopyOK** and uses the destination's UID to determine whether it can move or copy to the destination object. For example, a graphic component might reject a request to move to a text object.

The class that handles **msgEmbeddedWinMoveCopyOK** sends back values that indicate whether it can allow move and copy operations.

The source examines the values and, depending on the type of operation and the value, continues or returns an error.

Getting the Destination in the File System 9.3.7

If the move or copy is allowed, source sends **msgEmbeddedWinGetDest** to the destination to get more specific information about the destination (rather than just the location of the hot spot).

The destination receives the message and sends back a file system locator for its instance directory, a path to the embedded window (if any), and the sequence number in that directory.

When moving documents in the table of contents, the directory and sequence number information are important. They indicate specifically which directory the document will be moved to and the position of the moved document within that directory.

The selection owner needs the destination information to update its references to UUIDs (universal unique identifiers) in the global index table. When moving or copying components that contain or are targets for reference buttons, the PenPoint operating system must be able to redirect the reference button to the new location of the component.

PenPoint uses UUIDs to identify saved objects.

The directory and sequence number information is also important in case the selection includes an embedded application. When the selection is moved, an embedded application's directory structure must also be moved.

Moving or Copying the Data 9.3.8

The source sends its information to the destination using a protocol specific to the transfer type:

- For one-shot and stream transfers, the source uses **clsXfer** messages.
- For transfers that use special protocols (other than the embedded window protocol), the source and destination exchange data using that protocol.

For transfers that use the embedded window protocol, the message sent by the source depends on the type of move or copy:

- If the move or copy is within the same object, the source sends **msgEmbeddedWinMoveChild** to the destination.
- If the move or copy is between different objects in the same process, the source sends **msgEmbeddedWinInsertChild** to the destination.

- If the move or copy is between different processes, the source files the item, sends **msgEmbeddedWinRestoreChild** to the destination, and then sends **msgEmbeddedWinInsertChild** to the destination.

Getting the Exact Pen Location 9.3.9

One way to allow the user to indicate the destination is to create a marquee or label that the user can move with the pen and drop at the location. However, for two reasons, this creates a problem when determining the exact location:

- The user can put the pen down anywhere in the label to begin the move.
- When your application gets the x-y position of the label, the returned value is the lower left corner of the label, not the pen position.

To compensate for this imprecision, the destination sends **msgEmbeddedWinGetPenOffset** to the source. When **clsEmbeddedWin** created the label and the user put the pen down on the label, **clsEmbeddedWin** saved the x and y offsets from the pen position to the lower left corner of the label (as part of the embedded window instance data).

When the source receives **msgEmbeddedWinGetPenOffset**, it allows its ancestor to handle the message. **clsEmbeddedWin** sends back the offset values.

The destination can then use those offset values to calculate the exact location to insert the moved or copied item.

Example: Moving in Tic-Tac-Toe 9.4

The sample Tic-Tac-Toe application implements the move and copy protocol (by allowing **clsEmbeddedWin** to handle most of the protocol). The user can use the move or copy menu items or make a move or copy gesture on the Tic-Tac-Toe board. With the help of **clsEmbeddedWin**, the Tic-Tac-Toe application creates a default move or copy icon, which the user can use to move the data in the document to a new document. If the destination document is a MiniText document, the data becomes a string of nine characters (Xs, Os, and spaces) representing the characters on the board.

The User Requests a Move 9.4.1

To begin the example, the user either:

- Makes a hold gesture.
- Selects Move from the Edit menu.

Either way, the gesture translation system sends **msgSelBeginMove** to the Tic-Tac-Toe view.

Presenting a Move/Copy Icon 9.4.2

When the Tic-Tac-Toe view receives **msgSelBeginMove**, it handles the gesture with in the function **TttViewSelBeginMoveAndCopy()**. If Tic-Tac-Toe allowed **clsEmbeddedWin** to handle the message, it would create a marquee around the entire board (the entire view), which is too large to drag easily to another document. Instead, **TttViewSelBeginMoveAndCopy()**:

- Creates an EMBEDDED_WIN_BEGIN_MOVE_COPY structure.
- Sets the x-y coordinates in the structure using its **pArgs**.
- Sets the bounds in the structure to zero.
- Sends **msgEmbeddedWinBeginMove** to **self**.

```
/****************************************************************************
    TttViewSelBeginMoveAndCopy

    Handles both msgSelBeginMove and msgSelBeginCopy
****************************************************************************/
#define DbgTttViewSelBeginMoveAndCopy(x) \
    TttDbgHelper("TttViewSelBeginMoveAndCopy",tttViewXferDbgSet,0x1,x)

MsgHandlerWithTypes(TttViewSelBeginMoveAndCopy, P_XY32, PP_TTT_VIEW_INST)
{
    EMBEDDED_WIN_BEGIN_MOVE_COPY    bmc;
    STATUS                          s;

    DbgTttViewSelBeginMoveAndCopy(("self=0x%lx",self))
    //
    // If we don't handle this message, the default behavior is to
    // draw a marquee around the entire selection. For ttt, the marquee
    // would stretch around the entire board, which is too large to be
    // be easily dragged into another document. So, we handle this message,
    // and set the bounds of the move/copy area to zero.
    // msgEmbeddedWinBeginMove/Copy will know to display a move/copy icon
    // instead of drawing the marquee.
    //
    if (pArgs) {
        bmc.xy = *pArgs;
    } else {
        bmc.xy.x =
        bmc.xy.y = 0;
    }
    bmc.bounds.origin.x =
    bmc.bounds.origin.y =
    bmc.bounds.size.w =
    bmc.bounds.size.h = 0;
    ObjCallJmp(MsgEqual(msg, msgSelBeginMove) ?
            msgEmbeddedWinBeginMove : msgEmbeddedWinBeginCopy,
            self, &bmc, s, Error);
    DbgTttViewSelBeginMoveAndCopy(("returns stsOK"))
    return stsOK;
    MsgHandlerParametersNoWarning;
Error:
    DbgTttViewSelBeginMoveAndCopy(("Error; return 0x%lx",s))
    return s;
} /* TttViewSelBeginMoveAndCopy */
```

The Tic-Tac-Toe view does not handle **msgEmbeddedWinBeginMove**, but allows its ancestor to handle the message. When **clsEmbeddedWin** handles **msgEmbeddedWinBeginMove** it:

- Detects that the bounds are zero, so it creates a move or copy icon.
- Inserts the icon into the Tic-Tac-Toe view.
- Returns.

At this point, the current process is the icon instance.

The Move or Copy Icon 9.4.3

The move or copy icon is an instance of **clsMoveCopyIcon**. It is the responsibility of this class to handle pen input to move the icon on the screen, and to detect the pen-up event when the user has chosen the exact destination for the move or copy.

The move or copy icon is the only place in moving a reference button where the move and copy protocol is not handled by **clsEmbeddedWin**.

When the user lifts up on the pen, **clsMoveCopyIcon** sends **msgMoveCopyIconDone** to self. The instance of **clsMoveCopyIcon** handles the message by determining the UID of the destination and sending **msgSelMoveSelection** to the destination.

When the destination receives **msgSelMoveSelection**, it sends **msgXferList** to the source.

Determining the Data Type 9.4.4

The Tic-Tac-Toe view handles **msgXferList** by calling the function **TttViewXferList()**. The function adds the string type to the list and returns. **clsTttView** doesn't allow its ancestors to handle the message, to prevent them from adding other data types to the transfer list.

```
/****************************************************************************
    TttViewXferList
****************************************************************************/
static TAG
sourceFormats[] = {xferString};

#define N_SOURCE_FORMATS (SizeOf(sourceFormats) / SizeOf(sourceFormats[0]))

#define DbgTttViewXferList(x) \
    TttDbgHelper("TttViewXferList",tttViewXferDbgSet,0x4,x)

MsgHandlerWithTypes(TttViewXferList, OBJECT, PP_TTT_VIEW_INST)
{
    STATUS  s;

    DbgTttViewXferList(("self=0x%lx",self))
    //
    // Don't let ancestor add types.  We aren't interested in
    // moving/copying the window, which is the only type the
    // ancestor supports.
    //
    StsJmp(XferAddIds(pArgs, sourceFormats, N_SOURCE_FORMATS), s, Error);
    DbgTttViewXferList(("returns stsOK"))
    return stsOK;
    MsgHandlerParametersNoWarning;

Error:
    DbgTttViewXferList(("Error; return 0x%lx",s))
    return s;
} /* TttViewXferList */
```

Moving the Data 9.4.5

When the destination receives the list, it selects the transfer type that it can handle. In the case of Tic-Tac-Toe, the only transfer type on the list should be **xferString**. Because **xferString** is a type defined by **clsXfer**, the destination uses the **clsXfer** protocol. Therefore, the destination sends **msgXferGet** to the Tic-Tac-Toe view.

The Tic-Tac-Toe view responds to **msgXferGet** by packing its data into a string and passing the buffer back when it returns.

```
/****************************************************************************
    TttViewXferGet
****************************************************************************/
#define DbgTttViewXferGet(x) \
    TttDbgHelper("TttViewXferGet",tttViewXferDbgSet,0x2,x)

MsgHandlerWithTypes(TttViewXferGet, P_XFER_FIXED_BUF, PP_TTT_VIEW_INST)
{
    STATUS  s;

    DbgTttViewXferGet(("self=0x%lx",self))

    if (pArgs->id == xferString) {
        OBJECT dataObj;
        TTT_DATA_METRICS dm;
        U16 row;
        U16 col;
        P_XFER_FIXED_BUF p = (P_XFER_FIXED_BUF)pArgs;
        ObjCallJmp(msgViewGetDataObject, self, &dataObj, s, Error);
        ObjCallJmp(msgTttDataGetMetrics, dataObj, &dm, s, Error);

        //
        // initialize the length to the number of squares (9) plus 1
        // to allow for a string termination character (just in case
        // the user copies/moves the string into a text processor.
        //
        p->len = 10;
        p->data = 0L;
        for (row=0; row<3; row++) {
            for (col=0; col<3; col++) {
                p->buf[(row*3)+col] = dm.squares[row][col];
            }
        }
        p->buf[9] = '\0';
        s = stsOK;
    } else {
        s = ObjectCallAncestorCtx(ctx);
    }
```

```
        DbgTttViewXferGet(("returns 0x%lx",s))
        return s;
        MsgHandlerParametersNoWarning;

    Error:
        DbgTttViewXferGet(("Error; return 0x%lx",s))
        return s;
    } /* TttViewXferGet */
```

Intercepted Messages 9.5

clsEmbeddedWin intercepts **msgWinSend** and **msgGWinGesture**.

It responds to **msgWinSend** so that it can modify UUID data in **msgEmbeddedWinGotoChild** messages. Essentially, it modifies the UUID data so that "go to" operations to a nested embedded window perform the window location operations internally, before displaying the reference location on the screen.

As mentioned in the description of a move operation above, **clsEmbeddedWin** responds to **msgGWinGesture**. The class does not respond to all gestures, only those that have meaning for embedded windows.

Table 9-1
Embedded Window Gestures

Gesture	Gesture Name	Meaning
ꝏ	xgsDblCircle	Create reference button
∧	xgsUpCaret	Show stationery menu
∧̇	xgsUpCaretDot	Show stationery menu
⩓	xgsDblUpCaret	Show stationery menu
⊗	xgsCircleCrossOut	Undo last saved action
ǀ/	xgsVertCounterFlick	Toggle borders and controls
✓	xgsCheck	Show option sheet
U	xgsUGesture	Show option sheet
F	xgsFGesture	Start Find operation
ɸ	xgsCircleFlickUp	Start Find operation
φ	xgsCircleFlickDown	Start Find operation
S	xgsSGesture	Start spell check
P	xgsPGesture	Start spell check

clsEmbeddedWin sends all other gestures to its ancestor.

Gestures and Selection

9.6

Some abstract messages defined in **clsSelection** are actually part of the embedded window protocol. These messages are not sent to the owner of the selection, nor are they sent to the selection manager. Rather, they are self-sent by the target of a move, copy, or create reference button operation.

These messages are defined in **clsSelection** because they indirectly relate to the selection; by defining these messages in **clsSelection**, others do not have to define their own messages to do the same thing.

If you intend to handle **msgSelMoveSelection**, **msgSelCopySelection**, or **msgSelMarkSelection**, you must perform these tasks:

- Establish the owner of the selection.
- Use **clsXfer** messages to obtain the selected data from the owner of the selection.
- If the operation was a move, ensure that the owner of the selection knows to delete its copy of the data.
- Insert the data at the x-y location specified by the move, copy, or mark message.

Chapter 10 / Mark Concepts

In the PenPoint™ operating system, the data for most documents is stored in one or more components (which usually inherit from **clsEmbeddedWin**). For example, individual words can be stored in a text component, or shapes can be stored in a drawing component. However, because components contain the data, only the component knows how the data is stored.

Data within a component is not generally available outside the component.

Of course, there are times when other objects will want to manipulate the data within a component. Reference buttons, for example, allow the user to link to a specific point within a data item in a component; later, the user can use the reference button to turn back to that very same point—even if the user has added data before the point.

Another reason to want to manipulate data within a component is in traversal operations, such as checking spelling, or searching and replacing. In these operations, the traverser needs a mechanism for keeping track of its location within a component that it knows nothing about.

Traversal is directly related to embedded documents. Before reading this chapter, you should read Chapter 9, Embedded Documents.

To mark data within a component, the PenPoint operating system provides the mark class (**clsMark**). Traversal drivers can use the mark class to traverse applications and embedded windows.

All applications or components that allow themselves to be searched or spell-checked must handle **clsMark** messages, which implement the component half of the protocol. If an application or component implements new functionality similar to search and replace or spell-checking, it uses **clsMark**.

Mark Class 10.1

The mark class (**clsMark**) inherits from **clsObject**. Its messages, `#defines`, and data structures are defined in MARK.H.

A **mark** (which is an instance of **clsMark**) provides a way to refer to data items within components. The data item in a component referenced by the mark is called the **target**, because it is this data that the creator of the mark is really interested in. Notice that the target is not an object.

The object that uses the mark is called the **holder** of the mark.

For example, in the case of a reference button, the piece of information identified by the reference button is the target. The reference button itself is the holder of the mark.

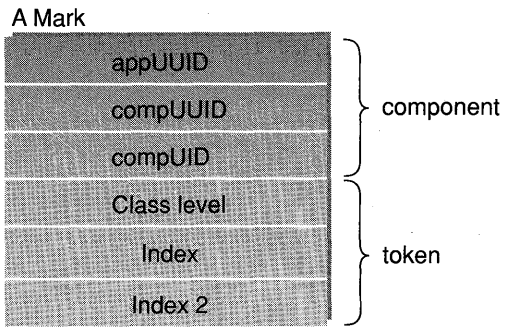
Parts of a Mark

10.1.1

There are two parts to a mark (as shown in Figure 10-1):

- A component part. This identifies the component that contains the target. The component part is managed by **clsMark**.
- A token part. This is used by the component to identify the specific location of the target within instances of itself. The token part is managed by the component.

Figure 10-1
Parts of a Mark



The component part of a mark contains:

- The UUID of the application containing the component.
- The UUID of the component that contains the target.
- The UID of the component that contains the target.

The token part of a mark contains:

- The UID of the class that contains methods to locate the target.
- Two 32-bit index values that are manipulated by the class.

Implementing Tokens

10.2

The token part of a mark is managed by the component. When you implement a component that handles marks, you must establish a relationship between the index values in the token and the actual location of the target within the component. In a simple relationship, a database might use the token to hold a record number. The mark then points to that specific record. However, a mark might persist beyond a single operation. Storing a record number in a token wouldn't work if records could be inserted or deleted from the database positionally before the target record.

A token references the target data, but there is no way for the component to update the token, once it is given to the holder.

To support marks that persist, your component must establish a mapping between the token and the target. If the target moves, the token must still be able to find the target.

There are two common forms of mapping: table mapping and stamp mapping. Regardless of how you implement your token, your program must manage and store the token.

Table Mapping 10.2.1

In table mapping, your component creates and maintains a table that contains pairs of token values and data that identifies what the token refers to. If the position of the data changes (for example, if the user adds or deletes characters), your component updates the positions in the token table so that the mark points to the target at the correct location.

When a token is requested of a table-mapping component, the component creates a new table entry with a new, unused token value. Once a number is used as a token, it cannot be reused; this ensures the integrity of the token.

MiniText implements tokens using table mapping. Table mapping is recommended if the data the program handles is densely stored.

Stamp Mapping 10.2.2

In stamp mapping, your component stores the token as a part of its target data. When your component receives a request for a mark, it creates a token and inserts it directly into the data. Your program must have a way to locate tokens within the data and a way to to identify each token.

Stamp mapping is a viable way to implement tokens when the overhead of adding a token to a data item is small. For example, the effort of storing a token for individual characters is high; for a text-based application, it's unlikely that you'll want to implement tokens using stamp mapping. However, with a scribble or some other graphical object, the effort of storing a token may be small enough to justify using stamp mapping.

The difficulty in implementing stamp mapping arises when you consider how to handle multiple marks pointing to the same object. There are two possible solutions:

- If your component can afford the storage space, it can store a token for each mark that points to your data.
- If your component only has room for one token at a time, and it receives a request for another mark, it can pass the current token to the new mark. (Thus, there are two marks with the same token.) When one of the marks moves, your component can assign a new token to the mark that moved. With this scheme, you have to decide how to hand out new token values. There are two alternatives:
    - Create a token value for the data item and leave it there forever. Although this is easy to implement, there is the possibility of running out of token values.

- Keep track of the number of marks that refer to a data item. When a mark that targets the data item is repositioned *and* the reference count is one, move the token value to the next data item and clear the token on the old data item. MiniNote implements this variant of stamp mapping.

How to Support Marks 10.3

At the very least, your component must handle these basic messages:

msgMarkCreateToken requests that your component create a new token.

msgMarkDeleteToken requests that your component delete a token.

msgMarkGetDataAncestor requests that your component return the next higher superclass that can traverse the component's data.

For a component that can be traversed, you must handle the following messages:

msgMarkPositionAtEdge requests that your component reposition a token to one end or the other of its data.

msgMarkPositionAtToken requests that your component reposition a token to the same position as another token in the same component.

msgMarkCompareTokens requests that your component compare the ordering of two tokens.

For components that have a graphical view of data, you must handle:

msgMarkShowTarget requests that your component identify the window that contains the view on the target.

msgMarkSelectTarget requests that your component select the target data.

msgMarkPositionAtSelection requests that your component reposition the token to the current selection.

msgMarkPositionAtGesture requests that your component reposition the token to the location of a gesture.

For components that manage their own embedded documents, you must handle:

msgMarkPositionAtChild requests that your component postion the token to an embedded component.

msgMarkNextChild requests that your component position the token to the next embedded component.

msgMarkGetChild requests that your component identify the component at the token.

For components that are not descendents of **clsEmbeddedWin** or **clsApp**, you must handle:

msgMarkGetParent requests that your component identify its parent component.

msgMarkGetUUIDs requests that your component identify its own application and component UUIDs.

Creating and Holding Marks

10.4

When a user selects an operation like Search/Replace or Spell, the PenPoint Application Framework creates a driver for that operation. The driver creates a mark, using some of the information it got from the PenPoint Application Framework. The driver communicates with the application and its embedded components (including embedded applications executing in different processes) by sending messages to the mark. The mark figures out what component to send them to.

The **clsMark** protocol describes how drivers communicate with the mark and how the mark communicates with client components. What it does *not* describe are the details of the messages that drivers use to communicate with components (because these messages vary depending on the job to be done).

Drivers communicate with components through a mark with three messages: **msgMarkDeliver**, **msgMarkDeliverPos**, and **msgMarkDeliverNext**. Each of these three messages "piggy-backs" a message and associated arguments that are sent from a driver to a component.

The messages that the Search/Replace and Spell drivers use to communicate with text-containing components are defined in SR.H.

A holder follows these steps to create and use a mark:

- Sends **msgNewDefaults** and **msgNew** to **clsMark**. This creates the mark and sets up the component for the mark and, optionally, positions the mark for you.
- Sends the appropriate **msgMarkPosition** message to the component using the mark. This sets the mark where you want it.
- Sends a message using **msgMarkDeliver**, **msgMarkDeliverPos**, and **msgMarkDeliverNext** to the component, using the mark, if you want to manipulate the mark.
- Sends **msgDestroy** to the mark when you're finished with it.

With a persistent mark, the target of the mark will never receive a delete token message, even if the holder is deleted. When a mark is copied or filed, it becomes persistent.

Link Files

10.5

When a mark is saved and restored, **clsMark** uses three low-level messages to create a link handle and link file that are used to keep track of the target data. These messages are described in APP.H:

msgAppCreateLink creates a link to another document, passing back the UUID of the document to be linked to. The linked-to document's UUID is stored in DOC.LNK.

msgAppDeleteLink deletes a link to another document. You must specify a link handle.

msgAppGetLink passes back the linked-to document's UUID.

Chapter 11 / Printing

Printing in the PenPoint™ operating system is different from printing in most other operating environments because PenPoint can defer output until the user connects the appropriate printer. When the application is requested to prepare its output for the printer, the application uses the same layout messages that it would for the screen, only the image is displayed on a piece of paper by a printer. This approach frees the application developer from having to understand the command set for a particular printer. All the application has to do is lay itself out for printing (if that is different from laying itself out on screen).

When printing in PenPoint, your application does not explicitly print to a device. It opens the document (or a copy of the document) in the background using a window device that is bound to a printer, rather to than the screen.

This chapter describes the printing messages that your application receives and how to respond to them.

The Out box mechanism, which is used to defer documents until the printer is ready, is described in *Part 10: Remote Interfaces.*

This chapter covers these topics:

- The concepts of printing, which include an overview of the flow of control in printing.
- How to participate in the option card protocol to add your own option cards for printing.
- The print protocol and how an application should respond to printing messages.

Concepts 11.1

Printing involves several aspects of the PenPoint operating system.

- When the user prints a document, the PenPoint operating system uses the Out box mechanism to queue the document for printing.
- When the user connects the printer, the Out box service section that contains the document creates, activates, and opens a **printing wrapper** for the document.
- When the service section opens the wrapper, the wrapper uses PenPoint Application Framework messages to open the document.
- The wrapper uses printing messages to tell the document when and what to print. The messages allow the document to behave correctly if it contains embedded documents.

- Finally, the document uses the UI Toolkit to lay out its pages for the printer.

If you write an application that prints, you should determine if your application is responsible for:

- Adding option cards to the Print Setup dialog sheets (the option card protocol is discussed later in this chapter).
- Handling open messages so that they remove unnecessary decorations from your frame (such as scroll bars, borders, and menus).
- Laying out pages in response to the printing messages.
- Handling embedded documents so that they print correctly.

All other aspects of printing (finding the device driver, queuing, and sending data to the printer) are handled by the PenPoint operating system.

Printing Embedded Documents 11.1.1

The PenPoint operating system's embedded document architecture presents certain challenges when printing documents that have embedded documents. This is particularly true when the embedded document is a full-sized document, of which the user only sees a portion through a scrolling window.

The Embedded Printing card of the Print Setup option sheet determines how to print documents embedded within the document being printed (the parent document). When the user prints a document, the Print option specifies whether to print embeddees at all. The Location option specifies either:

- Print In Place. That is, print the visible portion of each embeddee in place in the parent document where it is embedded.
- Print At End. That is, print each embedded document in full at the end of the parent document.

Thus, there are three possible printing situations for embedded documents.

- Do not print the embedded document (Print is No).
- Print the portion of the embedded document that you see on screen just as it appears (Print is Yes, Location is In Place).
- Print the entire embedded document after printing its embeddor (Print is Yes, Location is At End).

The PenPoint Application Framework provides default implementations for not printing and for printing At End.

If the user selects print at end and the PenPoint Application Framework encounters an embedded document, it closes the embedded document and queues it to the end of the print job. When the embedded document reaches the top of the queue, the PenPoint Application Framework opens the document as a new, top-level document, which can then receive printing messages. The embedded document begins printing on a new page. This expansion can be recursive. A deferred embeddee becomes top-level when it is printed. If the embedded document has embeddees of its own, they are queued for printing immediately after their parent.

Embedded documents printed In Place have no control of the page. You do not have to do anything special for these documents when printing. They are opened in place and are confined to the clipping window within their parent, just as they are displayed on screen. However, the embedded documents do know that they're printing, because they receive **msgAppOpen**. The message arguments for **msgAppOpen** and their application metrics indicate that they are printing.

Making Pagination Decisions 11.1.2

The printing protocol handles two forms of pagination:

flow for documents that can display their information in an arbitrarily-sized visual space. For example, MiniText documents can flow.

nonflow for documents that must display their information exactly as described by the user. For example, MiniNote documents cannot flow.

The printing protocols will ask your application whether it is a flow or nonflow document by sending **msgPrintGetProtocols** to your active document.

Paginating Nonflowing Documents 11.1.2.1

There are two methods for paginating a nonflowing document: tiling or scaling. Tiling is well defined, invariant across documents, and easy to implement. For these reasons, and to avoid duplication of tiling code in many applications, printing in the PenPoint operating system provides tiling by default. You do not have to do anything to paginate a tiling document.

The user interface for printing does not offer the tiling option to the user. An application that wants to use tiling as a pagination method must present a tile option to the user (on a Print Setup option card) or simply use it as its default pagination method.

Scaling is much more difficult to implement and depends greatly on the type of document being printed. For instance, scaling a spreadsheet that uses PenPoint fonts is possible, because ImagePoint is built to scale its elements. However, scaling a bitmap image, while possible, suffers from rounding errors and other problems. You must design and write your own scaling pagination routines.

Designing a PenPoint Application in the *PenPoint UI Design Reference* provides user interface guidelines on option presentation.

Paginating Flow Documents 11.1.2.2

Paginating flow documents is relatively simple. When your application receives a next page message, it flows its data into the space available and adds any other elements to the page. Your application must keep track of what it has printed and what it hasn't printed. When it receives the *next* next page message, it can resume flowing data where it left off.

Option Sheets for Printing 11.2

This section provides a brief summary of the option sheet protocol. *Part 4: UI Toolkit* describes option sheets and the option sheet protocol in detail.

Before printing, the user can change document printing options by tapping on the **Print Setup** button in the Document menu. Typically, the Print Setup option sheet allows the user to change the margins and the headers and footers for the document.

If your application has other printing options that you want the user to be able to change, you can add your own option cards to the Print Setup sheet. For example, if you are writing a drawing program, you might want to present the user with some options for tiling pages when printing a drawing larger than a single sheet.

When the user taps on **Print Setup**, which sends **msgAppPrintSetup** to the application, the following events occur:

1. **clsApp** handles **msgAppPrintSetup** by sending **msgAppShowOptionSheet** to **self**, specifying **tagAppPrintSetupOptSheet.**
2. **clsApp** handles **msgAppShowOptionSheet** by creating an option sheet by sending **msgAppGetOptionSheet** to self.
3. **clsApp** handles **msgAppGetOptionSheet** by creating the option sheet for the printer setup dialog. Eventually it sends **msgAppAddCards** to self.
4. Your application should handle **msgAppAddCards** by adding its option cards to the option sheet (as described below).
5. After handling **msgAppAddCards**, your application should allow its ancestor to handle the message, so that its ancestors can add their own cards to the option sheet.
6. **clsApp** adds its own option sheets and returns, which unwinds back to **clsApp** handling **msgAppShowOptionSheet**
7. **clsApp** then sends **msgOptionShowCardAndSheet** to insert the option sheet into your document's frame.

Handling msgAppAddCards 11.2.1

msgAppAddCards passes a pointer to an OPTION_TAG structure that contains:

option	The UID of the option sheet.
tag	The tag for that option sheet.

When your application handles **msgAppAddCards**, it should first check which option sheet is being built. You can identify the option sheet by checking the **tag** value. When creating the Print Setup option sheet, **tag** contains the value **tagAppPrintSetupOptSheet.**

To add cards to the option sheet, send **msgOptionAddCard** to the option sheet specified in **option**. When your application adds the last of its cards, use

msgOptionAddLastCard. If your application has only one card, it should use **msgOptionAddLastCard** exclusively.

After adding option cards, your application sends **msgAppAddCards** to its ancestor so that it can add its own cards.

Print Protocol Description

11.3

When the user taps on **Print** in the Document menu to print a document, the button sends **msgAppPrint** to the document. Usually, your application allows its ancestor (**clsApp**) to handle **msgAppPrint. clsApp** provides default print behavior and communicates with **thePrintManager. thePrintManager** responds by performing two actions:

- Displaying a dialog that asks the user to choose a printer.
- Moving a copy of the document to an appropriate service section in the Out box.

The document remains in the Out box until the user connects the appropriate printer. At that time, the manager of that service section creates a **wrapper** (a special embeddor application that is an instance of **clsPrint**). When the service section activates and opens the wrapper, the wrapper activates and opens your document. However, the window device used by your document is not the screen; it is a window device created by the wrapper.

Print Layout Driver (PLD)

11.3.1

When the wrapper activates and opens your document, it also creates an instance of **clsPrLayout** called a print layout driver (PLD). The printer layout driver essentially guides the pagination process by sending paginate page messages until the document returns **stsEndOfData** (or an error).

The process described here is a pagination process (as opposed to imaging). The real imaging happens as a result of the ImagePoint messages **msgWinStartPage** and **msgWinRepaint**.

The printing protocol messages listed in Table are defined by **clsPrint** and are described in PRINT.H.

Table 11-1
Printing Protocol Messages

Message	Takes	Description
msgPrintStartPage	P_PRINT_PAGE	Advance document to its next logical page.
msgPrintLayoutPage	P_PRINT_PAGE	Tells a document to lay out its logical page.
msgPrintGetMetrics	P_PRINT_METRICS	Gets the print metrics.
msgPrintSetMetrics	P_PRINT_METRICS	Sets the print metrics.
msgPrintApp	P_PRINT_DATA	Prints a document.
msgPrintPaperArea	P_PRINT_AREA	Passes back the width and height of the printing area on the paper.
msgPrintGetProtocols	P_PRINT_PROTOCOLS	Gets the pagination and embeddee protocols.
msgPrintEmbeddeeAction	P_PRINT_EMBEDDEE_ACTION	Requests document's permission to perform an action on an embeddee.
msgPrintExamineEmbeddee	P_PRINT_EMBEDDEE_ACTION	Request from document to interpret embedded window's print properties.
msgPrintSetPrintableArea	PRINTABLE_AREA	Requests margin adjustment for unprintable area.
msgPrintGetPrintableArea	PRINTABLE_AREA	Requests margin information.

Each time it is ready for the application to layout a page, the PLD sends **msgPrintStartPage** to the top-level document being printed. This is a signal to the application to advance its private context to the next page of display (depending on its layout type: flow or nonflow). This could mean simply advancing a data pointer or perhaps inserting a new window in the parent of the application's **mainWin**.

If an application chooses to account for the unprintable area on a page, it sends **msgPrintGetPrintableArea** and **msgPrintSetPrintableArea** to the PLD to make the adjustment. The PLD's default tiling does this by default.

After sending **msgPrintStartPage**, the PLD sends **msgPrintGetProtocols** to the top-level document. The message arguments passed back tell the PLD how the application wants to paginate its logical page and how embeddees are to be processed.

Removing Frame Decorations 11.3.2

When the printer wrapper is active, it activates and opens your document using **msgAppMgrActivate**. The arguments for the activation message use the wrapper's window device (the printer) as the window device for your document.

Eventually, the PenPoint Application Framework sends **msgAppOpen** to your document.

clsApp self-sends **msgAppSetPrintControls** in its handler for **msgAppOpen**. **clsApp** responds by:

1 Turning off all frame decorations when the application is top level (**pArgs** is **true**).

2 Turning off all frame decorations *except* alternate (user-set) borders when the application is embedded (**pArgs** is **false**).

The frame decorations include:

- Title, menu, and command lines.
- Tab bar.
- Scroll bars.
- Borders.

If you want non-standard behavior (for example, if you choose to leave some of your frame decorations on for printing), you should handle **msgAppSetPrintControls**.

When your application receives **msgAppOpen**, it should check the **printing** flag in the message's **pArgs**. If **printing** is **true**, your application should remove anything from its frame that you don't want to print (particularly things that are specific to the user interface rather than presentation).

Your method table entry for **msgAppOpen** *must* specify call-ancestor-after. When **clsApp** receives **msgAppOpen**, it self-sends **msgAppSetPrintControls** to remove the title, menu bar, tab bar, border, command lines, and scroll bars from the frame. **clsApp** *does not* remove decorations from custom frames that inherit from **clsFrame**, nor can it remove custom decorations that you added to the frame. The wrapper then sends messages to the document, telling it to paginate.

Pagination 11.3.3

The PLD can specify two forms of pagination: flow and tiling.

If **paginationMethod** is **prPaginationFlow**, pagination is left totally up to the application.

If **paginationMethod** is **prPaginationTile**, the PLD will paginate the document's main window by tiling it. All the document needs to do in preparation is to make its main display window lay out as full size. Then, when the print protocols indicate that tiling is requested, the PLD performs these steps:

1 Set the shrink-wrap bits on the document's frame, if it has one.

2 Send **msgWinLayout** to the print window (**prframe**) and relax its parent's constraints on the document's main window during the layout.

3 Send **msgPrintLayoutPage** to the document.

4 Calculate and process each tile.

Thus, the document can size its main display window when the document is opened, in response to **msgPrintStartPage**, during **winLayoutSelf**, or in response to **msgPrintLayoutPage** after the print protocols have been set.

If the document's main display window (usually the frame **clientWin**) is sensitive to shrinking (in other words, it won't expand back to full size when its parent relaxes constraints), the document should protect it with a scroll window to make sure the PLD's clipper window never forces it to shrink. Note that the PLD clipper window always forces the document's outermost window to match its own size before the PLD knows it is tiling.

msgWinLayout always follows **msgPrintGetProtocols. msgPrintLayoutPage** follows **msgWinLayout. msgPrintLayoutPage** is similar to **msgWinLayout**, but is intended for two types of clients:

- Clients wanting to be sure they only get one layout message per page.
- Clients having the page layout logic in the document, as opposed to in a view.

In response to **msgPrintLayoutPage**, a typical flow-type application begins calculations to layout its contents. If the application encounters embedded documents while laying its page out, it calls the print layout driver for the embeddees.

Handling Embeddees 11.3.4

There are two ways to handle embeddees:

- The PLD can enumerate the embeddees after laying out a page (**prEmbeddeeSearchByPrintJob**).
- The application finds the embeddees on its own (**prEmbeddeeSearchByApp**).

Using prEmbeddeeSearchByPrintJob 11.3.4.1

In **prEmbeddeeSearchByPrintJob**, the PLD uses **winEnum** to find all embedded windows in the document's **childAppParentWin** after the application lays out a logical page. Each time the PLD finds an embedded document, it sends **msgPrintEmbeddeeAction** to the document (document's layout UID, specified in pArgs to **msgPrintStartPage**) to inform it of the appropriate action. If the response is **stsOK** or **stsNotUnderstood**, the PLD takes the action, if there is one, and then sends **msgWinLayout** again. The current actions that PenPoint implements are **prEmbedActionAsIs** and **prEmbedActionExtract**.

The PLD proposes **prEmbedActionExtract** when the embeddee's print properties are set to invisible or defer to end. When the document approves the action, the PLD extracts the embedded window from the window tree (if it is inserted) and either forgets about it (invisibility) or puts in on a queue to deal with it after the current document is finished printing.

Handling prEmbeddeeSearchByApp 11.3.4.2

In **prEmbeddeeSearchByApp**, the document finds the embedded windows on its own (usually in response to **msgPrintLayoutPage**) and calls the PLD on each one (**msgPrintExamineEmbeddee**). The PLD obtains the embeddee's print properties and proposes an action by **msgPrintEmbeddeeAction**, as above. The document can process its embedded windows in response to either **msgPrintStartPage** or **msgPrintLayoutPage**. However,in the former case, **msgPrintEmbeddeeAction** will always be sent to the document, because the document has not yet returned an **appLayoutUID** from **msgPrintStartPage**.

Default Printing Behavior 11.3.5

The printing protocol is designed so that even if an application doesn't handle the printing messages, the PLD makes certain assumptions that enable it to print a document (or at least a part of it).

If the PLD sends printing messages to a document but the application does not define methods for the printing messages, the messages return **stsNotUnderstood**.

msgPrintStartPage Not Understood 11.3.5.1

If **msgPrintStartPage** returns **stsNotUnderstood** to the PLD, it indicates that the document doesn't know how to paginate or only has one logical page to print (such as a tiled drawing program or the Tic-Tac-Toe sample program).

When the PLD receives **stsNotUnderstood** in response to **msgPrintStartPage**, it tells the document to lay out and print the current page. If the document is not tiled, it prints the upper left portion of the document (the portion of the document's display window that is not clipped by the PLD clipper).

msgPrintGetProtocols Not Understood 11.3.5.2

If **msgPrintGetProtocols** returns **stsNotUnderstood** to the PLD, the PLD assumes that:

- **paginationMethod** is **prPaginationFlow**.
- **embeddeeSearch** is **prEmbeddeeSearchByPrintJob**.

msgPrintEmbeddeeAction Not Understood 11.3.5.3

If **msgPrintEmbeddeeAction** returns **stsNotUnderstood** to the PLD, the PLD acts as if the document returned **stsOK**. The assumption here is that if the document didn't know enough not to return **stsRequestDenied**, the PLD should be able to enter an embedded document anyway.

msgPrintLayoutPage Not Understood 11.3.5.4

If **msgPrintLayoutPage** returns **stsNotUnderstood** to the PLD, the PLD acts as if the document returned **stsOK**.

Chapter 12 / The Application Manager Class

The application manager class (**clsAppMgr**) defines messages to install application classes, to keep track of installed application classes, and to create, activate, and destroy instances of an application.

Your application uses these messages to create a new application class and to get information about installed classes. The **clsAppMgr** messages also include two observer messages that inform when applications have been installed or deinstalled.

This chapter covers the following topics:

- Installing a new application class.
- Creating a new document.
- Activating an application instance.
- Moving or copying an application instance.
- Deleting application instances.

Application Manager Metrics 12.1

Each application class has metrics that pertain to the class in general (not to each instance):

- The application name.
- The name of the company that wrote the application.
- How the application name appears in the Create menu.
- Whether the application allows embedding.
- Whether instances run in **hot mode** by default.
- Whether the user can create instances of the application.

This information allows the Notebook to let the user know about your application and provide your application with the right environment.

Because **clsAppMgr** stores this general information once for each application class, **clsApp** doesn't have to maintain it for each instance. Nor does **clsApp** have to respond to messages requesting this information.

The **clsAppMgr** messages are defined in APPMGR.H. Table 12-1 lists the messages defined by **clsAppMgr**.

Table 12-1
clsAppMgr Messages

Message	Takes	Description
msgNew	P_APP_MGR_NEW	Install a new class.
msgNewDefaults	P_APP_MGR_NEW	Initialize the defaults for a new class.
msgAppMgrGetMetrics	P_APP_MGR_METRICS	Get the class metrics.
msgAppMgrCreate	P_APP_MGR_CREATE	Create an instance of an application.
msgAppMgrActivate	P_APP_MGR_ACTIVATE	Activate an instance of an application.
msgAppMgrMove	P_APP_MGR_MOVE_COPY	Move a doc to a new location.
msgAppMgrCopy	P_APP_MGR_MOVE_COPY	Copy a doc to a new location.
msgAppMgrFSMove	P_APP_MGR_FS_MOVE_COPY	Low-level move message. Used by msgAppMgrMove.
msgAppMgrFSCopy	P_APP_MGR_FS_MOVE_COPY	Low-level copy message. Used by msgAppMgrCopy.
msgAppMgrDelete	P_APP_MGR_DELETE	Delete a doc.
msgAppMgrRename	P_APP_MGR_RENAME	Rename a doc.
msgAppMgrShutdown	P_FS_LOCATOR	Unconditionally shutdown an app instance and all children.
msgAppMgrGetRoot	P_APP_MGR_GET_ROOT	Get the root application (clsRootContainerApp) of a tree of applications.
msgAppMgrSetIconBitmap	OBJECT	Set the icon bitmap.
msgAppMgrSetSmallIconBitmap	OBJECT	Set the small icon bitmap.
msgAppMgrRevert	P_FS_LOCATOR	Revert to filed copy.
msgAppMgrRenumber	P_FS_LOCATOR	Renumber an application heirarchy.
msgAppMgrDumpSubtree	P_FS_LOCATOR	Display the attributes of a subtree of apps.
msgAppMgrGetResList	P_APP_MGR_GET_RES_LIST	Creates a resource list, given an application UUID.

Installing a New Class 12.2

When your application's **main** routine detects that **processCount** is 0, it should call its application class initialization routine. This routine declares an APPMGR_NEW structure, initializes it (by sending **msgNewDefaults** to **clsAppMgr**), modifies some of the arguments, and then sends **msgNew** to **clsAppMgr**. In addition to an OBJECT_NEW_ONLY structure, APPMGR_NEW contains two structures: a CLASS_NEW_ONLY structure and an APP_MGR_METRICS structure.

The CLASS_NEW_ONLY structure contains:

pMsg the address of the application's **msgProc.**

ancestor the application's ancestor class.

size a 20-bit value that specifies the size of the application class's instance data, in bytes.

newArgsSize a 20-bit value that specifies the size of the application class's _NEW structure.

The APP_MGR_METRICS structure contains:

dir the handle on the application directory that contains the installed application.

appMonitor the UID of the application monitor object. The application monitor is responsible for configuring an application the first time it is loaded. If the application is already loaded, the application monitor loads the application's resource file and other portions of the application.

resFile the handle on the resource file used by the application.

iconBitmap the resource ID of the icon bitmap for the application.

smallIconBitmap the resource ID of the small icon bitmap for the application.

appWinClass the UID of the application's window class.

defaultRect a RECT32 structure that specifies the application's default rectangle in points.

name a string that specifies the name of the application.

version a string that specifies the version of the application.

company a string that specifies your company's name.

defaultDocName a string that specifies the default name for a document created by the application. If you specify **pNull**, the PenPoint Application Framework will look for the default document name in **tagAppMgrDefaultDocName** in the resource file APP.RES.

copyright a pointer to a string that contains the copyright notice for the application.

programHandle an OS_PROG_HANDLE structure that specifies the location to receive the handle on the application's executable file in the loader database.

flags an APP_MGR_FLAGS structure that specifies other information about the application. Table 9-2 describes the application manager flags.

Table 12-2
Flags Described by APP_MGR_FLAGS

Flag	Meaning
stationery	Put in Stationery notebook.
accessory	Put in Accessories menu.
hotMode	Create instances in hot mode.
allowEmbedding	Allow child embedded applications.
confirmDelete	Ask the user for confirmation before deleting.
deinstallable	The user can deinstall the application.
systemApp	System application.
lowMemoryApp	Allow activation of this application under low memory conditions.
fullEnvironment	Provide instance 0 with a full environment.

Creating a New Document 12.3

To create a new document, send **msgAppMgrCreate** to the application class. **msgAppMgrCreate** creates a new directory and gives the directory an attribute that specifies the application class. The actual application instance does not exist until you send **msgAppMgrActivate** to **clsAppMgr**.

msgAppMgrCreate takes a pointer to an APP_MGR_CREATE structure that contains:

locator a locator for the directory of the document's parent. Usually, this is the Notebook Table of Contents or a section; for embedded documents, this can be any document.

pName a pointer to a string that contains the name of the new application instance.

sequence a U32 value that specifies the sequence number of the new application instance in its parent application.

renumber a Boolean value that indicates whether the global sequence numbers should be updated when creating this application instance. If the value is **true**, **clsAppMgr** updates the global sequence numbers.

Activating an Application Instance 12.4

To activate a document and all its embedded documents, send **msgAppMgrActivate** to the application class. The message takes a pointer to an APP_MGR_ACTIVATE structure that specifies:

winDev the UID of the window device for this application.

locator a locator for the directory that contains the application to activate.

parent the UID of the parent application.

uid a UID value that will receive the UID of the new application instance.

msgAppMgrActivate creates a new process and sends it the information it needs to create a **msgNew**. In **AppMain**, your application creates a **msgNew** and sends it to **clsClass**. This creates an application object in the process. From this point on, the application instance is on its own, and responds to **clsApp** messages.

If the application monitor was unable to activate a document because there wasn't enough memory, it returns **stsAppMgrLowMemNoActivate**.

Moving or Copying an Application Instance 12.5

To move or copy a document to a new location, send **msgAppMgrMove** or **msgAppMgrCopy** to the application class for that document. Both messages take a pointer to an APP_MGR_MOVE_COPY structure, which contains:

locator a file system locator for the source document.

source the UID of the source object.

dest the UID of the destination object that will contain the moved or copied document.

xy an XY32 structure that specifies the x-y coordinates of the location within the destination object where the document will be moved or copied.

name a string buffer that contains the name of the document being moved or copied. If the destination already contains a document with the same name, the application manager creates a new name for the document and stores the new name in this buffer.

renumber a Boolean value that indicates whether the global sequence numbers should be updated. If the value is **true**, **clsAppMgr** updates the global sequence numbers.

style An APP_MGR_MOVE_COPY_STYLE enumerated value that specifies the style for the move or copy. The possible values are:

showConfirm show the confirmation sheet to the user before moving or copying.

showProgress show the progress of the move or copy to the user.

appWin the UID of the application window that was moved or copied.

Deleting Application Instances 12.6

You use **msgAppMgrDelete** to destroy a document. That is, you use it to free the application object, destroy the process, delete the resource file, and delete the directory. If the application instance doesn't go away when you send it **msgAppDelete**, you can send **msgAppMgrDelete** to its class. **msgAppMgrDelete** does the same thing as **msgAppDelete**, but it does not rely on the application instance being able to respond to messages.

You send **msgAppMgrDelete** to the application's **class**, not to an instance of the application. The message takes a pointer to an APP_MGR_DELETE structure that contains:

locator a locator that specifies the document's directory.

renumber a Boolean value that indicates whether the global sequence numbers should be updated. If the value is **true**, **clsAppMgr** updates the global sequence numbers.

Getting Metrics for a Class 12.7

To get the metrics for a particular class, send **msgAppMgrGetMetrics** to the application class. The message takes a pointer to an APP_MGR_METRICS structure, which is the same structure used in **msgNew**.

Observer Messages

12.8

When applications are installed or deinstalled, these messages are sent to observers of clsApp:

msgAppInstalled indicates that an application has been installed.

msgAppDeInstalled indicates that an application has been deinstalled.

Both messages have a single argument, the UID of the class that was installed or deinstalled.

Chapter 13 / The Application Monitor Class

The application monitor drives application installation, performs application global functions, and helps deinstall an application. An application monitor instance runs in process 0 of an application, along with an application manager instance.

The application monitor functions are defined by **clsAppMonitor**. Applications can subclass **clsAppMonitor** to provide additional functions, such as performing specialized installations, providing file import, setting and saving global application configurations, and providing file converters.

Application Monitor Concepts 13.1

The application monitor assists in application installation and deinstallation.

For the application monitor to perform its work properly, your file organization must conform to the organization described in the File Organization chapter of *Part 12: Installation API.*

Application Monitor in Installation 13.1.1

When the user installs your application:

1 The installer calls **OSProcessCreate**, specifying your application executable file. The entry point for that file is **main**. Because the user is installing your application, this is the first process running your application executable; thus, it receives the process number 0.

2our **main** routine examines the process number and, if it is 0, calls some class initialization routines and then calls **AppMonitorMain. AppMonitorMain** is a PenPoint-provided routine that creates an instance of **clsAppMonitor**, running in the context of your process 0. This instance of **clsAppMonitor** is your application's application monitor.

3 AppMonitorMain sends **msgAppInit** to your application monitor.

4 If this is the first time the application has ever been installed, the application monitor puts up the installation option sheet so the user can specify the configuration. The results from the option sheet are stored in the application's resource file (APP.RES). The PenPoint™ operating system defines a default property sheet; your application can provide its own property sheet to override the defaults.

5 The application monitor uses the application's resource file to drive the rest of the installation.

6 Using the application resource file, the application monitor loads all other portions of the application, such as Stationery, Help, Accessories, and any miscellaneous resources.

To override the default behavior provided by **clsAppMonitor**, you may have to subclass it. The considerations for subclassing **clsAppMonitor** are described in this chapter in "Subclassing clsAppMonitor."

Other Application Monitor Functions 13.1.2

After installing an application, the application monitor does not go away.

When requested, the application monitor can deinstall the application.

Stationery, Accessories, and Help 13.1.3

The application monitor is also responsible for loading stationery, accessories, and help templates from the application's distribution disk to their appropriate notebooks.

The application monitor creates a section in the Stationery notebook for your application and copies the stationery templates into that section. If you do not provide stationery, the application monitor creates a blank document for your application and stores it in the Stationery notebook.

If the application's distribution disk contains accessory templates, the application monitor copies the accessories templates into Accessories. If there are no accessories, the application monitor skips this stage.

The application monitor creates a section in the Help notebook for your application and copies the help templates into that section.

clsAppMonitor Messages 13.2

The **clsAppMonitor** messages are defined in APPMON.H. Table 13-1 lists the application monitor's messages.

Table 13-1
clsAppMonitorMessages

Message	Takes	Description
		Instance Messages
msgAMGetMetrics	P_AM_METRICS	Gets the application monitor's metrics.
msgAMLoadInitDll	OBJECT	Loads, runs, and unloads an optional initialization .dll.
msgAMLoadMisc	void	Loads the application's miscellaneous files.
msgAMLoadStationery	void	Loads stationery and accessories templates from application's distribution disk.
msgAMRemoveStationery	void	Removes all the stationery and accessory templates for this application.
msgAMLoadHelp	void	Load help into the Help notebook.
msgAMRemoveHelp	void	Removes all Help notebook items for this application.

continued

Table 13-1 (continued)

Message	Takes	Description
msgAMPopupOptions	P_BOOLEAN	Pops up the global option sheet the first time the application is installed.
msgAMLoadAuxNotebooks	void	Performs all activities related to auxiliary notebooks.
msgAMLoadFormatConverters	void	Loads file format converter .dlls.
msgAMUnloadFormatConverters	void	Unloads file format converter .dlls.
msgAMLoadOptionalDlls	void	Loads an application's optional .dlls.
msgAMUnloadOptionalDlls	void	Unloads an application's optional .dlls.
msgAMTerminateOK	P_OBJECT	Asks if this application is willing to terminate.
msgAMTerminate	void	Terminates this application.
msgAMTerminateVetoed	P_AM_TERMINATE_VETOED	Application termination sequence was vetoed.
		Descendent Modified Messages
msgAppInit	DIR_HANDLE	Installs the application.
msgAppRestore	pNull	Reinitializes the application after a warm boot.
msgAppOpenTo	APP_OPEN_TO	Displays the application's configuration option sheet.
msgAppCloseTo	APP_CLOSE_TO	Removes the application's configuration option sheet.
msgAppClosed	APPMONITOR	Sent to observers when the configuration option sheet is closed.

Using clsAppMonitor Messages 13.3

You usually use the **clsAppMonitor** messages to get information about an application class (**msgAMGetMetrics**). From the application monitor's metrics, you can find the UID of the application class.

Most of the other messages are used by the installer application to load and unload an application's stationery, help, and related components.

Getting App Monitor Metrics 13.3.1

To get the application monitor's metrics, send **msgAMGetMetrics** to an application monitor. The message takes a pointer to an AM_METRICS structure that is uses to return the metrics. The structure contains a single element, the UID of the application class (**appClass**).

Loading and Unloading Stationery 13.3.2

To load stationery templates from the application's distribution disk to the Stationery notebook, send **msgAMLoadStationery** to the application monitor. The message takes no arguments.

clsAppMonitor looks for stationery in a directory named statnry (in the application directory). The stationery can be either a complete saved instance of a document, or simply a directory. A piece of stationery is loaded into the Stationery notebook only if its file has the attribute **smAttrStationeryMenu**.

To remove all stationery that belongs to an application from the Stationery notebook, send **msgAMRemoveStationery** to the application monitor. The message takes no arguments.

This message will remove:

- Stationery defined by the application that was loaded when the application was installed.
- Stationery that the user defined and added to the Stationery notebook after the application was installed.

Loading and Unloading Help 13.3.3

To load help applications from the application's distribution disk to the Help notebook, send **msgAMLoadHelp** to the application monitor. The message takes no arguments.

clsAppMonitor looks for subdirectories in a directory named help (in the application's directory). Each help subdirectory can contain a help application and its files or a single file that contains ASCII text or Microsoft RTF text.

If the application monitor finds a help directory in your application, it creates a section for your application in the Help notebook and loads the contents of each subdirectory as documents in that section. The name of each subdirectory in the help directory becomes the name of a help topic in the Help notebook.

When the application monitor encounters a help directory that contains a single file, the application monitor creates an instance of the text editor and imports the file as a text editor document.

To remove help for an application from the Help notebook, send **msgAMRemoveHelp** to the application monitor. The message takes no arguments.

clsAppMonitor locates the help files that belong to the application and removes them from the Help notebook.

Loading Other Information 13.3.4

Some applications require other information, such as additional resource files or data files. When distributing an application, these files are stored in a directory named misc (in the application directory).

To load these files into an installed application directory, you send **msgAMLoadMisc** to the application monitor. The message takes no arguments.

If the misc directory exists, **clsAppMonitor** copies the directory into the installed application directory.

When you remove an application, it deletes everything in the application directory, including anything loaded with **msgAMLoadMisc**.

Subclassing clsAppMonitor 13.4

When you subclass **clsAppMonitor**, your subclass will receive the messages described in this section. Although you might want to allow **clsAppMonitor** to handle these messages, receiving these messages gives you the opportunity to handle them yourself.

Because these messages and their arguments are already described above, this section deals with special considerations and return values you that you may have to use when you receive these messages.

Superclass Messages 13.4.1

The first set of messages you will receive are **clsApp** messages that are intercepted and altered by **clsAppMonitor**.

Handling msgAppInit 13.4.1.1

If you subclass **clsAppMonitor**, you will receive **msgAppInit** at installation time.

Your method table for **msgAppInit** should send the message to ancestor (**clsAppMonitor**) first. When you receive **msgAppInit**, you can perform any first-time processing that you might need.

Handling msgAppTerminate 13.4.1.2

When the installer deinstalls your application class, it sends **msgAppTerminate** to your application monitor.

Your method table for **msgAppTerminate** should call ancestor after you handle the message. When you handle **msgAppTerminate**, you should clean up and save whatever objects you need to save. When your ancestor (**clsAppMonitor**) receives the message, it destroys your task, so you cannot expect to do any further processing after the call ancestor.

Handling clsAppMonitor Messages 13.4.2

You should not have to handle most **clsAppMonitor** messages, your ancestor will handle them for you. Those messages that must be handled by your ancestor are labeled in the header file appmon.h.

Handling msgAMTerminateOK 13.4.2.1

Your method table entry for **msgAMTerminateOK** should call ancestor before handling the message. **clsAppMonitor** then sends **msgAppMgrShutdown** to your application class for each of its active documents (by default, **clsAppMonitor** unconditionally terminates all of your application's documents).

Chapter 14 / The Application Class

While **clsAppMgr** provides methods to create and activate a document (up to the point where the process contains an application object), **clsApp** provides methods to control the document once it has an application object. Most of these messages are sent by **clsApp** or the PenPoint Application Framework; applications should not need to send them.

Messages defined by **clsApp** perform tasks such as initializing, saving, or re-creating the application instance data, opening and controlling the application instance's windows, starting message dispatching, setting hot mode, floating, zooming, and deleting application instances. All these topics are covered in this chapter.

Application instances must be **clsApp** objects. When you define your application class (in the application class initialization routine called by **main**()), you must specify that its ancestor is **clsApp**.

clsApp Messages 14.1

Table 14-1 lists the **clsApp** messages.

Table 14-1
clsApp Messages

Message	Takes	Description
		Class Messages
msgNew	P_APP_NEW	Creates and initializes a new document.
msgNewDefaults	P_APP_NEW	Initializes the APP_NEW structure to default values.
		Document Life Cycle Messages
msgAppDispatch	nothing	Starts message dispatching.
msgAppInit	DIR_HANDLE	Creates the default document data file and main window.
msgAppActivate	nothing	Activates a document and its children.
msgAppOpen	P_APP_OPEN	Opens a document's main window.
msgAppOpenTo	U32	Opens a document to a specific state.
msgAppClose	nothing	Closes a document's main window.
msgAppCloseTo	U32	Closes a document to a specific state.
msgAppTerminateOK	nothing	Checks if a document is willing to terminate.
msgAppTerminate	BOOLEAN	Terminates a document.
msgAppSave	nothing	Saves a document to its working directory.
msgAppSaveTo	DIR_HANDLE	Saves a document to a specified directory.
msgAppRestore	nothing	Restores an document from its saved instance data.

continued

Table 14-1 (continued)

Message	Takes	Description
msgAppRestoreFrom	DIR_HANDLE	Restores an document from a specified directory.
msgAppDelete	nothing	Deletes a document from the system.
msgFree	nothing	Destroys a document.
msgFreeOK	nothing	Checks to see if a document and its children are willing to be freed.
Document Hierarchy Messages		
msgAppGetRoot	P_APP	Gets the document's root document (which is typically the Notebook).
msgAppSetParent	APP	Sets the parent document.
msgAppActivateChildren	nothing	Activates the document's embedded documents.
msgAppActivateChild	P_APP_ACTIVATE_CHILD	Instantiates and activates an embedded document.
msgAppSaveChild	APP	Saves the specified child document.
msgAppSaveChildren	nothing	Saves a document's children.
msgAppOpenChildren	BOOLEAN	Opens all of the documents on the metrics.children list.
msgAppOpenChild	APP_OPEN_CHILD	Opens a specific child.
msgAppCloseChildren	nothing	Closes a document's children.
msgAppCloseChild	APP	Closes a specific child.
msgAppGetEmbeddor	P_APP	Gets a document's direct parent in the filesystem heirarchy.
msgAppCreateLink	P_APP_LINK	Creates a link to another document.
msgAppDeleteLink	P_APP_LINK	Deletes the specified link handle.
msgAppGetLink	P_APP_LINK	Gets the document's UUID for the specified link handle.
msgAppActivateCorkMarginChildren	nothing	Activates the embedded documents in the cork margin.
Document Attributes		
msgAppSetHotMode	BOOLEAN	Turns hot mode on or off.
msgAppSetMainWin	WIN	Sets the document's main window.
msgAppGetMetrics	P_APP_METRICS	Gets a copy of the application metrics.
msgAppSetName	P_STRING	Sets a document's displayed name (in its main window title).
msgAppGetName	P_STRING	Gets a document's name.
msgAppRename	P_STRING	Renames a document.
msgAppSetReadOnly	BOOLEAN	Sets the read only flag.
msgAppSetDeletable	BOOLEAN	Sets the deletable flag.
msgAppSetMovable	BOOLEAN	Sets the movable flag. Not implemented.
msgAppSetCopyable	BOOLEAN	Sets the copyable flag. Not implemented.
msgAppOwnsSelection	P_APP_OWNS_SELECTION	Tests if any object in a document owns the selection.
msgAppIsPageLevel	nothing	Asks a document if it shows up as a page in the Notebook (as opposed to being embedded).
msgAppSetSaveOnTerminate	BOOLEAN	Tells the document to save itself before terminating.

continued

Table 14-1 (continued)

Message	Takes	Description
		Document Window Messages
msgAppSetTitleLine	U32	Turns the document's title line on or off.
msgAppSetMenuLine	U32	Turns the document's menu bar on or off.
msgAppSetScrollBars	U32	Turns the document's scroll bars on or off.
msgAppSetBorderStyle	U32	Sets the border style.
msgAppSetCorkMargin	U32	Turns the document's cork margin on or off.
msgAppProvideMainWin	P_OBJECT	Asks a document to provide its main window.
msgAppCreateMenuBar	P_OBJECT	Creates the standard application menu bar.
msgAppCreateClientWin	P_OBJECT	Creates the document's client window.
msgAppGetEmbeddedWin	P_APP_GET_EMBEDDED_WIN	Finds the specified clsEmbeddedWin object within a document.
msgAppGetAppWin	P_APP_GET_APP_WIN	Finds a clsAppWin object within a document.
msgAppAddFloatingWin	WIN	Adds a window to the document's list of floating windows.
msgAppRemoveFloatingWin	WIN	Removes a window from the document's list of floating windows.
msgAppFindFloatingWin	P_APP_FIND_FLOATING_WIN	Finds the floating window that matches the given tag.
msgAppSetChildAppParentWin	WIN	Sets the window that is used as the parent window for child documents.
msgAppHide	nothing	Hides an open document.
msgAppSetFloatingRect	P_RECT32	Sets a document's floating size and position.
msgAppSetOpenRect	P_RECT32	Sets a document's open size and position.
		Standard Application Menu Messages
msgAppRevert	BOOLEAN	Reverts to the filed copy of the document.
msgAppSend	OBJECT	Sends a document.
msgAppPrint	OBJECT	Prints a document.
msgAppPrintSetup	nothing	Displays the print setup option sheet.
msgAppImport	nothing	Obsolete message. Not implemented.
msgAppExport	OBJECT	Prepares to export a document as a file.
msgAppAbout	nothing	Displays the document's "About" option sheet.
msgAppHelp	nothinged	Shows help for the application. Not implemented - reserved.
msgAppUndo	nothing	Undoes the previous operation.
msgAppMoveSel	nothing	Prepares to move the document's selection.
msgAppCopySel	nothing	Prepares to copy the document's selection.
msgAppDeleteSel	nothing	Deletes the document's selection.
msgAppSelectAll	nothing	Selects all of the objects in the document.
msgAppSearch	OBJECT	Searches a document for a string.
msgAppSpell	OBJECT	Prepares to check the document's spelling.
msgAppInvokeManager	OBJECT	Routes a message to a manager.

continued

Table 14-1 (continued)

Message	Takes	Description
msgAppExecute	P_APP_EXECUTE	Sent to the manager to execute the manager's behavior on a document.
msgAppExecuteGesture	P_GWIN_GESTURE	Invokes the default gesture behavior for a document's title line.
msgAppAddCards	P_OPTION_TAG	Adds cards to the specified option sheet.
msgAppShowOptionSheet	P_APP_SHOW_OPTION_SHEET	Shows or hides an option sheet.
msgAppGetOptionSheet	P_APP_GET_OPTION_SHEET	Gets the requested option sheet.
msgAppGetDocOptionSheetClient	P_OBJECT	Gets the client for the document's option sheets.
		Printing Messages
msgAppApplyEmbeddeeProps	OBJECT	Applies Embedded Printing option card values to first level embeddees.
msgAppGetBorderMetrics	P_APP_BORDER_METRICS	Gets the document's border metrics.
msgAppSetControls	U32	Turns controls on or off.
msgAppSetPrintControls	BOOLEAN	Turns screen decorations off for printing.
		Observer Messages
msgAppDeleted	P_APP_DELETED	Sent to observers of clsApp when a document is deleted.
msgAppFloated	P_APP_FLOATED	Sent to observers when a document is floated or unfloated.
msgAppTerminateConditionChanged	nothing	Try to terminate the document; sent when a terminate condition changed.
msgAppSelChanged	BOOLEAN	Sent to a document when something in it becomes selected or deselected.
msgAppOpened	APP_OPENED	Sent to observers when a document is opened.
msgAppClosed	APP_CLOSED	Sent to observers when a document is closed.
msgAppCreated	P_APP_CREATED	Sent to observers of clsApp when a document is created.
msgAppMoved	P_APP_MOVED_COPIED	Sent to observers of clsApp when a document is moved.
msgAppCopied	P_APP_MOVED_COPIED	Sent to observers of clsApp when a document is copied.
msgAppChanged	P_APP_CHANGED	Sent to observers of clsApp when a document has changed.
msgAppChildChanged	P_APP_CHILD_CHANGED	Sent to observers of a document when a child document is opened or closed.
msgAppInstalled	CLASS	Sent to observers of clsApp when an application is installed.
msgAppDeInstalled	CLASS	Sent to observers of clsApp when an application is deinstalled.

Although the header file for **clsApp** (APP.H) describes **msgNew** in its comments, **clsApp** does not define a method for **msgNew**. If you subclass **clsApp**, you should provide a method for **msgNew** that initializes a new document life cycle messages.

Several **clsApp** messages are intended only to be sent by the PenPoint Application Framework, especially those used in the document lifecycle. If you need to use any of these messages, refer to the *PenPoint API Reference* or the header file, APP.H.

msgAppInit
msgAppSave
msgAppRestore
msgAppOpen
msgAppClose
msgAppDelete

Document Hierarchy Messages 14.2

If your application cannot use the default PenPoint Application Framework behavior for dealing with embedded documents, it can use these messages.

Managing Embedded Documents 14.2.1

Embedded documents are also known as child application instances. Usually the Notebook and the create menu take care of creating embedded documents for the user. However, if your application has a special need, you can use these messages to create embedded documents.

Activating All Embedded Documents 14.2.1.1

To activate all embedded documents, send **msgAppActivateChildren** to the parent application object. The message has no arguments.

Activating a Single Embedded Document 14.2.1.2

To activate a single embedded document, send **msgAppActivateChild** to the parent application object. The message requires a pointer to an APP_ACTIVATE_CHILD structure that contains two arguments:

pPath the path to the child's directory, relative to self.
uid a location to receive the new child application's UID.

Document Links 14.2.2

The document links allow a document with embedded documents to be moved to other locations, yet keep track of its embeddees.

Getting Document Information 14.2.3

There are two messages that can get information about a specific document: **msgAppGetMetrics** and **msgAppGetRoot.**

When a client sends **msgAppGetMetrics** to a document, it obtains the metrics for that document. The message requires a pointer to an APP_METRICS structure that receives these arguments:

uuid the document's UUID.

dir the document's directory.

parent the document's parent document.

children a list of document activated by this document.

mainWin the main window UID.

floatingWins the floating windows, if any.

childAppParentWin the parent window of a child application.

resList the resource file list for the document. The default resource list contains

- A document resource file.
- An application resource file.
- A preference resource file.
- The system resource file.

resFile The document's resource file.

flags An APP_FLAGS value that contains flags for the document. The **flags** values are:

state the document state. Possible values are: **appTerminated, appActivated, appOpened.**

hotMode whether the document is in hot mode.

floating whether the document is floating.

printing whether the document printing.

topLevel whether the document is printing as top level.

When a client sends **msgAppGetRoot** to an application object, it obtains the root application object for a tree of applications. The only argument for the message is a pointer to an application UID to receive the UID for the root application object.

Setting Hot Mode 14.2.4

To change an application's hot mode metric, send **msgAppSetHotMode** to the application object. The only argument is a Boolean value that indicates whether hot mode should be on or off.

Most applications do not handle this message. They allow **clsApp** to handle it for them.

Renaming a Document 14.2.5

To rename a document, send **msgAppRename** to the application object. The only argument for the message is a pointer to a string that contains the new name for the document.

Applications should not process this message. They should allow **clsApp** to handle it for them. When **clsApp** has changed the application's metrics, it sends **msgAppSetName** to self (see below).

Getting an Application's Name 14.2.6

To get an application's name, send **msgAppGetName** to the application object. The only argument is a pointer to the string that receives the document's name.

Setting an Application's Title 14.2.7

To set an application's main window title, send **msgAppSetName** to the application object. The only argument is a pointer to the string that receives the document's name.

Document Window Messages 14.3

Setting the Main Window 14.3.1

After creating a main window (usually in **msgAppInit**), applications need to set the main window. To do this, they send should send **msgAppSetMainWin** to self. The only argument is a UID that identifies the main window.

The application should not process **msgAppSetMainWin**, but should pass it to **clsApp**.

To add a window to the list of floating windows, send **msgAppAddFloatingWin** to the application object. The only argument is the UID of the window to add to the list.

To remove a window from the list of floating windows, send **msgAppRemoveFloatingWin** to the application object. The only argument is the UID of the window to remove from the list.

Standard Application Menus 14.4

The protocol for modifying the Options menu is discussed in "Options Menu Protocol," later in this chapter.

To provide continuity among all applications running under the PenPoint operating system, three **standard application menus** (or SAMs) should appear on the menu bar of all applications: Document, Edit, and Options. These menus contain a number of predefined buttons. The system resource file contains a menu bar with these standard application menus. When you create an application's user interface, you can use this resource to add your own buttons to the menu bar. (*Part 4: UI ToolKit* describes how to add the standard application menus to your interface.)

When your application is opened, it should create a menu bar and then send **msgAppCreateMenuBar** to **self**. **clsApp** handles **msgAppCreateMenuBar** by adding the Document, Edit, and Option menus in front of any other menus specified by your application. When **msgAppCreateMenuBar** returns, your application can further adjust the menu by removing buttons from the menus that your application does not support or adding additional buttons to the menus.

When the user taps on a menu (but before the menu is displayed), the menu sends **msgControlProvideEnable** to the document for each of the buttons in the menu. Each time **msgControlProvideEnable** is sent, it contains a tag for a menu button.

It is up to your application and its ancestors to determine whether the particular button should be enabled or disabled. When a button is disabled, it still appears on the menu, but it is grayed out.

Your application should first allow its ancestor to handle **msgControlProvideEnable**. **clsApp** will enable or disable the buttons as described in Table 14-2. If your application owns the selection, **clsApp** enables or disables **tagAppMenuMove**, **tagAppMenuCopy**, or **tagAppMenuDelete**, depending on what is selected. If there is no data selected, **clsApp** disables all three buttons. If the application data is read-only, **clsApp** disables Move and Delete.

Apart from the selection-dependent buttons, **clsApp** simply enables or disables buttons based on its own defaults. Your application does not necessarily have to take **clsApp**'s decision as final; **clsApp** doesn't know enough about an individual application's data. For example, **clsApp** always disables **tagAppMenuSelectAll**. However, if your application supports the Select All button, it should re-enable **tagAppMenuSelectAll**.

When **clsApp** returns, your application should handle **msgControlProvideEnable** by:

- ◆ Examining the tag that identifies the button in question.
- ◆ Determining whether you should disable or enable the button.
- ◆ Setting the **enable** bit in the **pArgs** for the message.

Table 14-2
How clsApp Handles Menu Button Tags

Tag	Action
tagAppMenuPrintSetup	Always enabled.
tagAppMenuAbout	Always enabled.
tagAppMenuCheckpoint	Always enabled.
tagAppMenuRevert	Always enabled.
tagAppMenuSearch	Always enabled.
tagAppMenuSpell	Always enabled.
tagAppMenuUndo	Enabled when undo transactions exist.
tagAppMenuPrint	Asks thePrintManager.
tagAppMenuSend	Asks theSendManager.
tagAppMenuMove	Asks theSelectionManager.
tagAppMenuCopy	Asks theSelectionManager.
tagAppMenuDelete	Asks theSelectionManager.
tagAppMenuSelectAll	Always disabled.
Any unrecognized tag	Always disabled.

Document and Edit Menus 14.4.1

When the user taps a menu button, the menu sends a specific message to **self** (the document that owns the current selection). Table 14-3 lists the buttons in the Document and Edit menus and the messages that result from tapping that button. Some buttons in the table list the name of a well-known manager object, which is sent as one of the message arguments. (The reason for this is described after the table.)

Table 14-3
Standard Application Menus

Menu Button	Message	Manager (if exists)
Document Menu		
Revert	msgAppRevert	
Send	msgAppSend	theSendManager
Print	msgAppPrint	thePrintManager
Print Setup	msgAppPrintSetup	
Export	msgAppExport	
About	msgAppAbout	
Edit Menu		
Undo	msgAppUndo	
Move	msgAppMoveSel	
Copy	msgAppCopySel	
Delete	msgAppDeleteSel	
Select All	msgAppSelectAll	
Find	msgAppSearch	theSearchManager
Spell	msgAppSpell	theSpellManager

For application-specific behavior, applications can intercept these messages and perform the operations themselves. For example, the browser must intercept **msgAppPrint**, **msgAppSend**, **msgAppSpell**, and **msgAppSearch** so that it can act on the selected documents, not the Browser itself.

If your application does not intercept these messages, **clsApp** does one of two things:

- It provides the generic behavior.
- It routes the message to an object that provides the behavior.

To route the message to an object that provides the behavior, **clsApp** sends **msgAppInvokeManager** to self. The argument to the message is the well-known UID of a manager that performs the operation. When **clsApp** receives **msgAppInvokeManager**, it sends **msgAppExecute** to the manager object indicated by the argument to **msgAppInvokeManager**.

msgAppExecute takes a pointer to an APP_EXECUTE structure that contains four arguments:

app the UID of the application requesting the action.

sel the UID of the object that is currently selected. This argument is optional, depending on the manager's implementation.

count the number of UUIDs in the **uuid** array.

uuid an array of UUIDs that the action will affect. Each UUID indicates an application. This allows standard application menu messages to affect more than one application. The minimum content of the **uuid** array is usually this application.

When the manager object receives **msgAppExecute**, it uses this information to perform the operation.

Adding Menu Buttons 14.4.1.1

Usually when you add a button to a menu, the message sent by the button is defined by your application. However, if the button activates a system-wide facility that you expect many applications to use (such as a grammar checker), the button should send **msgAppInvokeManager**.

Because **msgAppInvokeManager** is handled by **clsApp** and reroutes the button information, you can use it to add additional buttons to the standard application menus without actually modifying **clsApp**.

If you are adding a system wide button to a standard application menu, specify that the button sends **msgAppInvokeManager**, and that its argument is the manager that handles the operation. When the user taps the button, the button will send **msgAppInvokeManager** to self. **clsApp** then sends **msgAppExecute** to your manager object.

Managers for Menu Buttons 14.4.1.2

A manager that is referenced by a standard application menu must respond to **msgAppExecute**.

As described above, the arguments to **msgAppExecute** include:

- The UID of the application that is making the request. This allows the application to implement behavior (pop-up dialogs go away when the application goes away).
- An optional selection UID to indicate where functions such as spell and find should start.
- An array of UUIDs that indicate the applications to operate upon. The default behavior of **clsApp** is to send only the UUID of the application itself.

Default Behavior Provided by clsApp 14.4.1.3

The following sections describe the default behavior when **clsApp** handles the messages generated by the standard application menus.

msgAppPrintSetup 14.4.1.4

When **clsApp** receives **msgAppPrintSetup**, it sends **msgAppShowOptionSheet** to self. This allows your application to add its own option cards to the Print Setup option sheet.

Your application should allow its ancestor to handle **msgAppShowOptionSheet.** When clsApp receives **msgAppShowOptionSheet**, it creates an option sheet by sending **msgAppGetOptionSheet** to self. Again, your application should allow **clsApp** to handle **msgAppGetOptionSheet.** Eventually it sends **msgAppAddCards** to self.

When your application receives **msgAppAddCards**, it can add its own option cards to the option sheet (as described below).

msgAppAddCards passes an OPTION_TAG structure that contains two arguments:

option	UID of the option sheet.
tag	tag for that option sheet.

To add your own option cards to the Print Setup option sheet, make sure that **tag** contains **tagAppPrintSetupOptSheet.** If it does, you add cards by sending **msgOptionAddCard** to the option sheet specified in **option.**

Part 4: UI Toolkit describes option sheets and the option sheet protocol in detail.

After adding your option cards, allow your ancestor to handle **msgAppAddCards,** so that it can add its own cards.

msgAppPrint 14.4.1.5

When **clsApp** receives **msgAppPrint**, it prints the application that was sent **msgAppPrint.** If your application allows other applications to be selected, you must handle **msgAppPrint** yourself to print the selected applications.

clsApp will forward the **msgAppExecute** message, the application UID, the selection UID (if the application owns the selection), and the application UUID to a well-known object, **thePrintManager,** for processing.

msgAppSend 14.4.1.6

When **clsApp** receives **msgAppSend**, it sends the application that was sent **msgAppSend** to the Out box. If your application allows other applications to be selected, you must handle **msgAppSend** yourself to send the selected applications.

clsApp will forward the **msgAppExecute** message, the application UID, the selection UID (if the application owns the selection), and the application UUID to a well-known object, **theSendManager,** for processing.

msgAppSpell 14.4.1.7

When **clsApp** receives **msgAppSpell**, it starts a spelling check on the current application. The spelling manager must use the traverse protocol to determine the range to be checked.

clsApp will forward the **msgAppExecute** message, the application UID, the selection UID (if the application owns the selection), and the application UUID to a well-known object, **theSpellManager**, for processing.

msgAppSearch 14.4.1.8

When **clsApp** receives **msgAppSearch**, it starts a search of the current application. The search manager must use the traverse protocol to determine the range to be searched.

clsApp forwards the **msgAppExecute** message, the application UID, the selection UID (if the application owns the selection), and the application UUID to a well-known object, **theSearchManager**, for processing.

msgAppRevert 14.4.1.9

When **clsApp** receives **msgAppRevert**, it terminates the current application without saving the data and creates a new instance from the application files. Applications that modify their application files (or other files that affect their state directly) must provide their own support for **msgAppRevert**.

msgAppMoveSel 14.4.1.10

When **clsApp** receives **msgAppMoveSel**, it sends **msgSelBeginMove** to the owner of the selection. This causes the move icon to pop up.

msgAppCopySel 14.4.1.11

When **clsApp** receives **msgAppCopySel**, it sends **msgSelBeginCopy** to the owner of the selection. This causes the copy icon to pop up.

msgAppAbout 14.4.1.12

When **clsApp** receives **msgAppAbout**, it brings up the Comments option sheet for the application and displays the About card. **clsApp** constructs the About card from the information available to it when the class is installed.

msgAppSelectAll 14.4.1.13

There is no default **clsApp** behavior for **msgAppSelectAll**.

Options Menu Protocol 14.4.2

Remember that an option sheet can contain one or more option cards.

The Options menu is dynamic; it contains options for both the document and the selection. When the user taps on the Options menu, **clsApp** sends **msgAppAddCards** to the document that contains the current selection. The document can add cards to the option sheet before or after sending the message to its ancestor. Each of its ancestors handle the message in the same way until **clsApp** receives the message.

clsApp then sends **msgAppAddCards** to the selected object. Again, the object and its ancestors can add cards to the option sheet. Finally, when **clsApp** receives the message again, it presents the Options menu on screen. The buttons in the menu reflect the titles of all the option cards in the option sheets. The position of your card titles in the Options menu depends on whether you call ancestor before or after you send **msgOptionAddCard**.

Responding to msgAppAddCards 14.4.2.1

When your application or object receives **msgAppAddCards**, you can add cards by sending **msgOptionAddCard** or **msgOptionAddLastCard** to the option sheet. Send **msgOptionAddLastCard** to add your last (or only) card to the option sheet; **msgOptionAddLastCard** creates the separator line in the option menu. At some point in handling **msgAppAddCards**, you should also send **msgAppAddCards** to your ancestor so that it can add its cards to the option sheet. You can send **msgAppAddCards** to your ancestor before or after sending **msgOptionAddCard** and **msgOptionAddLastCard**.

msgAppAddCards passes a pointer to an OPTION_TAG structure that contains:

option the UID of the option sheet to which you can add cards.

tag a tag that identifies the option sheet. The tag is provided as a convenience so that your application can quickly determine the option sheet for which it is creating a card. For the Options menu protocol, **tag** will always contain **tagAppMenuOptions**.

If you want to add cards to the option sheet, you send **msgOptionAddCard** to the option sheet specified in **option**; to add the last (or only card) send **msgOptionAddLastCard** to the option sheet. **msgOptionAddCard** and **msgOptionAddLastCard** are described in *Part 4: UI Toolkit.* In brief, these messages take a pointer to an OPTION_CARD structure that contains:

tag a tag that identifies the card to add.

pName pointer to a buffer holding the card's name.

win this field must contain **pNull**.

client the UID of the client that manages the card.

You do not actually create the card until the option sheet sends you **msgOptionProvideCardWin**. This prevents a card from being created until the user turns to it.

Check Gesture Handling 14.4.3

When the user makes a check ✓ gesture on an object in your application, you must be prepared to begin an option sheet creation. You respond to the check gesture by sending **msgAppShowOptionSheet** to **OSThisApp()**.

This code fragment shows how an application can respond to **msgGWinGesture:**

```
APP_SHOW_OPTION_SHEET   show;
                .
                .
                .
        case Msg(xgsCheck):
        case Msg(xgsUGesture):  // Allow the user to by sloppy

           // Make self the selection.
           ObjCallRet(msgSelSelect, self, pNull, s);

           // Show the doc option sheet turned to the correct card.
           show.sheetTag   = tagAppDocOptSheet;
           show.cardTag    = tagAppOptGotoButtonCard; // your tag here
           show.show               = true;
           ObjCallRet(msgAppShowOptionSheet, OSThisApp(), &show, s);

           break;
```

Observing System Preferences 14.5

The system preferences are resources stored in the preferences resource file (in \PENPOINT\SYS\PREFS\PREFS). The system preferences describe system settings, such as the system font, left- or right-handed operation, screen orientation, and so on. Clients get and set the system preferences through the well-known object **theSystemPreferences.**

Applications observe **theSystemPreferences** by default. Thus, when the user changes the system preferences (such as the system font, user font, orientation, and hand preference), **theSystemPreferences** sends **msgPrefsPreferenceChanged** to observers.

Your application should not handle **msgPrefsPreferenceChanged**, but should allow its ancestor to handle the message so that **clsApp** can dirty all windows that are visible and lay them out again. This means that all your visible windows will acquire the attributes specified by the new preference.

The message passes a pointer to a PREF_CHANGED structure that contains:

manager the UID of the object that sent the notification (usually **theSystemPreferences**).

prefId a RES_ID value that contains the id of the preference that changed.

If you receive **msgPrefsPreferenceChanged** while you have windows that are not visible, you must dirty these windows and lay them out again yourself (after you send the message to **clsApp**). This code fragment suggests how to do this.

```
WIN_METRICS             wm;
OBJECT                  someWin;    // a window that needs re-laying out
ObjCallRet(msgWinSetLayoutDirtyRecursive, someWin, (P_ARGS)true, s);
wm.options = wsLayoutDefault;
ObjCallRet(msgWinLayout, someWin, &wm, s);
```

Advanced Messages 14.6

The messages described in this section are useful only if you are writing a systems application such as the Notebook. Unless your application is performing systems functions, it should not send or respond to these messages.

Setting a Parent Document 14.6.1

You can establish the parent of a document by sending **msgAppSetParent** to the document. The message takes the UID of the parent.

Setting Priority 14.6.2

To change the priority for an application task, send **msgAppSetPriority** to the application object. **msgAppSetPriority** uses the same enums as the **OSTaskPrioritySet** system service defined in OS.H. The message requires an APP_SET_PRIORITY structure that contains:

priorityMode the task or group of tasks to be altered. Possible enum values are: **osThisTaskOnly** and **osTaskFamily**. You cannot use **osAllTasks** with this message.

priorityClass the priority class. The priorities are grouped into five classes: system (which is for use by PenPoint only, and has no enum), high (**osHighPriority**), medium high (**osMedHighPriority**), medium low (**osMedLowPriority**), and low (**osLowPriority**). These enum values are defined in OS.H.

priority the new priority value. The **priority** value must be between 1 and 50, where 50 is the lowest priority. If you specify 0 for this argument, the **priority** value will stay the same; this allows you to change the class without changing the **priority**.

Chapter 15 / The View Class

The view class (**clsView**) is an abstract class that defines messages used to display an object's data. **clsView** is a descendent of **clsEmbeddedWin**. A view is a window that observes a single data object. When inserted in a window, the view displays the contents of the data object. A component is typically composed of a view-object pair.

Chapter 15 covers these topics:

- Creating new views
- Subclassing **clsView**

View Concepts 15.1

Because any PenPoint object can be observed and can send messages to its observers, any object can be a data object. The observed object is responsible for maintaining its data, including storing and manipulating it.

The messages defined by **clsView** allow clients to create new views, and change the viewed object. **clsView** also responds to the object filing messages (**msgSave** and **msgRestore**) and passes these messages to its viewed objects.

Because **clsView** is an abstract class, you must either define your own subclass of **clsView** or use an existing subclass. Subclasses of **clsView** include **clsTextView** and **clsGrafpaper**.

You don't have to use **clsView** to display information on screen. Any descendant of **clsWin** is free to maintain its own data without having an associated data object.

clsView uses the window hierarchy; it does not maintain a separate view hierarchy. **clsView** does not filter out or respond to any messages defined by **clsWin**, so a subclass of **clsView** is free to manipulate the view with window messages if it wishes.

Table 15-1 lists the **clsView** messages.

Table 15-1
clsViewMessages

Message	Takes	Description
msgNewDefaults	P_VIEW_NEW	Initializes arguments for a new view.
msgNew	P_VIEW_NEW	Creates a new view.
msgViewSetDataObject	OBJECT	Sets a view's data object.
msgViewGetDataObject	P_OBJECT	Gets a view's data object.

View Filing 15.2

Views file themselves like other objects. **clsView** responds to the common filing messages defined by **clsObject** (**msgSave** and **msgRestore**). An advantage to using views is that they then pass the filing messages to their viewed objects. The viewed objects must then respond to the filing messages.

Creating a New View 15.3

To create a new view, send **msgNewDefaults** and **msgNew** to the subclass of **clsView**. The message requires a VIEW_NEW structure that contains:

- **object** an OBJECT_NEW_ONLY structure.
- **win** a WIN_NEW_ONLY structure.
- **view** a VIEW_NEW_ONLY structure that contains:
  - **dataObject** the UID of the object the view is to observe.
  - **createDataObject** a Boolean value that indicates whether the view should automatically create the data object.

The **msgNew** defined by **clsView** cannot create the observed object (the **createDataObject** argument is meaningless); however, if you subclass **clsView**, your class can redefine **msgNew** to create the observed object.

When your subclass of **clsView** receives this message, it should check the **createDataObject** argument. If the argument is **true** and the object does not exist, your view should create the object. However, the arguments for VIEW_NEW_ONLY do not tell your view which object to create. Either your view must know which object to create, or it must define its own arguments to **msgNew** that include the object to create.

Setting the Data Object 15.4

To set or change the data object observed by a particular view, send **msgViewSetDataObject** to the view. The only argument to the message is the UID of the object to view.

Getting the Data Object 15.5

To find out what data object is observed by a particular view, send **msgViewGetDataObject** to the view. The only argument to the message is a pointer to the location that receives the UID of the object.

Subclassing clsView

15.6

The messages defined by **clsView** provide object filing, allow clients to create new views, and allow clients to change the viewed object. By themselves, these messages do not perform any of the tasks that clients require from views. It is up to your subclass of **clsView** to perform these tasks.

Your view class should:

- Make itself a subclass of **clsView**.
- Define a message that an observed object can send to your view when its data changes.
- Repaint its window when it receives the notification message.

Your view can also:

- Enable the user to interact with the data.
- Notify its observed object when the user makes a change (if the observed object defines such a message).

Chapter 16 / The Application Directory Handle Class

The application directory handle class, **clsAppDirHandle**, provides access methods to manipulate documents in the application hierarchy. **clsAppDirHandle** inherits from **clsDirHandle**.

clsAppDirHandle provides methods to access and modify application directory attributes. Because **clsAppDirHandle** is a descendent of **clsDirHandle**, clients can use **clsAppDirHandle** to create, destroy, and modify application directories.

Most application designers should not need to create an application directory handle. It is created for you during **AppInit** by the PenPoint Application Framework and stored in the **dir** element of the APP_METRICS structure. Therefore, normal applications should never need to use the messages defined by **clsAppDirHandle**.

This chapter covers the following topics:

- Creating application directories.
- Getting and setting application directory attributes.
- Getting attributes for many application directories.
- Determining a document's name.
- Counting embedded documents.
- Setting a document's tab.

Using clsAppDir 16.1

An application directory node represents a document in the document hierarchy. The PenPoint Application Framework uses the application directory structure to keep its documents in order and to communicate with the documents. Each document uses its application directory to store its resource files and any other files it uses. Because each document is contained in a separate directory in the file system, **clsAppDir** defines messages that augment the messages defined by its ancestor—**clsDirHandle**.

Application directory attributes contain information that pertains to several components:

- The document.
- The document's application class.
- The document's position within a section (or within another document).

- The tab for the document.
- The document's page number.

Note Tabs are called "bookmarks" in the PenPoint API.

The document's position within a section is determined by the document's **sequence number.** A document's page number within the Notebook is determined by its **global sequence number.** Embedded documents do not have global sequence numbers.

Table 16-1
clsAppDir Messages

Message	Takes	Description
msgAppDirGetAttrs	P_APP_DIR_GET_SET_ATTRS	Get the application directory attributes for a document.
msgAppDirSetAttrs	P_APP_DIR_GET_SET_ATTRS	Set the application directory attributes for a document.
msgAppDirGetFlags	P_APP_DIR_GET_SET_FLAGS	Get the application directory flags for a document.
msgAppDirSetFlags	P_APP_DIR_GET_SET_FLAGS	Set the application directory flags for a document.
msgAppDirGetClass	P_APP_DIR_UPDATE_CLASS	Get the application directory class.
msgAppDirSetClass	P_APP_DIR_UPDATE_CLASS	Set the application directory class.
msgAppDirGetUUID	P_APP_DIR_UPDATE_UUID	Get the application directory uuid.
msgAppDirSetUUID	P_APP_DIR_UPDATE_UUID	Set the application directory uuid.
msgAppDirGetSequence	P_APP_DIR_UPDATE_SEQ	Get the application directory sequence.
msgAppDirSetSequence	P_APP_DIR_UPDATE_SEQUENCE	Set the application directory sequence.
msgAppDirGetNumChildren	P_APP_DIR_UPDATE_NUM_CHILDREN	Get the numChildren attribute.
msgAppDirSetNumChildren	P_APP_DIR_UPDATE_NUM_CHILDREN	Set the numChildren attribute.
msgAppDirGetGlobalSequence	P_APP_DIR_GET_GLOBAL_SEQUENCE	Get the application directory global sequence number.
msgAppDirGetBookmark	P_APP_DIR_GET_BOOKMARK	Get the application tab.
msgAppDirSetBookmark	P_APP_DIR_SET_BOOKMARK	Set the application tab.
msgAppDirGetNextInit	P_APP_DIR_NEXT	Initialize the get next structure.
msgAppDirGetNext	P_APP_DIR_NEXT	Get the next application directory attributes.
msgAppDirReset	P_APP_DIR_NEXT	Free resources after a series of msgAppDirGetNext.
msgAppDirSeqToName	P_APP_DIR_SEQ_TO_NAME	Return an embedded document's name given its sequence number.
msgAppDirGetDirectNumChildren	P_U32	Get the number of direct embedded documents (not recursive).
msgAppDirGetTotalNumChildren	P_U32	Get the number of embedded documents (recursive).

Creating an Application Directory Handle 16.2

To create an application directory handle, send **msgNewDefaults** and **msgNew** to **clsAppDir**. Both messages require a FS_NEW structure that contains:

object an OBJECT_NEW structure.

fs an FS_NEW_ONLY structure that contains:

locator a locator for the node, which includes a directory handle and a path. If you do not specify the directory handle, the default is **theWorkingDir**; if you do not specify a path, the default is nil.

dirIndex an optional directory index. If you use a directory index, the locator indicates the volume to use.

mode flags that indicate handle characteristics.

exist what to do if the directory does or doesn't exist.

Part 7: The File System describes in great detail how to create directory handles. Use **msgNewDefaults** to initialize the fields to their default values, then modify any of the fields.

Destroying an Application Directory Handle 16.3

To destroy an application directory handle, send **msgFree** to the application directory handle. The message takes a lock value.

Getting the Application Directory Global Sequence Number 16.4

To get the global sequence number for an application directory, send **msgAppDirGetGlobalSequence** to the application directory. The message takes a pointer to an APP_DIR_GET_GLOBAL_SEQUENCE structure that contains:

pPath a path, relative to the target directory.

globalSequence a U32 that will receive the directory global sequence value.

msgAppDirGetGlobalSequence calculates the global sequence number each time you call it.

If you need to calculate many global sequence numbers or need to make the calculation often, you should use the file system directly and not rely on **msgAppDirGetGlobalSequence** because it traverses the File System for each request.

For example, because the browser caches directories as it displays them, it makes the global sequence calculation based on its own data structures. You can calculate the **globalSequence** number of a document based on its local sequence number (with **msgAppDirGetSequence**) and number of children (with **msgAppDirGetNumChildren**).

Getting and Setting Application Directory Attributes 16.5

There are two ways to get or set the application directory attributes: you can get or set all of the attributes at once, or you can get or set specific attributes with specific messages.

As a rule, it is faster to get or set single attributes.

Getting and Setting All Attributes 16.5.1

To get all system attributes for a single application directory, send **msgAppDirGetAttrs** to an application directory handle; to set all the attributes, send **msgAppDirSetAttrs** to the application directory handle. Both messages take an APP_DIR_GET_SET_ATTRS structure that contains:

- **pPath** a path to the target application directory.
- **attrs** an APP_DIR_ATTRS structure that contains:
  - **appClass** the application class.
  - **uuid** the application uuid.
  - **sequence** the local sequence number.
  - **numChildren** the total number of embedded documents within a document, including nested embedded documents.
  - **flags** the application directory flags. The flags are described in Table 16-2.

Table 16-2
File Mode Flags

Flag	Definition
application	This is an application.
newInstance	This is a new application instance.
disabled	The application is disabled. Do not activate it.
bookmark	The application has a tab.
readOnly	The application is read only.
deletable	The application can be deleted.
moveable	The application can be moved.
copyable	The application can be copied.

Getting or Setting Individual Attributes 16.5.2

These messages get or set individual attributes for application directories.

Getting and Setting Flags 16.5.2.1

To get or set the application directory flags, send **msgAppDirGetFlags** or **msgAppDirSetFlags** to the application directory handle. Both messages take a pointer to an APP_DIR_GET_SET_FLAGS that contains:

- **pPath** a path, relative to the target directory.
- **flags** an APP_DIR_FLAGS structure, as described in Table 16-2.

Getting and Setting the Class 16.5.2.2

To get or set the application class, send **msgAppDirGetClass** or **msgAppDirSetClass** to the application directory handle. Both messages take a pointer to an APP_DIR_UPDATE_CLASS structure that contains:

pPath a path, relative to the target directory.

appClass a CLASS specifier. On **msgAppDirSetClass**, this field specifies the application class; on **msgAppDirGetClass**, the application class is passed back in this field.

Getting and Setting the UUID 16.5.2.3

To get or set the application directory UUID, send **msgAppDirGetUUID** or **msgAppDirSetUUID** to the application directory handle. Both messages take a pointer to an APP_DIR_UPDATE_UUID structure that contains:

pPath a path, relative to the target directory.

uuid a UUID. On **msgAppDirSetUUID**, this field specifies the UUID; on **msgAppDirGetUUID**, the UUID is passed back in this field.

Getting and Setting the UID 16.5.2.4

To get or set the application directory UID, send **msgAppDirGetUID** or **msgAppDirSetUID** to the application directory handle. Both messages take a pointer to an APP_DIR_UPDATE_UID structure that contains:

pPath a path, relative to the target directory.

uid an application directory UID. On **msgAppDirSetUID**, this field specifies the UID; on **msgAppDirGetUID**, the UID is passed back in this field.

Getting and Setting the Sequence Number 16.5.2.5

To get or set the application directory sequence number, send **msgAppDir-GetSequence** or **msgAppDirSetSequence** to the application directory handle. Both messages take a pointer to an APP_DIR_UPDATE_SEQUENCE structure that contains:

pPath a path, relative to the target directory.

sequence a U32 for the sequence number. On **msgAppDirSetSequence**, this field specifies the sequence number; on **msgAppDirGetSequence**, the sequence number is passed back in this field.

Getting and Setting the Number of Embedded Docs 16.5.2.6

To get or set the number of embedded documents in an application directory, send **msgAppDirGetNumChildren** or **msgAppDirSetNumChildren** to the application directory handle. Both messages take a pointer to an APP_DIR_UPDATE_NUM_CHILDREN structure that contains:

pPath a path, relative to the target directory.

numChildren a U32 that specifies or passes back the number of embedded documents.

Getting and Setting the Application Tab

16.5.2.7

Note Tabs are called "bookmarks" in the PenPoint API.

To get or set the application tab, send **msgAppDirGetBookmark** or **msgAppDirSetBookmark** to the application directory handle. **msgAppDirGetBookmark** takes a pointer to an APP_DIR_GET_BOOKMARK structure that contains:

pPath a path, relative to the target directory.

label a buffer of **nameBufLength** characters that will contain the tab label.

msgAppDirSetBookmark takes a pointer to an APP_DIR_SET_BOOKMARK structure that contains:

on a Boolean value that specifies whether to turn the tab on or off.

pPath a path, relative to the target directory.

label a buffer of **nameBufLength** characters that specifies the tab label. If `label[0]` is null, the use the default label (the name of the document).

Getting Attributes for Many Application Directories

16.6

clsAppDir provides messages to recursively get the attributes for a number of application directories, starting at a particular application directory. To get attributes in this way, you must first send **msgAppDirGetNextInit** to **clsAppDir**. The message takes an APP_DIR_NEXT structure that contains:

attrs an APP_DIR_ATTRS structure. This is the same structure that was described above in **msgAppDirGetAttrs**.

pName a pointer to a name string.

fsFlags a set of file system flags.

pFirst a pointer to the first directory handle. When you initialize the structure, you use this argument to indicate where to start. On subsequent reads, this argument serves as a reminder for where you started.

pNext a pointer to the next directory handle.

handle a pointer to the current directory handle.

When you have initialized the structure, you can get the attributes for the first directory in the search. Send **msgAppDirGetNext** to the directory handle, specifying the APP_DIR_NEXT structure that you initialized with **msgAppDirGetNextInit**.

To get attributes for the succeeding application directories, send **msgAppDirGetNext** to the directory handle.

When you have examined all application directories (the **pNext** attribute is Nil), free the resources used by **msgAppDirGetNext**. To free the resources, send **msgAppDirReset** to the directory handle.

Determining a Document's Name 16.7

If you have a document's sequence number or UUID, you can determine its name.

To determine the document's name from its sequence number, send **msgAppDirSeqToName** to the application directory file handle. The message takes a APP_DIR_SEQ_TO_NAME structure that contains:

sequence the sequence number of the document.

pName a pointer to the string that receives the document name.

To determine an embedded document's name from its UUID, send **msgAppDirUUIDToName** to the application directory file handle of the document in which it is embedded. The message takes a APP_DIR_UUID_TO_NAME structure that contains:

uuid the UUID number of the embedded document.

pName a pointer to the string that receives the document name.

Counting Embedded Documents 16.8

To get the number of embedded documents in a document, send **msgAppDirGetNumChildren** to the application directory handle of the document you are interested in. The only argument for the message is a pointer to the U32 value that receives the number of children.

The number of children is determined recursively. It includes not only the number of directly embedded documents, but the embedded documents within an embedded document, and so on.

Setting a Tab 16.9

Note Tabs are called bookmarks in the **clsAppDir** API.

Users can identify a document by creating a tab for that document (these tabs appear as the tabs on the edge of the Notebook). Because each application directory contains a specific document, it is natural for **clsAppDir** to provide a method for a client to create a tab associated with an application directory.

To set a tab, send **msgAppDirSetBookmark** to the root container application. The message takes a pointer to an APP_DIR_SET_BOOKMARK structure that contains:

on a Boolean value that indicates whether the tab is on or off. When this value is **true**, the tab is turned on.

pPath the path to the file being marked, relative to the target directory. Usually this field is null, because the tab identifies the application directory. However, if you want to identify an embedded document, **pPath** contains the path to that document.

label a string containing the tab label. The label can be up to **nameBufLength** bytes. If the first byte of label is null, **clsAppDir** uses the default label (the application directory name).

When the message completes successfully, it returns.

You turn to a tab by sending **msgRCAppGotoDoc** and specifying the application UUID of the tab for the application UUID.

Chapter 17 / Container Application Classes

The PenPoint™ operating system uses **container application classes** to identify applications whose primary purpose is to contain (embed) other documents.

You might use the container application classes if you write an alternative to the Notebook or if you create your own section application.

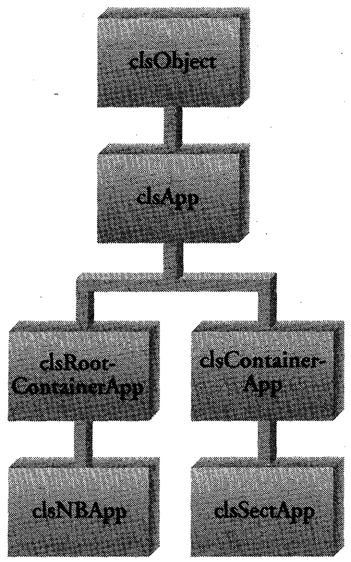
Concepts 17.1

The browser and other such components rely on the container application classes to distinguish between documents embedded in a section and documents embedded in any other document. Documents embedded in a section or Notebook can be listed by the browser and must be page numbered. Documents embedded in any other document should not be numbered by the browser and should not have page numbers. Embedded documents are described in Chapter 9 and Chapter 18.

The PenPoint operating system defines two container application classes: **clsContainerApp**, which defines a container application (such as a section) and **clsRootContainerApp**, which defines a root container application (such as a Notebook). Both container application classes are descendents of **clsApp**; both are abstract superclasses.

Figure 17-1 shows the hierarchy of the container application classes.

Figure 17-1
Container Application Class Hierarchy



Container Application Class 17.2

clsContainerApp describes an abstract superclass used to embed documents. Creating an application that descends from **clsContainerApp** implies that the application's embeddees can be page numbered. Note that other application classes can contain embedded documents (such as a text editor document containing a database application), but that those embedded documents are not assigned page numbers.

Currently, the only descendent of **clsContainerApp** is **clsSectApp**, the section application.

clsContainerApp doesn't define any messages.

To test that a particular class descends from **clsContainerApp**, send **msgAncestorIsA** to the class, specifying **clsContainerApp**.

Root Container Application Class 17.3

clsRootContainerApp is an abstract superclass used to embed documents and containers. Creating a class that descends from **clsRootContainerApp** implies that the class is the highest level in the file system that should be searched for other containers.

Currently, the only descendent of **clsRootContainerApp** is **clsNBApp**, the Notebook application. The desktop manager creates an instance of **clsNBApp** when the PenPoint operating system is booted. Other instances of **clsNBApp** include the Help notebook and the Stationery notebook.

clsRootContainerApp Concepts 17.3.1

Because an application cannot cause itself to be displayed on the screen, it must send a request to an application manager of some form. In PenPoint, **clsNBApp** receives the messages indicating which application to display. **clsNBApp** acts on the page turn messages by activating and deactivating instances of applications.

The messages defined by **clsRootContainerApp** are concerned with turning to different pages. This is the generalized set of messages that any implementation of a root container would have to handle in order to replace the **clsNBApp**.

A descendent of **clsRootContainerApp** manages its contents. It is responsible for displaying the current page on the screen and handling the page turn messages.

To test that a particular class descends from **clsRootContainerApp**, send **msgAncestorIsA** to the class, specifying **clsRootContainerApp**.

The root container application instance is created at boot time. If you need to get the UID of an application's root container application, send **msgAppGetRoot** to the application; to get the UID of your own root container application, send **msgAppGetRoot** to self.

clsRootContainerApp Messages 17.3.2

The messages for **clsRootContainerApp** are defined in RCAPP.H.

Table 17-1
clsRootContainerApp Messages

Message	Takes	Description
msgRCAppNextDoc	nothing	Increments pointer to the next document.
msgRCAppPrevDoc	nothing	Decrements pointer to the previous document.
msgRCAppExecuteGotoDoc	nothing	Moves to the goto document.
msgRCAppCancelGotoDoc	P_UUID	Resets the goto document to the current document.
msgRCAppGotoContents	nothing	Turns to the contents of the target root container.
msgRCAppGotoDoc	P_RCAPP_GOTO_DOC	Turns to or brings to a document.

Changing the Current Document 17.3.3

To tell the root container application to go to the next or previous document, you must send two messages to the root container application. First, to establish the document to turn to (the reference document, you must send **msgRCAppNextDoc** or **msgRCAppPrevDoc** to the root container application. Then, to turn to the reference document, send **msgRCAppGotoDoc** to the root container application.

All three messages take no arguments. **msgRCAppNextDoc** and **msgRCAppPrevDoc** return the UUID of the new reference document. When **msgRCAppGotoDoc** returns **stsOK**, the reference document is the current document.

Cancelling the Reference Document 17.3.4

If you have set the reference document and want to reset the reference document to be the current document, send **msgRDAppCancelGotoDoc** to the root container application instance. The message takes no arguments. If the message returns **stsOK**, it has successfully cancelled the reference document.

Turning to the Contents Page 17.3.5

To go to the contents page, send **msgRCAppReferenceContents** to the root container application instance. The message takes no arguments. If the message returns **stsOK**, the current document is the contents page.

Chapter 18 / Embedded Window Class

Using clsEmbeddedWin 18.1

The following table lists the messages defined by **clsEmbeddedWin** in EMBEDWIN.H.

Table 18-1
clsEmbeddedWin Messages

Message	Takes	Description
		Class Messages
msgNewDefaults	P_EMBEDDED_WIN_NEW	Initializes embedded window data.
msgNew	P_EMBEDDED_WIN_NEW	Creates a new embedded window.
		Object Messages
msgEmbeddedWinGetMetrics	P_EMBEDDED_WIN_METRICS	Passes back the embedded window metrics.
msgEmbeddedWinGetStyle	P_EMBEDDED_WIN_STYLE	Passes back the style of the embedded window.
msgEmbeddedWinSetStyle	P_EMBEDDED_WIN_STYLE	Sets the style of the embedded window.
msgEmbeddedWinBeginMove	P_EMBEDDED_WIN_BEGIN_MOVE_COPY	Places the embedded window in move mode.
msgEmbeddedWinBeginCopy	P_EMBEDDED_WIN_BEGIN_MOVE_COPY	Places the embedded window in copy mode.
msgEmbeddedWinMove	P_EMBEDDED_WIN_MOVE_COPY	Moves an embedded window to the destination.
msgEmbeddedWinProvideIcon	P_EMBEDDED_WIN_PROVIDE_ICON	Provides the icon for move/copy.
msgEmbeddedWinCopy	P_EMBEDDED_WIN_MOVE_COPY	Copies an embedded window to the destination.
msgEmbeddedWinMoveCopyOK	P_EMBEDDED_WIN_MOVE_COPY_OK	Checks that it is OK to move or copy the window to a destination.
msgEmbeddedWinGetPenOffset	P_XY	Gets pen offset during move or copy.
msgEmbeddedWinGetDest	P_EMBEDDED_WIN_GET_DEST	Gets the destination for embedded window move or copy.
msgEmbeddedWinForwardedGetDest move or copy.	P_EMBEDDED_WIN_GET_DEST	Gets the destination for embedded window
msgEmbeddedWinInsertChild	P_EMBEDDED_WIN_INSERT_CHILD	Inserts a child window into an embedded window.
msgEmbeddedWinExtractChild	P_EMBEDDED_WIN_EXTRACT_CHILD	Extracts a child window into an embedded window.
msgEmbeddedWinPositionChild	P_EMBEDDED_WIN_POSITION_CHILD	Repositions a child window within the same embedded window.
msgEmbeddedWinShowChild	P_EMBEDDED_WIN_SHOW_CHILD	Shows a given area to the user
msgEmbeddedWinSetUUID	P_UUID	Sets the embedded window's UUID.
msgEmbeddedWinDestroy	OBJ_KEY	Destroys an embedded window.
msgEmbeddedWinGetPrintInfo	P_EMBEDDEE_PRINT_INFO	Gets print information from an embedded window.

Creating an Embedded Window 18.1.1

Most clients do not sent **msgNew** to **clsEmbeddedWin**. Rather, they send **msgNew** to one of the descendents of **clsEmbeddedWin**. If you are writing a descendent of **clsEmbeddedWin**, you must be prepared to define your own procedure for **msgNew** and create the arguments required by **clsEmbeddedWin**.

msgNew takes an EMBEDDED_WIN_NEW structure that contains structures for **clsEmbeddedWin**'s ancestors (**clsGWin**, **clsWin**, and **clsObject**) and an EMBEDDED_WIN_NEW_ONLY structure (**embeddedWin**) that contains:

uuid a UUID that identifies the embedded window.

style an EMBEDDED_WIN_STYLE style structure that specifies the attributes of the embedded window. The style attributes specify whether the embedded window itself can be an embeddor or an embeddee. The actual attributes are described later in this chapter in "Getting and Setting the Style of an Embedded Window."

Destroying an Embedded Window 18.1.2

To destroy an embedded window, send **msgEmbeddedWinDestroy** to the embedded window object. The message takes a single argument: the object key used to create the embedded window object.

Before destroying the object, the message cleans up all references to the embedded window (such as reference buttons that point to components in the window).

After sending **msgEmbeddedWinDestroy** to the embedded window object, you should also send **msgFree** to the object.

Getting Embedded Window Metrics 18.1.3

To get the metrics for an embedded window, send **msgEmbeddedWindowGetMetrics** to an embedded window object. The message takes a pointer to an EMBEDDED_WIN_METRICS structure that the message uses to send back the metrics of the window. The structure contains:

uuid the UUID of the embedded window.

style an EMBEDDED_WIN_STYLE structure that contains the style of the window. The contents of the style structure are explained in the following section.

Getting and Setting the Style of an Embedded Window 18.1.4

The EMBEDDED_WIN_STYLE structure describes the attributes of an embedded window. This structure is part of the embedded window metrics, and is also used when creating a new embedded window.

To get the style of an embedded window, send **msgEmbeddedWinGetStyle** to the window. To set the style of an embedded window, send **msgEmbeddedWinSetStyle** to the window. Both messages take a pointer to an EMBEDDED_WIN_STYLE structure. The structure contains:

embeddor a Boolean value that indicates whether the embedded window allows embedding.

embeddee a Boolean value that indicates whether the embedded window can be embedded.

selection a two-bit value that indicates the selection style to take when the embedded window receives **msgSelSelect**. The three possible selection styles are:

ewSelectUnknown the selection style is unknown; use the style of your parent windows.

ewSelect make this window the current selection.

ewSelectPreserve preserve the current selection before making this the current selection.

moveable a Boolean value that indicates whether the embedded window can be moved.

copyable a Boolean value that indicates whether the embedded window can be copied.

moveCopyMode a two-bit value that indicates the current move or copy mode. Clients and subclasses must not alter the value of this field. Possible values are:

ewMoveCopyModeOff not moving or copying.

ewMoveMode moving in progress.

ewCopyMode copying in progress.

deletable a Boolean value that indicates whether the embedded window can be destroyed.

moveCopyContainer a private Boolean value.

embedForward a Boolean value that indicates whether **msgEmbeddedWinGetDest** should be forwarded to the embedded window's parent window.

quickMove a Boolean value that indicates that **clsEmbeddedWin** should use optimizations when moving windows within a common parent or process.

The selection styles are fully described in the Selection Manager chapter of *Part Nine: Utility Classes.*

Beginning a Move or Copy Operation 18.1.5

If the source in a move or copy operation uses the **clsEmbeddedWin** protocol it should indicate that it is ready to go into move or copy mode by sending **msgEmbeddedWinBeginMove** or **msgEmbeddedWinBeginCopy** to self. The message takes a pointer to an EMBEDDED_WIN_BEGIN_MOVE_COPY structure that contains:

xy an xy32 structure that specifies the pen location when you begin the move or copy.

bounds a **rect32** structure that specifies the bounding box around the area to move or copy.

If the source allows **clsEmbeddedWin** to handle **msgEmbeddedWinBeginMove** or **msgEmbeddedWinBeginCopy**, it creates a default icon or a marquee around the selection and waits for the user to drop the object somewhere. If the bounds are zero, **clsEmbeddedWin** uses the default move/copy icon; otherwise, it uses the marquee.

Moving or Copying an Embedded Window 18.1.6

When the destination is ready to move or copy an embedded window from the source, it sends **msgEmbeddedWinMove** or **msgEmbeddedWinCopy** to the owner of the embedded window. The message takes a pointer to an EMBEDDED_WIN_MOVE_COPY structure that contains:

xy an **xy32** structure that specifies the x-y location in the destination window.

dest the UID of the destination.

format a tag that specifies the data transfer format.

The source should respond to this message by moving or copying itself to the destination. When the message returns, it passes back the UID of the object that was moved or copied (**uid**).

Confirming the Move or Copy 18.1.7

When the owner of the source in a move or copy operation receives **msgEmbeddedWinMove** or **msgEmbeddedWinCopy**, it sends **msgEmbeddedWinMoveCopyOK** to self to ensure that the destination can handle the thing being moved. The message takes a pointer to an EMBEDDED_WIN_MOVE_COPY_OK structure that the receiver uses to send back permission for a move and copy operation. The structure contains:

moveOK a Boolean value that the receiver uses to specify that a move is possible.

copyOK a Boolean value that the receiver uses to specify that a copy is possible.

target an EMBEDDED_WIN_MOVE_COPY structure that indicates the proposed move or copy operation.

Getting the Destination of a Move or Copy 18.1.8

Before the source actually moves or copies the selection, it needs to determine the actual file system location of the destination object. This is especially true when moving or copying an embedded window. To get the file system location, send **msgEmbeddedWinGetDest** to the destination. The message takes a pointer to an EMBEDDED_WIN_GET_DEST structure that the destination uses to send back the destination information. The structure contains:

xy an **xy32** structure that indicates the destination.

locator a file system locator that indicates the parent of the destination.

sequence a sequence number that indicates the sequence of the destination in the parent.

path a pointer to the buffer that receives the path to an embedded window within the **locator** parent directory. Usually the path is **null**.

source the UID of the object to be moved or copied.

Handling Child Embedded Windows 18.1.9

To move or copy a child window between different objects in the same task, the easiest thing to do is to extract the child window from one parent and insert it in another. To extract the child window, send **msgEmbeddedWinExtractChild** to the parent. The message takes a pointer to an EMBEDDED_WIN_EXTRACT_CHILD structure that contains:

xy an **xy32** value that indicates the location in the source.

win the UID of the embedded window to extract.

source the UID of the object requesting the extraction (usually your UID).

To insert the child in a different parent, send **msgEmbeddedWinInsertChild** to the new parent. The message takes a pointer to an EMBEDDED_WIN_INSERT_CHILD structure that contains:

xy an **xy32** structure that contains the destination relative to the window.

win the UID of the embedded window to insert.

source the UID of the object requesting the insertion (usually your UID).

Getting Pen Offsets 18.1.10

As explained in this chapter, the x-y coordinates used by the embedded window move/copy protocol does not necessarily indicate the pen location when the user indicates the destination. Rather, it usually indicates the lower left corner of the icon or marquee when the user lifts the pen. To retrieve the offset of the pen from the lower left corner, send **msgEmbeddedWinGetPenOffset** to the source. The message takes a pointer to an **xy32** structure that the message uses to send back the offsets.

Setting an Embedded Window's UUID 18.1.11

To set the UUID for an embedded window, send **msgEmbeddedWinSetUUID** to an embedded window. The only argument for the message is a pointer to the new UUID. If the message returns **stsOK**, the embedded window has the new UUID.

Chapter 19 / Application Window Class

clsAppWin is a descendent of **clsEmbeddedWin** that wraps an embedded application and provides the interface between the application and the PenPoint Application Framework.

When **clsAppWin** contains an embedded application, the user can tap on the close box to shrink the embedded application down to a button in the document. When the user taps on the button, the embedded application expands to the size of the Notebook. When the user double taps on the button, the embedded application floats above the Notebook. **clsAppWin** implements this application window behavior.

Using clsAppWin Messages 19.1

The messages and #defines for the application window class are defined in APPWIN.H.

Table 19-1
clsAppWin Messages

Message	Takes	Description
		Class Messages
msgNewDefaults	P_APP_WIN_NEW	Initializes data for a new application window.
msgNew	P_APP_WIN_NEW	Creates a new object.
		Instance Messages
msgAppWinGetMetrics	P_APP_WIN_METRICS	Gets the application window metrics.
msgAppWinGetState	P_U16	Gets the application window state.
msgAppWinSetState	U16	Sets the application window state.
msgAppWinGetStyle	P_APP_WIN_STYLE	Gets the application window style.
msgAppWinSetStyle	APP_WIN_STYLE	Sets the application window style.
msgAppWinSetLabel	P_STRING	Sets the application window label.
msgAppWinSetIconBitmap	BITMAP	Sets the application window's icon bitmap.
msgAppWinSetSmallIconBitmap	BITMAP	Sets the application window's icon bitmap.
msgAppWinOpen	nothing	Opens a document associated with an app win.
msgAppWinClose	nothing	Closes a document associated with an app win.
msgAppWinDelete	BOOLEAN	Deletes an application window.
msgAppWinSetUUID	P_UUID	Sets the UUID to which an application window is linked.
msgAppWinCreateIcon	P_UUID	Creates the app win's icon.
msgAppWinDestroyIcon	P_UUID	Destroys the app win's icon.
msgAppWinStyleChanged	OBJECT	Notification that an app win style changed.
msgAppWinEditName	nothing	Pop-up edit pad to allow user to rename document.

Creating an Embedded Application 19.1.1

To create an application window, send **msgNewDefaults** and **msgNew** to **clsAppWin**. Both messages take an APP_WIN_NEW structure that contains structures for **clsCustomLayout** and its ancestors and an APP_WIN_NEW_ONLY structure, which contains:

appUUID the UUID of the application that will be embedded in the application window.

style an APP_WIN_STYLE value that specifies the styles for the application window.

open the open style for the window. The possible values are: **awOpenInPlace** and **awOpenFloating.**

type the icon type. The possible values are: **awPictAndTitle, awPictOnly, awSmallPictAndTitle, awSmallPictOnly,** and **awSmallPictOverTitle.**

openStyleLock a Boolean value that specifies whether the open style can change. If **true**, the open style cannot be changed.

state a U16 that specifies the state of the application window. The valid states are: **awClosed, awOpenedFloating, awOpenedInPlace,** and **awOpenedInPlaceFloating.**

label a buffer that contains the icon label for the application window.

Changing the Style of an Application Window 19.1.2

The styles for application windows (described above in **msgNew**) can be changed. To change the style, send **msgAppWinSetStyle** to the application window. The only argument is the new style (**style**).

Opening an Application Window 19.1.3

When you open an application window, you specify whether it should float above the or be in-line in its embeddor. To open a window, send **msgAppWinOpen** to the application window. The message takes no arguments.

Closing an Application Window 19.1.4

To close an application window, send **msgAppWinClose** to the application window object. The message takes no arguments.

Getting the Metrics of an Application Window 19.1.5

To get the current settings of an application window, send **msgAppWinGetMetrics** to the application window object. The message takes an APP_WIN_METRICS structure that returns:

appUUID the UUID of the contained application.

icon the application window icon.

iconBitmap the icon used for the open button.

smallIconBitmap the small icon used for the open button.

appClass the application's class.

style the style of the application window. The styles are defined in APP_WIN_STYLE, and are listed in the description of **msgNew**.

state the application window state.

label the label used for the button.

Chapter 20 / The Mark Class

This chapter provides a brief description of the messages defined by **clsMark** in MARK.H. The concepts of using marks are explained in Chapter 10.

Table 20-1
The Class Mark Messages

Message	Takes	Description
		Class Messages
msgNewDefaults	P_MARK_NEW	Initializes the MARK_NEW structure to default values.
msgNew	P_MARK_NEW	Creates a new mark, initialized to the given component.
		Holders Send to Marks
msgMarkDeliver	P_MARK_MESSAGE	Delivers a message to the target that does not move the token.
msgMarkDeliverPos	P_MARK_MESSAGE	Delivers a message to the target that moves the token but does not change the component.
msgMarkDeliverNext	P_MARK_MESSAGE	Delivers a message to the target that moves the token and sometimes (but not always) changes the component.
msgMarkSend	P_MARK_SEND	Sends a message not designed to work with marks to the target.
msgMarkSetComponent	P_MARK_COMPONENT	Sets the mark to refer to the given component.
msgMarkGetComponent	P_MARK_COMPONENT	Returns the UUID of the application that contains the token, and the UUID and UID of the component that contains the token.
msgMarkCompareMarks	MARK	Determines if two marks refer to the same component, and if so, what order their targets are in.
msgMarkCopyMark	P_MARK	Creates a new mark identical to this mark.
msgMarkGotoMark	P_MARK_GOTO	Causes a mark to be selected and displayed to the user.
msgMarkSetSaveMode	U32	Sets the mode that the mark will use for future saves.
		Marks Sent to Components
msgMarkCreateToken	P_MARK_TOKEN	Instructs a component to create a token for its data items, and starts the token pointing at before all data items.
msgMarkGetToken	P_MARK_TOKEN	Sent from one mark to another to get the other's token.
msgMarkDeleteToken	P_MARK_TOKEN	Tells a component that the given token will no longer be in use.
msgMarkCompareTokens	P_MARK_COMPARE_TOKENS	Asks a component to compare the ordering of two tokens.

continued

Table 20-1 (continued)

Message	Takes	Description
msgMarkGetDataAncestor	P_CLASS	Asks for the next higher superclass that contains traversable data.
msgMarkGetParent	P_MARK_COMPONENT	Asks a component to set the argument to its parent (embedding) component.
msgMarkGetUUIDs	P_MARK_COMPONENT	Asks a component to set the argument to its own application and component UUIDs, if it can.
msgMarkValidateComponent	P_MARK_COMPONENT	Asks a component to verify that it is OK to traverse it.
		Messages Sent to Components via msgMarkDeliver
msgMarkPositionAtEdge	P_MARK_POSITION_EDGE	Asks a component to reposition the token to one end or the other of the data.
msgMarkPositionAtToken	P_MARK_POSITION_TOKEN	Asks a component to reposition the token to the same position as another token for the same component.
msgMarkPositionAtChild	P_MARK_POSITION_CHILD	Asks a component to reposition the token to the given child component, which is given as a UUID/UID pair.
msgMarkPositionAtGesture	P_MARK_POSITION_GESTURE	Asks a component to reposition the token at the given gesture.
msgMarkNextChild	P_MARK_MESSAGE	Requests the component to move the token to the next child.
msgMarkGetChild	P_MARK_GET_CHILD	Requests the component to fill in the component at the current token.
msgMarkSelectTarget	P_MARK_MESSAGE	Requests the component to select the target data item.
		Messages Sent Internally
msgMarkEnterChild	P_MARK_MESSAGE	Sent when a component requests the mark to enter a child (usually via returning stsMarkEnterChild to a message sent with msgMarkDeliverNext).
msgMarkEnterLevel	P_MARK_MESSAGE	Sent when a component requests the mark to bump up a level in its class chain, or when a position or next message fails and the mark tries the next class level.
msgMarkEnterParent	P_MARK_MESSAGE	Sent when a component runs out of data altogether and the mark needs to move on (and up).

Marks Sent to Components 20.1

If a component wants to support search and replace, spell checking, reference buttons, and so on, it must respond to **clsMark** messages.

Creating a Token 20.1.1

msgMarkCreateToken instructs a component to create a token for its data items and start the token pointing before all data items.

Deleting a Token 20.1.2

msgMarkDeleteToken informs a component that a token will no longer be in use. It is up to the component and its mapping scheme to determine how to handle this message.

Comparing Tokens 20.1.3

msgMarkCompareTokens asks a component to compare the order of two tokens. Your component should examine the tokens and return one of these status values:

stsMarkTokensEqual	the two tokens point to the same place.
stsMarkTokenAfter	the first token comes after the second.
stsMarkTokenBefore	the first token comes before the second.

Finding a Component's Ancestor 20.1.4

msgMarkGetDataAncestor asks your component to pass back the first of its ancestors that can handle traversal within the component.

Finding a Component's Parent 20.1.5

If your component doesn't inherit from **clsEmbeddedWin** or **clsApp**, it should handle **msgMarkGetParent** by passing back either the UID or UUID of its parent (embedding) component. Components that inherit from **clsEmbeddedWin** or **clsApp** can allow their ancestors to handle this message.

Setting the UUIDs 20.1.6

If your component doesn't inherit from **clsEmbeddedWin** or **clsApp**, it should handle **msgMarkGetUUID** by passing back its UUID and the UUID of the application that contains it. If your component can't get this information, it should return **stsMarkNoUUIDs**. Components that inherit from **clsEmbeddedWin** or **clsApp** can allow their ancestors to handle this message.

Validating a Component 20.1.7

msgMarkValidateComponent is sent to objects before a mark refers to them, allowing the component to redirect the mark to another object.

Messages Sent to Components by msgMarkDeliver 20.2

The messages in this section are sent by the holder to marks or components by the mark delivery messages (**msgMarkDeliver**, **msgMarkDeliverPos**, or **msgMarkDeliverNext**). The mark delivery messages are described at the end of this chapter.

These messages can be sent directly to the component without using mark delivery messages, but some special processing performed when the message is sent *with* mark delivery will not be done.

Positioning Messages 20.2.1

msgMarkPositionAtEdge requests your component to reposition the token to the beginning or the end of the data.

msgMarkPositionAtToken requests your component to reposition the token to the same position as another token in the same component.

msgMarkPositionAtChild requests your component to reposition the token to a specified child component.

msgMarkPositionAtSelection requests your component to reposition the token to the current selection, assuming that your component owns the selection.

msgMarkPositionAtGesture requests your component to reposition the token at a specified gesture.

Messages Sent to Components That Have Children 20.2.2

If your component contains children (embedded components), it might receive these mark messages.

msgMarkNextChild requests your component to move the token to the next child.

msgMarkGetChild requests your component to pass back the UID and UUID of the embedded component at the current token.

Messages Sent by Holders 20.3

A **holder** is an object that creates and uses a mark. Most applications and components will not need to hold marks. However, if your application must traverse documents or otherwise keep a pointer to a location in data, it should create a mark.

Sending Messages to Marks 20.3.1

After creating a mark and telling it to map its token, your application or component uses mark delivery messages to pass your own protocol messages to the mark. For example, a spell checker might ask the component containing the target to search for the next word or embedded document.

There are three delivery messages:

- Deliver a message to the target.
- Deliver a message that might reposition the mark.
- Deliver a message to the component that contains the target.

You use **msgMarkDeliver** to deliver a message to the target. Usually, you use **msgMarkDeliver** after the mark fills in the token field.

You use **msgMarkDeliverNext** to deliver a messages that might reposition the mark or that might move the mark to a different component.

You use **msgMarkSend** to deliver an arbitrary message to the component that contains the mark. Use this form when the message you are sending applies to the component as a whole, not the target in particular.

Setting a Mark to a Component 20.3.2

To set the mark to refer to a specific component, send **msgMarkSetComponent** to the mark. This message deletes the previous mark, if necessary. To make the mark point to nothing, pass a pointer to an all-zero structure; *do not* pass it a null pointer.

This message sends a **msgMarkCreate** to the component.

Getting a Component's UUID and UID 20.3.3

To get the UUID and UID of the component that contains the mark, and the UUID of the application that contains the component, send **msgMarkGetComponent** to the mark.

Copying a Mark 20.3.4

msgMarkCopyMark creates a new mark that is identical to the mark that receives this message. The new mark is not associated with the mark it was copied from (the receiver of **msgMarkCopyMark**). If the receiver is moved, the mark created by **msgMarkCopyMark** does not move.

Part 3 / Windows and Graphics

PENPOINT ARCHITECTURAL REFERENCE / VOL I
PART 3 / WINDOWS AND GRAPHICS

Chapter 21 / Introduction

Every PenPoint™ operating system application with a user interface presents that interface in a rectangular area of the screen called a **window**. The application draws its user interface elements in that window using an imaging model called **ImagePoint**™. This part describes windows and ImagePoint, and how you use them together to create images on the screen or other devices (such as printers).

Overview 21.1

When your application creates an image on an output device such as the screen or a printer, it uses the features of ImagePoint to draw in a window on the output device. ImagePoint provides a rich selection of drawing operations to facilitate the construction of complex images. The fundamental window class, **clsWin**, defines basic characteristics of a window such as the area of the output device in which to draw. In practice, however, effective use of windows usually requires subclasses of **clsWin** that add to these basic characteristics. For example, the PenPoint User Interface (UI) Toolkit, described in *Part 4: UI Toolkit*, is a collection **clsWin** subclasses that implements common user interface components such as buttons, menus, and input fields.

Windows 21.1.1

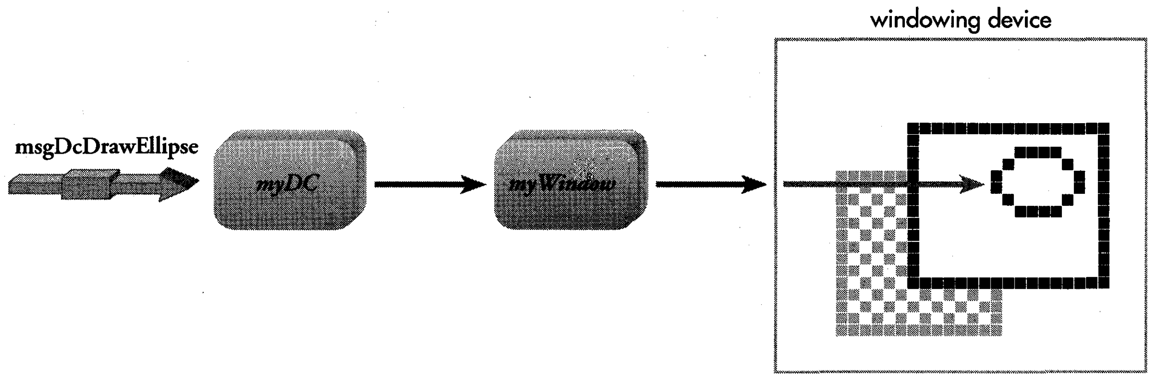
A window defines an area of an output device in which a drawing context can draw. In PenPoint, a window is an instance of **clsWin**, and an output device that allows the display of windows is an instance of **clsWinDev**. PenPoint provides a well-known instance of **clsWinDev** called **theScreen**, which represents the primary display screen. Devices other than the screen (printers, for example) can also serve as window devices.

ImagePoint 21.1.2

The User Interface Toolkit classes inherit from **clsWin**, so you need to understand windows to use the UI Toolkit classes effectively. However, because the UI Toolkit classes handle rendering for you, you don't need to learn about ImagePoint to use them.

An application uses a **drawing context** (or **DC**) to create images in a window. A drawing context is an a set of **drawing operations** (such as an operation to draw a rectangle) together with a graphic state (a set of attributes such as line thickness). The graphic state determines the way in which the DC executes its drawing operations. For example, with the line thickness attribute set to 0.1 centimeters, the DC draws lines 0.1 centimeters thick. If an application changes the line thickness attribute to 0.25 centimeters, the DC draws subsequent lines 0.25 centimeters thick.

Figure 21-1
A Drawing Context Bound to a Window



The standard imaging model for the PenPoint operating system is called **ImagePoint**. Because ImagePoint is the system standard, an ImagePoint drawing context is called a **system drawing context**. In PenPoint, a system drawing context is an instance of **clsSysDrwCtx**. Every system drawing context shares the same set of ImagePoint drawing operations, but each drawing context maintains its own graphic state to determine the way in which it renders images.

Windows and ImagePoint Together 21.1.3

Before a drawing context can render an image, an application must specify the window in which to render it. The process of connecting a drawing context to a window is called **binding**. Once a drawing context and a window are bound, an application sends messages to the drawing context telling it which drawing operations to execute. The corresponding images appear in the area of the output device defined by the bound window.

Windows and Graphics Classes 21.2

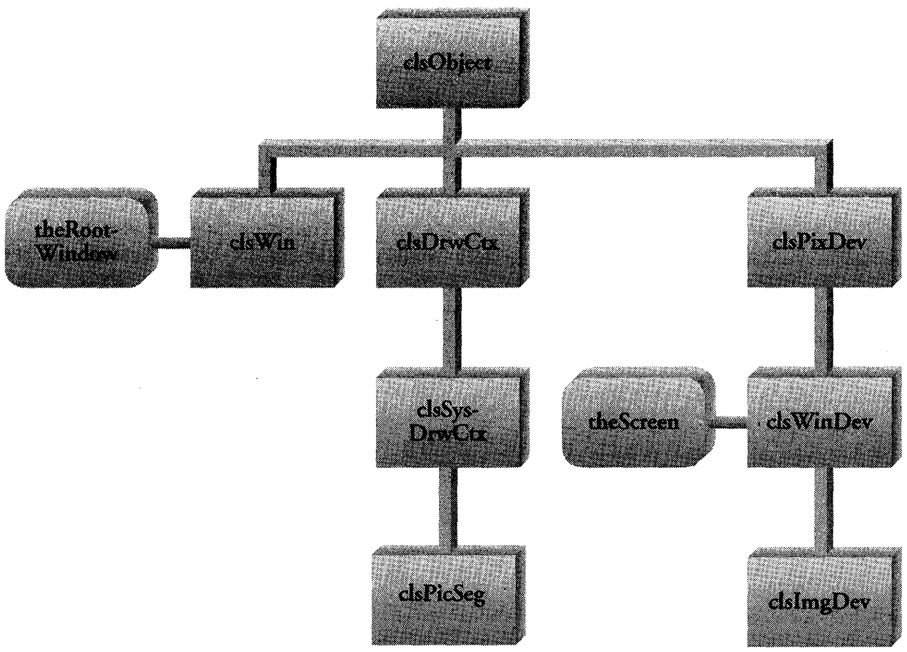
This part describes three main class groups: devices, windows, and drawing contexts. These groups form the class hierarchy shown in Figure 21-2.

Window Devices 21.2.1

In PenPoint, an output device that supports the display of windows in an instance of **clsWinDev**. Each instance of **clsWinDev** corresponds to a physical output device that can display windows. For example, **theScreen**, a well-known instance of **clsWinDev**, represents the primary system display. **clsImgDev** is a subclass of **clsWinDev** which supports windows in memory, without a physical output device. See Chapter 24, Window Device Classes, for more information.

clsPixDev is an abstract class that defines the minimal behavior of pixel-based devices. The only way you should use **clsPixDev** is to create classes that inherit from it.

Figure 21-2
PenPoint Windows and Graphics Classes Hierarchy



Windows 21.2.2

clsWin is the fundamental window class. PenPoint creates **theRootWindow**, a well-known instance of **clsWin**, to serve as the root window of **theScreen**. The User Interface Toolkit classes, described in *Part 4: UI Toolkit*, are subclasses of **clsWin** with specialized user interface behavior. You will probably use the UI Toolkit classes in your applications, or create your own **clsWin** subclasses, rather than use **clsWin** directly, so it is important that you understand the basic behavior of **clsWin**. This chapter and Chapter 23, The Window Class, provide most of the information you need to understand the UI Toolkit classes and **clsWin** subclasses in general.

Drawing Contexts 21.2.3

System drawing contexts, drawing contexts that implement the system-standard ImagePoint imaging model, are instances of **clsSysDrwCtx**. **clsSysDrwCtx** is a subclass of the abstract drawing context class **clsDrwCtx**. It is possible to implement an imaging model other than ImagePoint as another subclass of **clsDrwCtx**. Chapter 26, The Drawing Context Class, describes **clsDrwCtx** and **clsSysDrwCtx**, but does not explain how to implement another imaging model as a subclass of **clsDrwCtx**.

Application Writer's Overview 21.3

The following steps provide an outline of the messages required to create a window and render images in it.

1 Send **msgNew** and **msgNewDefaults** to **clsSysDrwCtx** and **clsWin** to create a drawing context and a window, respectively.

2 Send **msgWinInsert** to the window to insert the window into a window tree. The parent window often is an **application frame** created by the PenPoint Application Framework. *Part 2: PenPoint Application Framework* and *Part 4: UI Toolkit* describe frames in more detail.

3 Send **msgDcSetWindow** to the drawing context to bind it to the window.

4 Send graphic state messages such as **msgDcSetLineThickness** to the drawing context.

5 To render images in the window, send drawing messages such as **sysDcDrawRectangle** to the drawing context. The drawing context will render the images in the window to which it is bound.

Usually, your application renders an image not because it has new elements to draw, but because PenPoint informs one of your application's windows that it must **repaint** itself. Chapter 22, Window System Concepts, describes repainting in more detail.

Example 21.3.1

For almost every application, the PenPoint Application Framework creates a window called the application **frame**. The frame serves as a container for all of the application's other windows. The primary application window within the frame is the frame's **client window** (you can learn more about frames in *Part 2: PenPoint Application Framework* and *Part 4: UI Toolkit*).

The following code example shows how to create a client window for an application frame. You'll probably need to learn more about windows and ImagePoint before you can practically use the techniques shown here (for example by drawing in a window), the example provides a general idea of common use of windows.

Example 21-1
Creating and Drawing in a Window

This example from the Hello World SDK sample application (on the SDK distribution under \PENPOINT\SDK\SAMPLE\HELLO\HELLO.C). The HelloOpen() message handler shows how to create a window and insert the window as the client of the application's main window, or **application frame**.

```
MsgHandler(HelloOpen)
{
    HELLO_WIN_NEW    hwn;
    APP_METRICS      am;
    STATUS           s;
    // Get the app's metrics, including the app main window, or frame.
    ObjCallRet(msgAppGetMetrics, self, &am, s);
    // Create the Hello window.
    // The Hello World app defines clsHelloWin as a subclass of clsWin
    ObjCallWarn(msgNewDefaults, clsHelloWin, &hwn);
    ObjCallRet(msgNew, clsHelloWin, &hwn, s);
    // Insert the HelloWin (hwn.object.uid) as client window of the frame.
    ObjCallJmp(msgFrameSetClientWin, am.mainWin, (P_ARGS)hwn.object.uid,
               s, exit);
    // Ancestor clsApp will display the windows on the screen.
}
```

Organization of This Part 21.4

This part is organized into nine chapters. This chapter, Chapter 21, provides an introduction to windows and ImagePoint. Of the remaining chapters, three describe windows, and four describe ImagePoint and related drawing classes.

Chapter 22, Window System Concepts, provides a detailed overview of windows and window management in the PenPoint operating system.

Chapter 23, The Window Class, describes the messages defined by **clsWin** for creating, displaying, and manipulating windows. It also discusses the use of subclasses of clsWin to implement specialized window behavior.

Chapter 24, Window Device Classes, describes the messages defined by **clsWinDev** for creating a device that supports the display of windows. The chapter also describes **clsImgDev**, a subclass of **clsWinDev** that supports a window tree without an associated display device.

Chapter 25, Graphics Concepts, provides a detailed overview of the features of the ImagePoint imaging model. If you can do your work entirely with the UI Toolkit classes (described in *Part 4: UI Toolkit*), you may be able to skip Chapter 5 and subsequent chapters in this part. Chances are good, though, that you will need to implement one or more custom subclasses of **clsWin** in order to build a fully functional application.

You may be able to use the UI Toolkit classes after reading only the first four chapters in this part.

Chapter 26, The Drawing Context Class, describes the messages defined by **clsSysDrwCtx** for creating ImagePoint drawing contexts, binding them to windows, and drawing figures and text.

Chapter 27, The Picture Segment Class, provides an overview of the features of **clsPicSeg**, a subclass of **clsSysDrwCtx** which adds special features to the ImagePoint model, and describes the messages defined by **clsPicSeg**.

Chapter 28, Bitmaps and TIFFs, describes two classes that support the rendering of sampled bitmap and TIFF (Tagged Image File Format) images.

Chapter 29, ImagePoint rendering details, provides a technical overview of some low-level implementation details of ImagePoint's rendering mechanism

Other Sources of Information 21.5

Some aspects of PenPoint windows and graphics are described elsewhere in this document. For example, *Part 4: UI Toolkit* describes frames, the application windows provided by the PenPoint Application Framework.

Outside of this *PenPoint Architectural Reference*, the best source of information on using PenPoint windows and graphics is the *Application Writing Guide.* In particular, its Hello World and Tic-Tac-Toe application development tutorials provide good examples of the topics described in this part of the *PenPoint Architectural Reference.*

Chapter 22 / Window System Concepts

This chapter describes the PenPoint™ operating system model of windows and window management. It provides a detailed conceptual treatment of features of the window system, preparing you for the chapters describing the classes that implement those features.

Topics covered in this chapter include:

- The hierarchical window tree model
- Graphics support such as clipping
- The interactions between windows and the window system
- Programming support features
- Creating subclasses of **clsWin**.

What is a Window? 22.1

In the simplest sense, a **window** is an object that represents and defines a rectangular area of an output device. A window acts as a kind of canvas onto which a drawing context can render an image (in fact, some other window systems use the term **canvas** to describe what PenPoint refers to as a window). **clsWin** is the fundamental window class in PenPoint.

In practice, PenPoint applications use subclasses of **clsWin** to implement a wide variety of display elements such as status messages and user interface controls. The User Interface Toolkit (described in *Part 4: UI Toolkit*) is a standard collection of subclasses of **clsWin** that implements most of the user interface elements applications require. You need to understand **clsWin** in order to understand the features the UI Toolkit classes inherit from **clsWin**.

Much of the information in this chapter is useful in designing subclasses of **clsWin**. Because the UI Toolkit provides many standard **clsWin** subclasses, it may be tempting to skip this part and jump ahead to *Part 4: UI Toolkit.* However, every application requires that you design at least one custom subclass of **clsWin** (to act as the main window of the application), so it is important that you understand the information in this part.

Window System Concept Overview 22.2

The PenPoint window system offers a number of features that enhance the value of windows as a programming tool:

- A hierarchical **window tree** supports the appearance of multiple, overlapping windows.

- Windows are **lightweight**. You can use hundreds of them at once without overburdening the system, you can use subclasses of **clsWin** for frequently-used objects such as user interface elements.
- Windows support **clipping**, so that images rendered outside the window bounds do not appear on the output device.
- PenPoint automatically notifies a window that it needs to **repaint** itself when its image is damaged.
- Window position is not tied absolutely to the display device, but is relative its parent window. Applications and the user can change the position and size of most windows.
- Windows support a comprehensive **layout** system so that the arrangement of elements in the window is not dependent on the size of the window.
- PenPoint provides methods for **enumerating**, **tagging**, sorting, searching for, and **filing** windows, and for sending a message that will propagate up the window tree.
- **clsWin** self-sends a number of messages, providing hooks for custom behavior in your **clsWin** subclasses.

The remainder of this chapter describes these features in more detail.

Hierarchical Model 22.3

The PenPoint window system can maintain many windows on a single output device, organizing them into a hierarchy called a **window tree**. Every output device that supports the display of windows must have an initial window to serve as the **root window** of its window tree. PenPoint provides a well-known object called **theRootWindow** to serve as the root window on the primary system display.

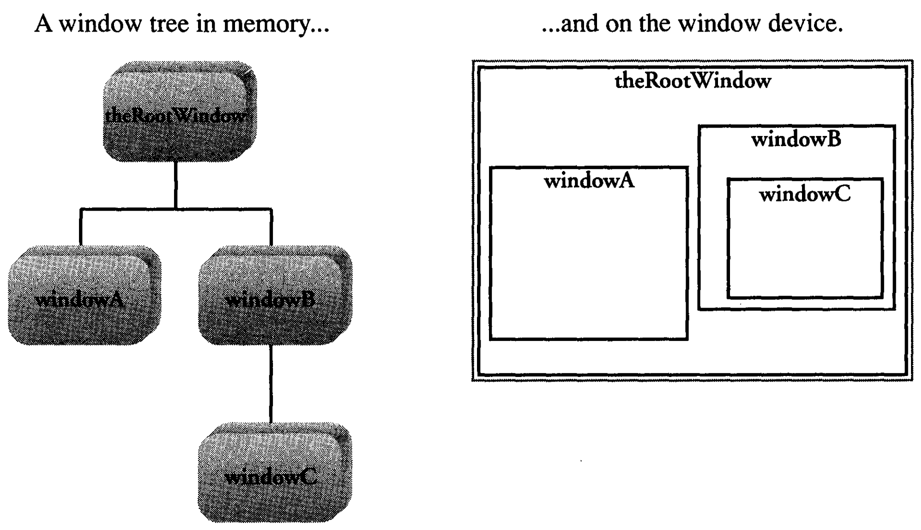
Parents, Children, and Siblings 22.3.1

The window tree is a hierarchy in which every window (except for the root window on the window device) is a **child** of some other window in the window tree. A window that has a child window is the **parent** of that child. Any two or more windows with the same parent **share a sibling** relationship. A tree of windows whose root is a child of the root of another tree is a **subtree** of that other tree.

In figure 22-1, **windowA** and **windowB** are siblings, since both are children of the same parent (**theRootWindow**). **windowC** is the only child of **windowB**, and thus has no sibling. **windowB** is the root of a subtree that includes **windowB** and **windowC**. Even though it has no children, **windowA** is also a subtree (this is a degenerate case). In the same sense, **theRootWindow** is a window tree even when it has no children.

There is no limit to the number of children or siblings a window can have. The root window of a window device only has children.

Figure 22-1
A Simple Window Tree



Window Devices

22.3.2

In almost every case, the system displays a window tree on a physical output device. PenPoint represents each of these physical devices as an instance of **clsWinDev**. PenPoint associates the root window of a window tree with a particular window device, and renders the window tree on that device. Any device that supports the rendering of output, from display screens to printers, can be a window device. PenPoint provides a well-known object called **theScreen** to represent the primary system display.

When PenPoint prints a document, it simply attaches a copy of that document's window as the root window of the printer window device. The document displays itself on the printer just as it would on the screen.

Window Life Cycle

22.3.3

An instance of **clsWin** typically undergoes four procedures: **creation**, **insertion**, **extraction**, and **destruction**.

Creation

22.3.3.1

When an application creates a new window, the window exists in memory just like any other object, but it is not part of any window tree. A window such as this is called an **orphan**, because it has no parent in the window tree. Orphan windows are not part of any window tree, and therefore cannot display themselves on the corresponding window device.

Insertion

22.3.3.2

Establishing an orphan window's parent in a window tree is **called inserting** the window into the window tree. Once inserted into the window tree, the window can display itself on the window device. In most cases, this means the window will display itself on the window device, because the window system instructs windows in the tree to redisplay themselves when there are changes in the window tree.

Extraction

22.3.3.3

The process of removing a window from a window tree is called **extracting** the window from the window tree. Extracted windows (and their children, if any) are not part of any window tree, and therefore cannot display themselves on any window device. If an application later reinserts an extracted window into a window tree, the window will appear exactly as when it was extracted (unless the application changed some attributes of the window while it was extracted).

Destruction

22.3.3.4

Destroying a window is like destroying any other PenPoint object: the window ceases to exist and the system frees up its memory for other uses. When you send a message to a window to destroy itself, it recursively sends the same message to its children (so the entire window subtree is destroyed). It is possible to set a flag in a window so that its parent does not destroy it in this way, but the flag is not on by default. Windows with this flag set become **orphans**, windows without parents, when their parent window is destroyed.

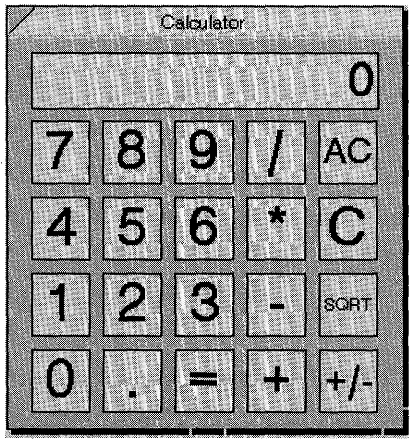
Windows are Lightweight

22.4

PenPoint implements windows as **lightweight** objects. This means that windows are not costly in terms of system resources such as memory or processor time. It is possible for the system to display and maintain hundreds of windows with very little performance degradation.

Figure 22-2 shows a typical user interface built of windows (actually, specialized subclasses of **clsWin**). Note that many windows, such as buttons and text fields, are not what the user normally considers to be a window. Nevertheless, these items inherit from **clsWin**. Because windows are so lightweight, even windows as common as user interface elements do not seriously reduce system performance.

Figure 22-2
A User Interface Built of Windows



Using Window Subclasses 22.4.1

Because windows are lightweight, you can design specialized classes that inherit from **clsWin** to implement commonly used user interface elements such as message displays and input fields. You can combine dozens of small windows, each responsible for managing a small part of your application's user interface, to create a complete interface for your application. In addition to reducing the time required to implement your application's user interface, the reuse of standard user interface elements makes your application easier to use.

Clipping 22.5

If an application attempts to draw an image that extends outside the boundary of the window to which it is bound, the basic behavior of **clsWin** prevents the part of the image that falls outside the window bounds from appearing. This process of filtering out the parts of images that fall outside the window's bounds is called **clipping** the image.

The Clipping Region 22.5.1

Each window maintains a **clipping region** that defines the area in which it will allow drawing. Normally, a window clips any part of a child window that extends past the parent's bounds. In Figure 22-4, **windowB** clips its child, **windowC** (the gray line indicates the part of **windowC** that does not appear on the display). One consequence of this feature is that only siblings, such as **windowA** and **windowB**, can overlap one another.

Figure 22-3
Clipping an Image

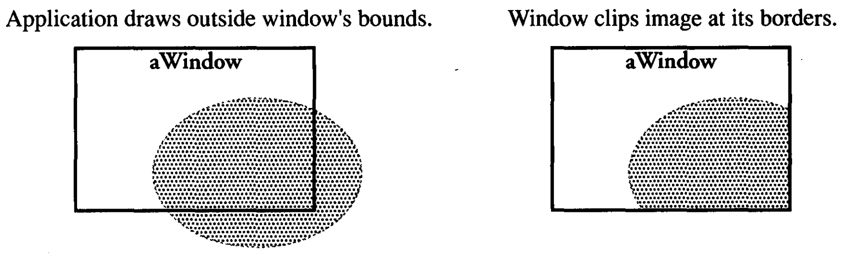
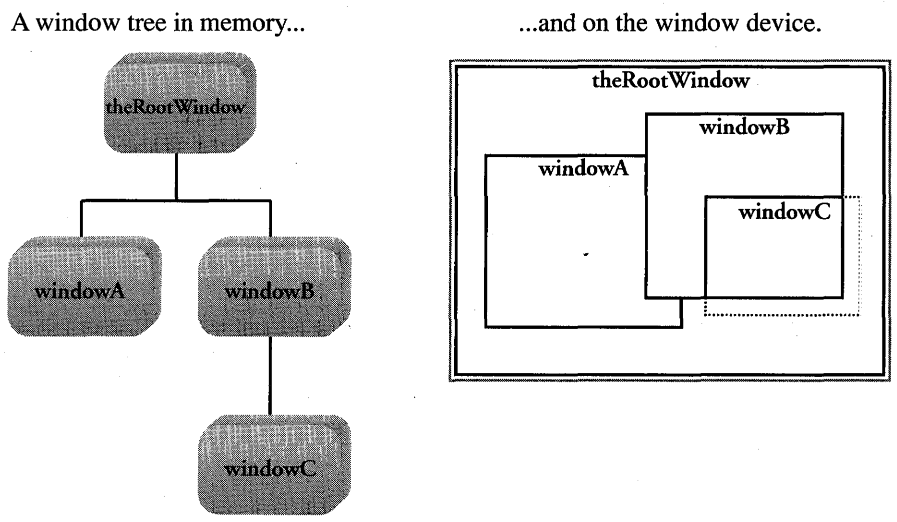

Application draws outside window's bounds.
aWindow
Window clips image at its borders.
aWindow

Figure 22-4
Window Clipping Regions



Clipping allows drawing operations to treat a window as a coherent drawing area. Drawing operations do not need to account for the fact that parts of the rectangle defined by a window object may be obscured on screen, either by the window's children or by its overlapping siblings. The disadvantage of clipping is that it can slightly increase the performance overhead of drawing operations.

Overriding Automatic Clipping 22.5.2

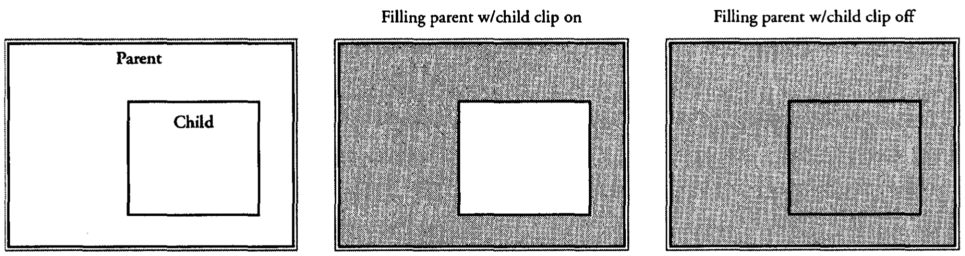
Clipping is not always necessary. For example, the UI Toolkit class **clsTabButton** is a descendant of **clsWin** that implements a tab along the side of a PenPoint notebook. An instance of **clsTabButton** displays a label inside a border, and its window is always large enough to contain the entire image. This means that the label image in each tab will never extend past the tab window bounds, and therefore that there is no need to prevent the window from drawing in its parent.

PenPoint provides several levels of control over automatic clipping: **clip children**, **clip siblings**, and share **parent clipping region**. This allows you to optimize drawing operations by turning off the automatic clipping you know is unnecessary.

Clip Children 22.5.2.1

By default, window clipping prevents drawing operations from affecting the child windows contained within the bounds of the target window. When you want to allow drawing operations to affect children of the target (to fill them all with the same color, for example), you can turn off child clipping.

Figure 22-5
Clipping Children

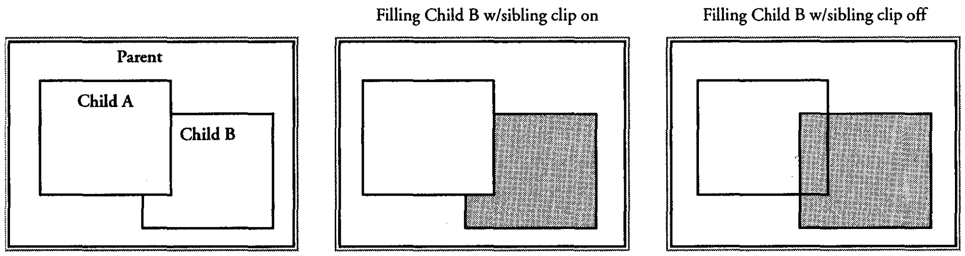

Filling parent w/child clip on
Filling parent w/child clip off
Parent
Child

Clip Siblings

22.5.2.2

By default, window clipping prevents drawing operations from affecting siblings of the target window that happen to overlap the target window. When you want to allow drawing operations to affect overlapping siblings of the target window, you can turn off sibling clipping.

Figure 22-6
Clipping Siblings

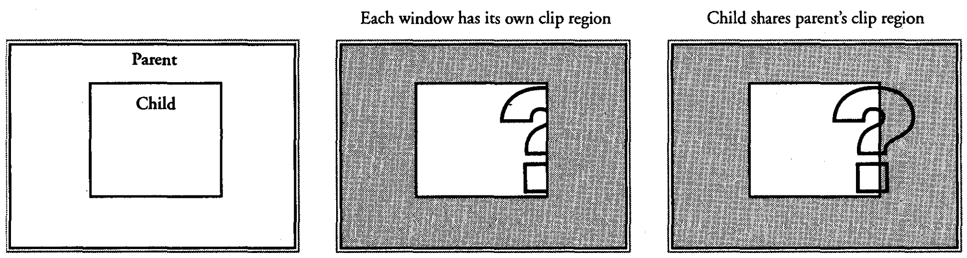

Filling Child B w/sibling clip on
Filling Child B w/sibling clip off
Parent
Child A
Child B

Parent Clipping Region

22.5.2.3

A window must reserve some memory to store its clipping region. To conserve memory, a window can use its parent's clipping region instead of maintaining its own. This is appropriate when you know there will never be an attempt to draw images in the child window that extend outside the window bounds. In the **clsTabButton** example above, for instance, because tabs are always as large as the label they display, a **clsTabButton** does not require its own clipping region.

Figure 22-7
Sharing a Parent's Clipping Region


Each window has its own clip region
Child shares parent's clip region
Parent
Child

Repainting 22.6

The information in this section is particularly useful if you are planning to create or use a class that inherits from **clsWin**.

Painting is the process of drawing an image in a window. An application paints a window by sending it a series of drawing requests, so painting is entirely under the application's control. However, a window's appearance may change because of factors outside of the application's control. For example, the user may resize the window.

When the display no longer accurately reflects the structure of the window tree, the window system notifies modified windows that they must repaint themselves. The default repaint behavior of **clsWin**, the fundamental window class, is simply to fill its bounding rectangle with white. Applications typically use subclasses of **clsWin** to implement more useful user interface behavior.

The window system does not keep track of the images displayed in windows. Each window is responsible for sending the appropriate drawing instructions when it receives a repaint request. By default, an instance of **clsWin** simply fills its bounding rectangle with white. Descendants of **clsWin** such as the User Interface Toolkit classes, add to or alter this basic behavior to repaint more meaningful imagery.

Why Windows Must Repaint 22.6.1

Each window must be prepared to repaint itself at any time. The window system will instruct a window to repaint itself whenever part of the window's image becomes **damaged**. A window is considered damaged when a change to the window tree affects one or more pixels contained within the window (the term **dirty** is a synonym for **damaged**, especially when referring to individual pixels).

For example, suppose a sibling overlaps an underlying window. If the user moves the sibling, the move may expose some pixels in the underlying window. These newly-exposed pixels, still display whatever was in the overlapping window before the user moved it. The pixels are therefore dirty, so the window system instructs the underlying window to repaint itself.

The Update Region 22.6.2

Before sending a repaint request, the window system calculates the **update region**, a rectangle containing all damaged pixels. The performance cost of repainting an entire window can be high, especially if the window receives damage frequently or its imagery is complex. In these cases, if you are writing a class that inherits from **clsWin**, you can improve its performance by repainting only that portion of the window that falls within the update region. However, it is rare that a window will require a level of processing that warrants this kind of optimization.

Printing 22.6.3

Another reason it is important for **clsWin** subclasses to respond to repaint requests is that PenPoint uses the repaint mechanism to print documents. When the user asks to print a document, the system makes a copy of the document window on a window device representing the printer, turns off the window borders, then sends a repaint request to the window. The window uses exactly the same code to repaint itself on the printer as it would on any window device, providing a printer image that is virtually identical to the screen image.

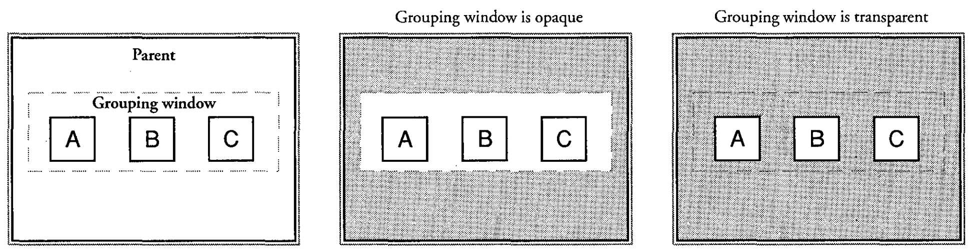
Transparency 22.7

Windows can be transparent. Transparent windows do not fill themselves with white when they repaint, so they don't obscure other windows. When a transparent window needs to repaint, the window system causes windows below it to repaint first. In effect, the transparent window uses whatever is in the window behind it as its own background. In other words, if you don't draw in a transparent window, it is invisible.

You can draw in a transparent window just as in an opaque one. The effect is like painting on a piece of glass. One use for a transparent window is to group its children without obscuring what is behind them.

The UI Toolkit class **clsTabBar** is one example of the use of a transparent window to group several opaque child windows. **clsTabBar** implements the tab bar along the edge of the notebook as a transparent window. When the user adds a tab to the notebook, the notebook application creates the tab as an opaque child of the tab bar. Because the tab bar window is transparent, the window system instructs the window *behind* the tab bar to repaint before the tab bar can repaint itself. This ensures that any area not obscured by the opaque children shows through the grouping window.

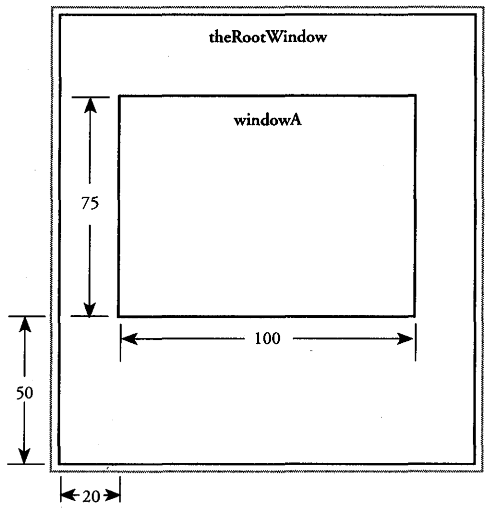
Figure 22-8
Grouping Windows in a Transparent Window



Window Size and Position 22.8

A window defines a rectangular region of the display device. Applications measure the x (horizontal) and the y (vertical) size of a window in pixels, and specify the origin (lower-left corner) of a window in pixels relative to the origin of its parent window. For example, in Figure 22-9, **windowA** is a child of **theRootWindow**. Relative to **theRootWindow**'s origin, **windowA**'s origin is 20 pixels in the *x* direction and 50 pixels in the *y* direction. **windowA**'s size is 100 pixels in the *x* direction and 75 pixels in the *y* direction.

Figure 22-9
Window Size and Position



Although applications specify each window's initial position and size, several factors can change them. For example, if your application allows it, the user can move and resize the window outside of your application's control. If you are designing your own subclass of **clsWin**, the repaint code will have to take into account that the window size, or that the positions of child windows, can change. PenPoint provides a mechanism for prohibiting changes to a window's position and size outside of application control, on an instance-by-instance basis.

Layout 22.9

PenPoint provides a scalable user interface model. That means that your application can make no assumptions about the size of the display device. One user may run it on a clipboard-sized machine, while another may use a pocket-sized machine. An application window needs to **lay out** its child windows (user interface components) in a reasonable fashion, independent of the size of the display.

Every window class inherits a mechanism called window **layout** that gives each window varying degrees of control over the position and sizes of its children. PenPoint provides three layout models: **unconstrained** layout, **parent-veto** layout, and **episodic** layout.

Note that for a window to lay itself out is for it to determine the positions and sizes of its children.

Unconstrained Layout 22.9.1

Unconstrained window layout is the type of layout most window systems provide. In such window systems, you are responsible for hard-coding layout algorithms into your application. PenPoint allows you to use unconstrained layout in which the parent allows child windows of any position and size. By default, the parent will always clip children that extend past the bounds of the parent. Unconstrained layout may leave the parent completely covered by children, leaving no space of its own on which to draw.

Parent-Veto Layout 22.9.2

In the parent-veto layout model, the window notifies the parent window of any pending operation that will insert, remove, move, or resize a child window. The parent must respond by approving, constraining, or vetoing the operation. If the parent approves the operation, it proceeds as requested. If the parent constrains the operation, the operation must select from a range of sizes and positions the parent specifies. Finally, the parent may veto outrageous requests, in which case the insert, remove, move, or resize operation does not take place.

Episodic Layout 22.9.3

Episodic layout is the most flexible layout model. When the application determines that it is necessary to lay out a window's children (for example when the parent changes its size), it instructs the parent to initiate a **layout episode**. The parent requests size and position proposals from all of its children, the children respond with proposals, and the parent lays out the child windows while trying to preserve the positions and sizes they requested.

Since there may be conflicts between the various children's initial proposals, the parent may need to request additional rounds of proposals, mediating the children's requests until it establishes an acceptable compromise. Because of this, a layout episode can have a high performance cost, especially when there are many children involved. On the other hand, episodic layout provides the greatest degree of flexibility, because it keeps a user interface entirely independent of the size of the display or other variable elements.

To see an example of an intricate layout episode, change the system font. This causes a layout episode beginning with the root window of the system display.

Episodic layout provides a great deal of flexibility at the cost of a somewhat complex programming model. Chapter 23, The Window Class, describes episodic layout in more technical detail.

Window Management 22.10

clsWin provides a number of features that facilitate the management of group of windows. These facilities can be particularly useful when you are designing a special-purpose subclass of **clsWin**:

- A window can **enumerate** its children. In other words, it can generate a list of its children. The window system provides a number of enumeration options, including recursive enumeration.
- An application can associate a unique identifying **tag** with any window, allowing it to later refer to the window by its tag.
- An application can send a message to a window in a way that, if the window cannot respond to the message, the window will **propagate** a message up the window tree until one of its ancestors responds to the message (or the message reaches the root window).
- A window can **sort** its children, changing their placement on top of or below one another, based on a comparison routine your application provides.

- A window can file its state, possibly including its child windows, for later reference. For example, a window that files a complex layout state can later restore the layout from the file, without the performance overhead of a layout episode.

Subclassing clsWin 22.11

clsWin is a fairly abstract class; to get really useful behavior, you must use subclasses of **clsWin**. For example, the UI Toolkit classes (described in *Part 4: UI Toolkit*), are **clsWin** subclasses that implement standard user interface elements such as text fields and buttons. However, you may have to design at least one custom subclass of clsWin to create an application. You can override the inherited response to certain messages to implement custom behavior.

For example, when a window system instructs a window to repaint itself, an instance of **clsWin** simply fills itself with white. If you were writing a spreadsheet application, you might design a subclass of clsWin that responds to **msgWinRepaint** by displaying the elements of an array of values and formulas in a grid. Layout is another area that may require custom behavior in **clsWin** subclasses. See Chapter 23, The Window Class, to learn more about **clsWin**'s default behavior and how you might want to override it.

Chapter 23 / The Window Class

The window class (**clsWin**) provides basic window behavior upon which descendants such as the User Interface Toolkit classes (described in *Part 4: UI Toolkit*) are built. The primary purpose of windows is to serve as a canvas for drawing contexts, described in Chapter 26, The Drawing Context Class. This chapter describes the programming interfaces for clsWin, going on the assumption that you have read and understood the preceding chapter on window system concepts.

Topics covered in this chapter:

- Important structures in the implementation of **clsWin**
- Messages to which **clsWin** responds.

clsWin Structures 23.1

Before using clsWin, it is important to have a general understanding of two structures: **window metrics** and **window flags**. Window metrics, encoded in the WIN_METRICS structure, define what makes each instance of **clsWin** unique. One important element of the WIN_METRICS structure is the **flags** field, which defines a window's display style and, for some subclasses of **clsWin**, its input behavior.

Window Metrics 23.1.1

Each instance of **clsWin** maintains a set of **window metrics** that define its appearance and behavior. An application can directly modify the window metrics before sending **msgNew** to create an instance of **clsWin**. After creating the window object, however, the application should modify its metrics only by sending messages that **clsWin** defines.

The messages clsWin defines for reporting and modifying window metrics generally take a P_WIN_METRICS as an argument. P_WIN_METRICS is a pointer to a WIN_METRICS structure, which includes fields for all of the window metrics information. **clsWin** messages that use a P_WIN_METRICS argument either report particular window metrics in the corresponding fields of the WIN_METRICS argument, or set particular window metrics according to the corresponding fields in the WIN_METRICS argument. These messages ignore the WIN_METRICS fields that are not relevant to the operation at hand.

Although messages ignore irrelevant WIN_METRICS fields in the final result, they may use them for intermediate calculations. Do not rely on the state of any WIN_METRICS fields except those the message is intended to report or set.

The WIN_METRICS structure includes **parent**, **child**, **bounds**, **flags**, **tag**, and **options** fields. This section briefly describes how each of these fields is commonly interpreted.

- The **parent** field normally represents the window's parent in a window tree. One notable exception is that when used with **msgWinInsertSibling**, the parent field represents the intended sibling of the window.
- The **child** field is used by some window layout messages.
- The **bounds** field represents the origin and size of the window. The **origin** is a coordinate pair (**bounds.origin.x** and **bounds.origin.y**) in parent window coordinates that defines the location of the window's lower left corner. The **size** is a coordinate pair (**bounds.size.w** and **bounds.size.h**) in logical window coordinates that defines the width and height of the window relative to its origin.
- The **flags** field defines two sets of flags, the window style flags (**flags.style**) and the window input flags (**flags.input**). The style flags define the display and layout behavior of the window. **clsWin** does not support input, so this chapter does not describe the input flags. The input flags support a common mechanism for specifying input behavior classes that inherit from **clsWin** (see *Part 5: Input and Handwriting Translation* for information about input flags).
- The **tag** field holds the window's tag. A *tag* is an arbitrary value you can can associate with a window. **clsWin** defines a message that searches for a window with a particular tag.
- The purpose of the **options** field is defined by the message that is taking the P_WIN_METRICS as an argument. Most of the clsWin messages use P_WIN_METRICS as an argument. For those that need special information to complete their tasks, WIN_METRICS provides the **options** field to carry that information.

Window Flags

23.1.2

Input flags are discussed in Part 5: Input and Handwriting Translation.

The display style and input behavior of each instance of **clsWin** is modified by a set of **flags**. **clsWin** supports the **input** flags to support subclasses of **clsWin** that respond to input, but because **clsWin** does not respond to input, it ignores the input flags. Window **style** flags, on the other hand, affect every instance of **clsWin** and all its subclasses. Table 23-1 lists the window style flags.

Table 23-1
Window Style Flags

Flag	What happens if flag is set
wsClipChildren	Drawing operations in the window do not affect children.
wsClipSiblings	Drawing operations in the window do not affect overlapping siblings.
wsParentClip	The window shares the same clipping region as its parent.
wsSaveUnder	The window stores for later retrieval the pixels it obscures on insertion.
wsGrowTop	When the window's size changes, the bottom edge of its image stays with the bottom edge of the window.
wsGrowBottom	When the window's size changes, the top edge of its image stays with the top edge of the window.
wsGrowLeft	When the window's size changes, the right edge of its image stays with the right edge of the window.
wsGrowRight	When the window's size changes, the left edge of its image stays with the left edge of the window.
wsCaptureGeometry	The window gets a chance to veto any insertion, change in position or size, or extraction of a child window.
wsSendGeometry	The window system tells the window whenever it has been successfully inserted, moved, resized, or extracted.
wsSendOrphaned	When the window's parent is freed, the window system sends msgWinOrphaned to the window instead of msgFree.
wsSynchRepaint	The window receives msgWinRepaint synchronously (via ObjectCall rather than ObjectSend).
wsTransparent	The window is transparent.
wsVisible	The window is visible.
wsPaintable	Painting operations can affect the window.
wsSendFile	msgFile will store the window in a file.
wsShrinkWrapWidth	During a layout episode, the width of the window will shrink to the minimum necessary to contain its children.
wsShrinkWrapHeight	During a layout episode, the height of the window will shrink to the minimum necessary to contain its children.
wsLayoutDirty	The window will lay out its children during the next layout episode.
wsCaptureLayout	The window will set wsLayoutDirty whenever a child window is inserted, moved, resized, or extracted.
wsSendLayout	The window will set wsLayoutDirty whenever it changes parent, position, or size.
wsFileInLine	The window will not file its object header when responding to msgFile.
wsFileNoBounds	The window will not file its bounds when responding to msgFile.
wsFileLayoutDirty	The window will set wsLayoutDirty when restored from a file.

clsWin Messages

23.2

Table 23-2 lists the messages defined by **clsWin**. They are organized into the following categories:

Creation messages handle the common tasks of creating and destroying windows.

Window attribute messages set and report flags that determine the appearance of the window.

Window display messages handle the display of window contents.

Window layout messages implement the protocols for a parent to lay out its children.

Window management messages provide special functions for organizing and managing windows.

Filing messages provide a mechanism for storing windows as files for later retrieval.

Table 23-2
clsWin Messages

Message	Description
	Creation Messages
msgNew	Creates a window.
msgNewDefaults	Initializes the WIN_NEW structure to default values.
msgFree	Destroys a window and frees its memory, and recursively destroys and frees any of the window's children that do not have wsSendOrphaned set.
	Window Metrics Messages
msgWinInsert	Sets the window's parent in the window tree.
msgWinInsertSibling	Sets the window's parent to the parent of another window.
msgWinExtract	Sets the window's parent to objNull, removing the window from the window tree.
msgWinDelta	Sets the window's size and position (bounds).
msgWinSetFlags	Sets the window's flags.
msgWinSetVisible	Sets the window's visibility flag, returns previous value.
msgWinSetPaintable	Sets the window's paintability flag, returns previous value.
msgWinGetFlags	Reports window style and input flags.
msgWinGetTag	Reports the tag (if any) associated with a window.
msgWinSetTag	Sets the window tag.
msgWinGetMetrics	Reports full window metrics.
	Window Display Messages
msgWinRepaint	Tells a window to repaint itself.
msgWinBeginRepaint	Sets up window for painting on dirty region.
msgWinEndRepaint	Tells window system that repainting has ended for this window.

continued

Table 23-2 (continued)

Message	Description
msgWinStartPage	Advises window that it is on a printer, and printing is about to commence.
msgWinBeginPaint	Sets up window for painting on its visible region.
msgWinEndPaint	Tells window system that painting has ended for this window.
msgWinDirtyRect	Marks all or part of a window dirty.
msgWinUpdate	Forces a window to repaint now, provided that it needs repainting.
msgWinCleanRect	Marks all or part of a window clean.
msgWinCopyRect	Copies pixels within a window.
msgWinTransformBounds	Transforms bounds from receiver's to another window's LWC.
	Window Layout Messages
msgWinLayout	Tells a window sub-tree to layout.
msgWinLayoutSelf	Tells a window to layout its children.
msgWinGetDesiredSize	Gets the desired size of a window (used during layout).
msgWinGetBaseline	Gets the desired x-y alignment of a window.
msgWinSetLayoutDirty	Turns wsLayoutDirty bit on or off, returns previous value.
msgWinSetLayoutDirtyRecursive	Turns wsLayoutDirty bit on for every window in subtree.
msgWinInsertOK	Informs a potential parent of a pending child insertion.
msgWinExtractOK	Informs parent of a pending child extraction.
msgWinDeltaOK	Informs parent of a pending change in a child window's size or position.
msgWinFreeOK	Informs parent of the pending destruction of a child window.
msgWinInserted	Advises window that it has been inserted.
msgWinExtracted	Advises window that it has been extracted.
msgWinMoved	Advises window that it, or an ancestor, has moved.
msgWinSized	Advises window that it, or an ancestor, has changed size.
msgWinOrphaned	Tells a window its parent has been freed.
	Window Management Messages
msgWinSend	Sends a message up a window ancestry chain.
msgWinEnum	Enumerates a window's children.
msgWinGetEnv	Gets the current window environment.
msgWinFindTag	Searches for a window tag in a window subtree. Returns match or objNull.
msgWinFindAncestorTag	Searches for a window tag in ancestor windows. Returns match or objNull.
msgWinSort	Sorts a window's children into a back to front order determined by a client supplied comparison function.
msgWinDumpTree	In lieu of msgDump, dumps a dense subset of information for the window and all it's children recursively.
	Filing Messages
msgFile	Stores the window as a file.
msgRestore	Restores a filed window.

Creating a New Window 23.3

The simplest window class is **clsWin**. To prepare to create an instance of **clsWin**, an application first sends **msgNewDefaults** to **clsWin**, with a WIN_NEW structure as an argument. **msgNewDefaults** initializes the WIN_NEW structure to contain default values. The application then must specify the window's *parent* in the window tree. Additionally, it may need to specify the window size and position, and various flags that determine the display and input behavior of the new window. Once the application has initialized the WIN_NEW structure, it creates an instance of clsWin by sending **msgNew** to **clsWin**, with the initialized WIN_NEW structure as an argument.

Size and Position 23.3.1

Unless you know that the new window's parent will position the new window (in a layout episode, for example), you should specify the window's initial size and location in **bounds. bounds** is a RECT32 structure, made up of four signed 32-bit coordinates:

bounds.origin.x

bounds.origin.y

bounds.size.w

bounds.size.h

The origin coordinates specify the position of the new window's lower-left corner in pixels relative to the lower-left corner of the parent window. The size coordinates are in logical window coordinates (LWC), or pixels relative to the origin of the new window.

Window Style Flags 23.3.2

The **flags.style** attributes control the display behavior of a window. **msgNewDefaults** initializes **flags.style** to **wsDefault**, a combination of window style flags summarized in Table 23-3. It sets all other window style flags false.

Table 23-3
Default Window Style Flags

Flag	What happens when the flag is set
wsPaintable	The window can be painted.
wsVisible	The window is visible.
wsClipChildren	Drawing operations in the window do not affect children.
wsClipSiblings	Drawing operations in the window do not affect overlapping siblings.
wsLayoutDirty	The window will lay out its children during the next layout episode.
wsCaptureLayout	The window will set wsLayoutDirty whenever a child window is inserted, moved, resized, or extracted.
wsSendLayout	The window will set wsLayoutDirty whenever it changes parent, position, or size.

Window Metrics Messages 23.4

An application can directly modify the window metrics before sending **msgNew** to create an instance of **clsWin**. After creating the window, however, the application should send messages that **clsWin** defines for changing the window's metrics values. These messages generally take a P_WIN_METRICS (a pointer to a WIN_METRICS structure) as an argument, but most of the messages refer to only those WIN_METRICS fields relevant to the operation at hand.

To determine a given window's complete metrics information, an application sends **msgWinGetMetrics** to the window with a P_WIN_METRICS as its argument. This sets the WIN_METRICS fields equal to the window's metrics information. The following sections describe how an application sets and retrieves subsets of a window's metrics information.

Setting the Window Device or Parent 23.4.1

To establish a window's position in a window tree, the application must **insert** it into the tree. To insert a window into a window tree is to establish its parent window in that tree. **clsWin** supports three ways to insert a window into a window tree. The application may specify the intended parent window, the intended window device, or an intended sibling window.

To remove a window from its window tree, an application must **extract** it. An extracted window still exists as an object, but it has no parent window. Because an extracted window has no parent window, neither the extracted window nor any of its children are visible on any window device.

Inserting the Window 23.4.1.1

A subtree of windows does not appear on a device until the root of the subtree is inserted. When inserting a subtree of windows, you'll get the smoothest display by inserting all descendants of the subtree before inserting its root.

An application sends **msgWinInsert** to a window to specify the window's parent or window device. In either case, **msgWinInsert** takes a P_WIN_METRICS as an argument, either with the **parent** field set to the intended parent window or with the **device** field set to the intended window device. If the argument specifies a device, the window will have the device's root window as its parent. If the argument specifies a window, the new window will share the parent window's device.

msgWinInsert also looks at the **options** field of the passed WIN_METRICS to determine the front-to-back ordering of the new window. If **options** is set to **wsPosTop**, the window will insert in front of all of its siblings. If **options** is set to **wsPosBottom**, the window will insert behind all of its siblings.

Instead of inserting a window by specifying an intended window device or parent window, an application can specify an intended *sibling* window. **msgWinInsertSibling**, takes as an argument a P_WIN_METRICS with the **parent** field set, but the **parent** field specifies the intended *sibling* window rather than an intended parent. After receiving **msgInsertSibling**, the newly-inserted window has the same parent as does the sibling window specified in the **parent** field.

Neither msgWinInsert nor msgWinInsertSibling refer to argument fields other than **parent**, **device**, and **options**. In particular, the insertion messages ignore the **bounds** information in the WIN_METRICS argument. Until an application sends **msgWinDelta** to a window, the window retains the bounds specified when it was created with **msgNew**.

Extracting the Window 23.4.1.2

To extract a window from the window tree, an application sends **msgWinExtract** to the window. **msgWinExtract** takes either a P_WIN_METRICS or **pNull** (a pointer to the null object) as its argument. If the window does not have a parent when the application sends it **msgWinExtract**, the message returns the status **stsWinParentBad**.

If the argument is pNull, **msgWinExtract** simply extracts the window from the window tree. If the argument is a P_WIN_METRICS, **msgWinExtract** sets the WIN_METRICS fields to reflect the metrics of the extracted window before extraction.

This is useful, for example, when you want to temporarily extract a window subtree, then reinsert it with the original parent. If your application gives **msgWinExtract** a P_WIN_METRICS argument, it will set the **parent** field to the parent of the window before it was extracted. If the application later sends **msgWinInsert** with the same WIN_METRICS argument, it will insert the window as a child of the same parent.

Setting the Window Bounds 23.4.2

A window's **bounds** are defined by two coordinate pairs: an **origin** (starting position) measured in pixels relative to the lower left corner of the window's parent, and a **size** measured in pixels relative to the origin. In a WIN_METRICS structure, these two coordinate pairs are encoded as a RECT32 called **bounds**.

To change the origin or size of an existing window, an application sends **msgWinDelta** to the window with a P_WIN_METRICS as an argument. **msgWinDelta** uses the **bounds.origin.x** and **bounds.origin.y** of the WIN_METRICS structure to set the origin of the window, and **bounds.size.w** and **bounds.size.h** to set its size.

Setting the Window Flags 23.4.3

In a WIN_METRICS structure, the window style flags are stored in the **flags.style** field. To set a window's flags, an application sets the **flags.style** fields of a WIN_METRICS structure to the desired values, then sends **msgWinSetFlags** to the window with a pointer to the WIN_METRICS structure (a P_WIN_METRICS) as its argument. To restore a window's style flags to the default, an application uses **msgWinSetFlags** twice: once to set the flags to zero, and once to set them to **wsDefault**.

Although this chapter does not discuss flags.input (described in *Part 5: Input and Handwriting Translation*), the messages described in this section use flags.input as well as flags.style.

Setting Individual Flags 23.4.3.1

If an application sends **msgWinGetFlags** to a window, with a P_WIN_METRICS as its argument, the **flags** field of the argument is set equal to the current **flags** of the window. The application can use bitwise logical operators to set and clear individual flags in the WIN_METRICS structure, then use the modified structure as an argument to **msgWinSetFlags** to set the window flags to the new values.

Because the window system sets the **wsVisible** and **wsPaintable** flags frequently, **clsWin** defines messages optimized for this purpose. **msgWinSetVisible** takes a **Boolean** value as its argument, sets the window's **wsVisible** flag equal to the argument, and returns the previous value of the **wsVisible** flag. **msgWinSetPaintable** works exactly the same way for the **wsPaintable** flag.

Setting the Window Tag 23.4.4

clsWin lets an application associate an arbitrary 32-bit number, called a **window tag**, with any window. Window tags are zero by default. An application can determine the tag of a given window by sending **msgWinGetTag** to the window, with a P_WIN_METRICS as its argument. This will set the tag field of the argument WIN_METRICS equal to the window's tag.

An application sets a window's tag by sending **msgWinSetTag** to the window with a P_WIN_METRICS as its argument. This sets the window tag equal to the **tag** field of the argument WIN_METRICS. Tags allow an application to identify the windows it creates without having to assign them well-known UIDs.

If an application maintains many child windows with meaningful tags, it can search through them for a particular tag value by sending **msgWinFindTag** to the parent window, with the target tag value as its message argument. This recursively enumerates each child window (not including the parent) in breadth-first order and returns the UID of the first child window with a tag equal to the argument.

The easiest way to create a unique tag is to use ***MakeTag****, which generates a tag from a well-known UID assigned to you (such as the UID of your application class) and an 8-bit number you select.*

Window Display Messages 23.5

You display images in a window by sending messages to a drawing context bound to the window. The drawing context alters the window, but it is also subject to constraints the window defines. For example, the window defines the **clipping region**, which restricts the area in which the drawing context can render images. This section discusses the interactions between objects that result in the display of images in windows.

Clipping 23.5.1

clsSysDrwCtx cannot draw your entire figure if it is larger than your window or pixelmap, and if you're drawing in a window it won't draw in hidden portions of your window. This process of selective drawing is called **clipping**. Repainting Dynamics, covers window clipping in intense detail.

Window Clipping 23.5.1.1

Normally windows don't get to draw on each other; each window has its own clipping region which does excludes all other windows. However, if you want to draw in child or overlapping sibling windows, you can reset the **wsClipChildren** and **wsClipSiblings** window flags.

For example, the UI Toolkit has a button table class which arranges its child windows into tables. The button table paints its background white; because it resets **wsClipChildren** this also paints the background of each child button.

As a performance optimization, child windows can share the clipping region of their parent if their **wsParentClip** flag is set. This means that child window painting is not restricted to the boundaries of the child window. For example, buttons don't attempt to draw outside their window boundaries, so it is safe for the button table to turn on **wsParentClip** in its children.

Unclipped Children 23.5.1.2

If a parent window does not have **wsClipChildren** set, then its drawing operations will show up in its child windows. This might be useful if a parent window is drawing a background that is appropriate for its child windows—without **wsClipChildren**, each child will have to redraw the background in itself.

Similarly, if a child window does not have **wsClipSiblings** set, then its drawing may show up on overlapping sibling windows. This isn't especially useful.

Maintaining a clipping region for each window takes some memory. If a child window only draws inside itself, it does not need its own clipping. If you set **wsParentClip**, the child window will try to borrow its parent's clipping region. For example, UI Toolkit labels don't draw outside themselves, so they can share their parents clipping.

Drawing in a Window 23.5.2

Assuming you have a window, and have associated a drawing context with it, you can then proceed to draw in the window.

Repainting is as Important as Painting 23.5.2.1

The window system does not remember what you have painted in a window. If some or all of your window's pixels are no longer visible on the display, then when they reappear, *you* have to repaint their contents. If you are going to be painting in a window, you need to concern yourself with how its pixels will be repainted. It turns out that figuring out how you are going to repaint your window is as important as what you will paint in it.

Repainting Dynamics 23.5.3

Dirty Windows 23.5.3.1

All windows must be able to redraw themselves at any time. The window system tells a window to repaint itself by sending it **msgWinRepaint**. This takes no arguments. Descendant classes sometimes create a DC and pass it with **msgWinRepaint** for their ancestors to draw with. You can check the message argument of **msgWinRepaint** to see if it is **pNull**.

When You're Told to Repaint 23.5.3.2

When part of the screen must be repaired, windows in that part can be sent **msgWinRepaint** redraw messages. Most programmers will want to have their windows sent redraw messages automatically. If you know that temporarily you don't want to receive these messages you can send your window **msgWinSetPaintable** with message argument **false** to reset its **wsPaintable** flag. For example, you might be repositioning many windows and want to delay repainting until you have finished.

Once a window is dirtied, it will eventually receive **msgWinRepaint** if it is paintable. As for when it receives **msgWinRepaint**:

- A window normally receives **msgWinRepaint** when its task has no other work to do: the task unwinds to its message dispatching loop, and takes **msgWinRepaint** off the queue.
- A window may receive **msgWinRepaint** immediately if it has **wsSynchRepaint** set. This causes any dirtying of itself by code in the same process to be repaired by an immediate **ObjectCall** of **msgWinRepaint**.
- A dirty window also receives **msgWinRepaint** if you send it **msgWinUpdate** yourself.
- A window could receive **msgWinRepaint** at random if someone else sends the message. This should never happen. **msgWinUpdate** is the correct way to tell a particular window and its children to repaint.

What to Do When Repainting 23.5.3.3

The first thing to do is to create a DC and bind it to your window, if you have not already.

If your window has changed size, you may want to change the scale of your DC. (Often you set window flags in order to be notified of changes in size and position in advance of repaint.)

Then you issue the appropriate **msgDc...** commands to repair the damage to the window by repainting part of it. Now, you would like to redraw only those areas of your window that are dirty. The window system makes it easy to do this, because it knows what area of your window is dirty and requires repainting. You must send **msgWinBeginRepaint** before you start repainting, so that your drawing operations only appear in the dirty region.

After **msgWinBeginRepaint**, any drawing messages you send to your DC only affect the dirty portion of the window. (This clipping is independent of the clipping area which you can set for your DC.)

Sample Repaint Code 23.5.3.4

Most programmers will want to have their windows sent redraw messages automatically (this is the default). Here is a typical code fragment for repaint:

```
MsgHandler(MyRepaint)
{
    SYSDC       myDc;       //  Created here, or in instance data, or shared.
    SYSDC_NEW   sdn;
    STATUS      s;
    ObjCallRet(msgWinBeginRepaint, self, pNull);
    // Create DC, if not already existing.
    ObjCallRet(msgNewDefaults, clsSysDrwCtx, &sdn, s);
    ObjCallRet(msgNew, clsSysDrwCtx, &sdn, s);
    myDc = sdn.object.uid;
    // Bind DC to window, if not already done.
    ObjCallJmp(msgDcSetWindow, myDc, (P_ARGS)self, s, Error);
    // Send messages to set up myDc to as necessary (scale, color,line thickness,...).
    ...
    // Send messages to myDc to repaint entire window.
    ...
    ObjCallJmp(msgWinEndRepaint, self, Nil(P_ARGS), s, Error);
    return stsOK;
Error:
    //  Clean up if DC created here.
    ObjCallWarn(msgDestroy, myDc, Nil(OBJ_KEY));
    return s;
}
```

clsHelloWin in the sample program Hello World (in \PENPOINT\ SDK\SAMPLE\ HELLO\HELLOWIN.C) implements a similar system except that it creates its DC when it is created instead of during repaint.

Smart Repainting 23.5.3.5

Even though the window systems restricts the drawing to the dirty region, the window object still sent messages to redraw every pixel in the window. This includes pixels which didn't need repainting. The window system overhead for drawing that gets clipped away is marginal, so this may not be a problem. However, if repainting the window requires a lot of computation, or if it involves dozens of drawing messages, it may be worth being smarter about what to repaint. GrafPaper and text views both use smart repaint strategies.

When you send **msgWinBeginRepaint**, the window system sets the **update region** to be the dirty region. If you pass in a pointer to a RECT32 structure, **msgWinBeginRepaint** passes back the coordinates of the bounding rectangle of your window's dirty region. If you write smart repainting code that can repaint parts of the window on demand, then you can look at the coordinates of this rectangle and only issue the messages to redraw the areas which need repainting.

For example, in an organizational-chart drawing program you could soup up the repainting code to use the rectangle enclosing the dirty region. You determine which boxes fall in the dirty region, and only repaint those boxes and their attached connector lines.

Ordinary Painting by Repainting 23.5.3.6

We have gone through how to repaint a window, without covering how to get something drawn in it in the first place. It turns out that the easiest and best way to paint something in your window is often to mark the area you want painted as dirty, then wait for the window system to send your window a **msgWinRepaint** message telling it to repaint itself. You send **msgWinDirtyRect** to a window (or to a DC bound to it) to dirty part of it. The message takes a pointer to a RECT32 structure in which you specify the area of the window to mark as dirty. The window system adds that area to the existing dirty region.

The benefits of this approach are:

- A single piece of code handles both painting and repainting.
- There's a minimum of flashing while you paint, since the window system will often have collapsed several dirty regions into one repaint message by the time you receive it.

However, the corresponding disadvantage of painting by marking dirty is that the image the user sees on the screen will be incorrect for a longer instant than if you painted immediately.

For example, suppose the org-chart application needs to add a new box to its chart at the top right. It could update its internal state to reflect a medium-size box in the upper right corner, and then dirty that region of its window with **msgWinDirtyRect**. At some point, the window gets sent **msgWinRepaint**. When the window starts repainting with **msgWinBeginRepaint**, the right corner will be part of the dirty region.

To mark your entire window as dirty (and hence paint the entire window), pass **pNull** as the message argument to **msgWinDirtyRect**.

Telling a Window to Repaint 23.5.3.7

If you don't want to wait for the window system to get round to telling your window to repaint, you can use **msgWinUpdate**. This makes the window system send (using **ObjectCall**) **msgWinRepaint** to your window and all its children that need repainting. Because the **msgWinRepaint** is delivered synchronously, the repaint happens before **msgWinUpdate** returns.

The Few Occasions When You Want to Explicitly Paint 23.5.3.8

There are a few inter-related situations in which you might want to explicitly paint:

- If you need to repaint synchronously (instead you could set **wsSynchPaint** and mark yourself dirty)
- If you don't want the window system to collapse painting operations. Normally the window system collapses all pending window damage into a single **msgWinRepaint** message covering the entire damaged area.
- If you need to paint during a grab, or in a single thread of control.

In all these cases, if you paint by repainting, the interaction is over before your window receives **msgWinRepaint** and you can start repainting.

Before starting painting, you must send **msgWinBeginPaint** to your window, and afterwards you must send **msgWinEndPaint**. This is like **msgWinBeginRepaint**, except that it sets the update region to the visible part of the window instead of the dirty region.

The Update Region 23.5.3.9

The update region is created at **msgWinBeginPaint/msgWinBeginRepaint** time. It belongs to the window and applies to all drawing (including nested calls to **msgWinBeginPaint/msgWinBeginRepaint**. DCs paint into this region or a subset of it (if they have a clip rectangle set up with **msgDcClipRect**).

msgWinBeginPaint sets the update region to be the visible area of the window.

msgWinBeginRepaint sets the update region to be the dirty area of the window. The update region will always be the same as, or smaller than, the visible area, since only visible parts of the window can need repainting.

When Updating Ends

The window system doesn't know when you've finished painting or repainting your window. You must always end a string of painting operations initiated with **msgWinBeginPaint** or **msgWinBeginRepaint** with a corresponding **msgWinEndPaint** or **msgWinEndRepaint** message.

When you send **msgWinEndRepaint**, if you've been repainting the dirty region, the window system believes that all damage that has accumulated has been repaired (new dirt may have slapped on while you were repainting—see the next section).

When you send the window system assumes that the region which was dirty is now clean, so long as you received that area via **msgWinBeginRepaint**.

If you've been painting, the window system makes no such assumption. If a region of your window is dirty, and you start painting (not repainting) in it, the window system can't tell whether or not your painting operations will repaint that region successfully. You might not repaint that area, or only paint every fifth pixel. So the window system will still later send you **msgWinRepaint** to repaint that area properly.

The window system doesn't attempt to figure out which pixels you actually updated, so it's your responsibility to completely repaint the area which you were supposed to repaint. Also, it is important to remember that when you get **msgWinRepaint**, your window's dirty pixels are not white or anything but pure garbage. You must completely paint the damaged area when responding to **msgWinRepaint**.

Nesting 23.5.3.10

Both repainting dirty regions and painting new pixels are designed to nest properly. Every **msgWinBeginPaint** must be matched with a corresponding **msgWinEndPaint**, and **msgWinBeginRepaint** must similarly be matched with **msgWinEndRepaint**. Only the outer-level **msgWinBeginPaint**/ **msgWinBeginRepaint** chooses the region (dirty or visible) to update— it doesn't change with nested paints and repaints.

Avoiding Repaints 23.5.3.11

Transient windows can turn on their **wsSaveUnder** flag to avoid dirtying the windows they appear over. See the explanation of **wsSaveUnder** elsewhere.

Stages in Optimizing Painting 23.5.3.12

In summary, here are the stages you should follow in writing your painting/ repainting code.

1. Write code which repaints everything in response to **msgWinRepaint**. To paint stuff, mark your entire window as dirty by sending **msgWinDirtyRect** to self with argument **pNull**.
2. To speed up painting, figure out what area of your window needs to be painted, and only mark that area as dirty with **msgWinDirtyRect**.

   If your window is an observer of a separate data object (the data/view model), write code to translate from notification of a change in the viewed object to marking part of the window dirty.
3. To speed up repainting and painting, add code to your repaint routine which tries to reduce repaint operations to the area which is in the dirty rectangle. Remember, even without this optimization, the graphics subsystem will only draw in the area in the update region, but it may increase repaint speed.
4. For areas of your application (if any) which need snappier or sequential painting, add code to do explicit painting (**msgBeginPaint**, **msgEndPaint**).
5. Design your data structures so that when repainting you can quickly determine from the dirty rectangle what you need to redraw, and that when you want to paint you can quickly figure out what rectangle to mark as dirty.

Design your application carefully to figure out how best to trade off between code size and speed of repainting. You want your window to draw quickly so that page turns and window manipulations are snappy, but you don't want to expend a lot of code space or memory on it.

The wsSynchRepaint Flag 23.5.3.13

Repaint messages always appear at the end of the message queue of the window's task. This means that when a window moves or disappears, other windows will ordinarily not repair themselves even though you may want them to. Consider a scrollwin (a window which scrolls another larger window inside itself) and its client window (the window inside the scrollwin). As the user scrolls the **scrollwin** by dragging its **drag handle** or **thumb**:

- The scrollwin moves its client window.
- The window system marks as dirty the parts of the client window which become exposed.

The client window will find out that it is dirty when it receives **msgWinRepaint**. But while the user drags the scroll thumb, it receives input, so ordinarily other windows don't receive their messages. Thus, the window inside the scrollwin may not repaint until the user finishes scrolling.

You might want the client window to repaint while the user drags the scroll thumb. If you set the **wsSynchRepaint** flag of a window, then if it needs repainting it will be repainted synchronously. The window system sends it **msgWinRepaint** using **ObjectCall** instead of **ObjectSend**. In the scroll thumb example, if you set the **wsSynchRepaint** flag of the client window, then if it is in the same subtask as the scrollwin, every motion of the scroll thumb will result in a call to the scrollbar to repaint.

Although **wsSynchRepaint** ensures smooth repainting of other windows in the same process, it is no smarter than an ordinary repaint, since it results in the same **msgWinRepaint**. In the scrollwin example, it is possible that the underlying window called to repaint because of scrolling has other dirty areas which require repaint; their repainting might delay repainting so much that interactive response suffers. There is a tradeoff between smooth repainting versus jerky tracking. One answer would be to make the area which requires synchronous repainting a separate window from areas which take a long time to repaint.

What Really Goes on When Repainting 23.5.3.14

The window system and the Class Manager message system conspire to deliver window repaints. The effect is that:

- **msgWinRepaint** is always the last message in a subtask's queue of Inter-Task Communication Messages. Thus objects receive all other pending messages before receiving **msgWinRepaint**.
- There is only ever one **msgWinRepaint** in a subtask's message queue. Only windows owned by the current subtask are painted.

- The order in which a subtask's windows receive **msgWinRepaint** is as follows:
  - Windows damaged as a result of resizes, movements, insertions, and extractions in the same subtask which have the **wsSynchRepaint** flag set are painted synchronously, outside the normal message queue.
  - Otherwise, windows in the same subtask receive **msgWinRepaint** in back-to-front order.
- The order in which windows owned by different subtasks receive **msgWinRepaint** is undefined—if moving a window exposes underlying windows in two different subtasks, there's no way of knowing which will receive **msgWinRepaint** first.

Copying Pixels in Windows 23.5.4

You can use **msgWinCopyRect** to copy pixels within a window. This copies all the pixels from a source rectangle to another area in the same window. You can use this message to reduce the amount of repainting you need to do. If what you want to draw is already in another part of your window, you can just copy it over instead of reissuing drawing commands. The window system uses an equivalent of this message to implement the different window grow styles. You can use it if you do your own scrolling. (It may be easier to implement scrolling using **clsScrollWin**, which scrolls by repositioning your window inside another.)

msgWinCopyRect takes a pointer to a WIN_COPY_RECT structure, in which you specify:

srcRect the source rectangle in LWC.

xy the lower-left corner of the destination location in LWC.

flags a number of style and input attribute flags (the input flags are described in *Part 5: Input and Handwriting Translation*).

planeMask an optional plane mask.

Normally the **flags** value is **wsCopyNormal** (a normal copy of the normal painting planes). If you set the **wsPlanePen** flag, the pen plane is copied too. If you set the **wsPlaneMask** flag, the window system copies the planes specified in the **planeMask** message argument.

Copied Pixels and Window Damage 23.5.4.1

The other flags determine how the window is dirtied after copying pixels. Normally when you copy part of the image in a window elsewhere, its original location needs to be filled with something else, so the window system marks the source rectangle dirty. However, this can be turned off by setting the **wsSrcNotDirty** flag.

Similarly, suppose that some of the source rectangle pixels have been damaged or are covered by another window. The window system does not copy these bad source pixels to the destination, and marks the corresponding destination locations dirty. However, this can be turned off by setting the **wsDstNotDirty** flag.

Because it doesn't normally copy dirty pixels, ***msgWinCopyRect*** *may not work while repainting. You should send it outside of a Begin/End update episode.*

Copied Pixels and Child Windows 23.5.4.2

Further complications arise when the source rectangle has child windows in it. Normally, the window system moves the child windows along with the source pixels, unless you set the **wsChildrenStay** flag.

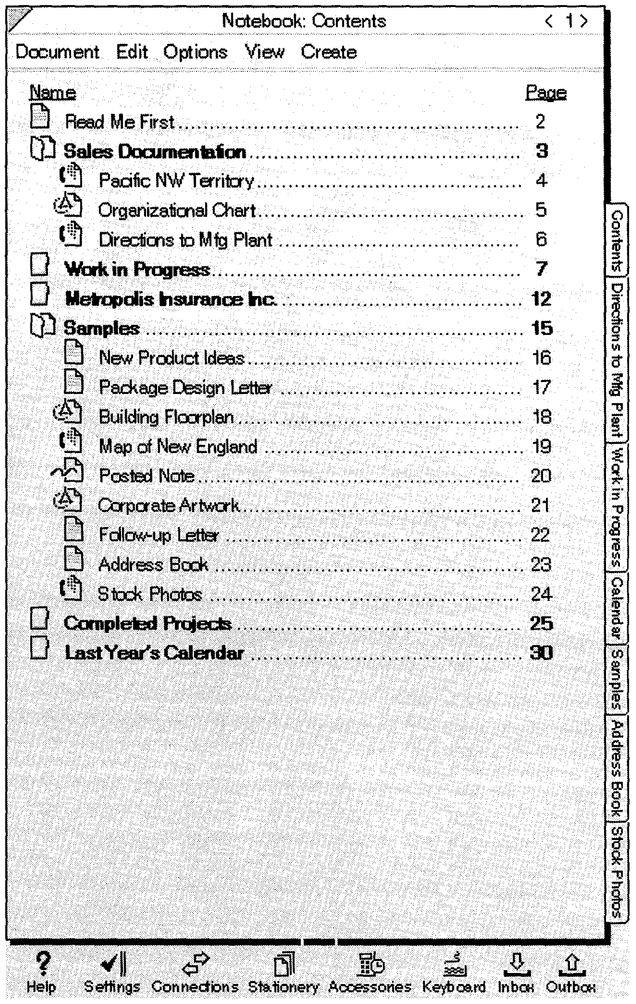
The operation of copying pixels in windows with child windows is complicated, and there are a few things to note about the interaction.

- The child windows are not damaged, they are moved.
- However, the move operation is not a first-class **msgWinDelta** operation, so capture geometry, layout, **msgWinDeltaOK**, and **msgWinMoved** are not involved.
- The sibling order of child windows is unchanged.
- If the child window is not completely enclosed by the **srcRect**, there may be problems. The window will not be moved, and the dirty region will probably be incorrect. It's best for you to expand the **srcRect** area to fully enclose any child windows partly within it.

Layout Messages 23.6

Applications somtimes require windows to have a particular size and (less often) location. Furthermore, when a window has many child windows, it needs to position each child window. As an example, take the main Notebook itself:

Figure 23-1
The Notebook



Name	Page
Read Me First	2
Sales Documentation	**3**
Pacific NW Territory	4
Organizational Chart	5
Directions to Mfg Plant	6
Work in Progress	**7**
Metropolis Insurance Inc.	**12**
Samples	**15**
New Product Ideas	16
Package Design Letter	17
Building Floorplan	18
Map of New England	19
Posted Note	20
Corporate Artwork	21
Follow-up Letter	22
Address Book	23
Stock Photos	24
Completed Projects	**25**
Last Year's Calendar	**30**

The Notebook is usually full-width, and takes over most of the screen leaving some space for the Bookshelf. It attempts to provide maximum room for a page, but also needs to leave room for the tabs on the right side of the display. Moreover, the user can set a preference to allow the Notebook to float and zoom, which changes the permitted sizing.

As this example shows, often the wants and needs of the parent window and its child windows conflict. This is one reason for the elaborate message passing involved when a window lays out its children.

The overriding principle of window interaction is that child windows *must* live with whatever their parent does. Parents have (rather, they can elect to have) the ultimate say in the geometry of their children, while children have the ultimate say in what they paint.

Altering Child Windows 23.6.1

When a window receives **msgWinInsert** or **msgWinDelta**, **clsWin** sends **msgWinInsertOK** or **msgWinDeltaOK** to the window's parent if the parent has the **wsCaptureGeometry** flag set. These **OK** messages include the WIN_METRICS structure passed to the child window. The parent window can return **stsOK** to allow the insertion/move/resize to proceed, but it can change the relevant WIN_METRICS fields such as **bounds** and **wsPosTop/wsPosBottom** too.

For example, a client sends its window **msgWinInsert** to insert it in the parent window. However, the child's position would be outside the visible area of its parent. The parent has **wsCaptureGeometry** set, so the window system sends it **msgWinInsertOK**. The parent realizes that the child window would be outside its boundary, so it changes the child's **bounds.origin** and **bounds.size** so that the child fits inside it, then returns **stsOK**. The **msgWinInsert** succeeds, but the child window appears at a different place than the client code specified. When **msgWinInsert** returns to the caller the WIN_METRICS structure has the revised metrics in it.

Finally, the child and its descendant windows receive **msgWinInserted** if **wsSendGeometry** is set in their flags. The message argument is the window that was actually inserted.

Resizing and Moving Windows 23.6.2

Your window receives **msgWinDelta** when someone wants to resize (or move) it. There are flags which control the behavior of a window on a resize.

A visible non-transparent window has an image in its pixels. When it is resized (whether expanded or shrunk), what should happen to the existing pixels? The flags **wsGrowTop**, **wsGrowBottom**, **wsGrowLeft**, and **wsGrowRight** control how visible pixels in the window are adjusted if the window expands or shrinks. You can think of these flags as controlling which sides of the window grow (or shrink) when the window changes size. The window system moves the window's contents (including repositioning child windows) as necessary.

For example, if a window has **wsGrowTop** and **wsGrowLeft** set, then when the window is expanded, the visible pixels remain in the lower right corner and the window is damaged so that new pixels will be painted along its top and left edges. When the window is shrunk, pixels vanish from its top and left sides.

This feature doesn't do much good in a layout episode (described below) because after a layout episode windows are usually made to completely repaint.

If a window has **wsSendGeometry** set, then after it or its parent or any ancestor window is sent **msgWinDelta**, the window system sends it **msgWinMoved** or **msgWinSized** depending on whether the result moved or resized the window. **msgWinMoved** is sent, then **msgWinSized**, if the window was both moved and resized. Note that **msgWinMoved** is sent if the window moves relative to the root window; this is regardless of whether the window moved relative to the parent, or whether the parent's parent (and so on...) moved.

The message arguments to **msgWinMoved** and **msgWinSized** are P_WIN_METRICS, as usual. **clsWin** sets **child** to be the window which was moved or sized; it is either self or some ancestor. **clsWin** also sets the **bounds** to the **previous** size and position of the window which actually moved in its parent's LWC. Note that **wsWinMoved** and **wsWinSized** flags in **options** are not set. Don't "borrow" the WIN_METRICS passed with **msgWinMoved/msgWinSized**. It is used to send the same message to self's sibling and child windows. If you write into it you will spoil the message for them.

Window Layout

23.6.3

Windows in PenPoint operating system are lightweight; you can afford to have lots of them. With windows inside windows, you must be concerned with how to position and reposition windows. There are three broad styles of window layout possible in PenPoint:

- Please be nice to me.

  The parent allows child windows to position and size themselves wherever they want. The parent may wind up covered by greedy children with little space of its own to draw on.

  This is the style used by some notebook applications, which allow themselves to be covered by child windows.

- I'll decide what you'll get away with.

  The parent has its **wsCaptureGeometry** flag set, so it gets **msgWin...OK** messages whenever a child window attempts to insert/extract/move/resize itself. The parent can veto outrageous requests, or return **stsWinConstrained** along with suggested acceptable positions and sizes.

  This is the style used by applications with embedded applications inside them. The outside application can't allow an embedded application to obscure all its own views, and it must assume that the embedded application may make mistakes.

- Give me your proposals.

  This is the most flexible. The parent asks the child windows to propose sizes and locations for themselves, then the parent lays the child windows out while trying to preserve the sizes and locations they asked for. This only works well if everyone who wants to adjust windows cooperates over use of **msgWinLayout**. Windows should not spontaneously resize themselves; instead an outside object should decide when windows need to be re-laid out and send **msgWinLayout** to a window at that point.

  This is the scheme used by the PenPoint User Interface Toolkit (described in *Part 4: UI Toolkit*). The client creates the various user interface components and then tells the parent window to lay itself and its children out.

A window subclass may veto or modify the **msgWinDelta** and **msgWinInsert** size/position messages it receives, but will work better with others if it accepts whatever size and position that its parent deltas it to.

More on msgWinLayout 23.6.4

The third technique uses **msgWinLayout**. When you want windows to lay out, send **msgWinLayout** to them. This message takes a pointer to a WIN_METRICS structure, but only pays attention to two fields, the **bounds** rectangle and **options**. If **wsLayoutResize** is set in **options**, the window receiving **msgWinLayout** is allowed to change its own size. If **wsLayoutResize** is not set, the window receiving **msgWinLayout** must use the **bounds.origin** and **bounds.size** in the message arguments. As an example of the latter, when the user resizes a floating window by dragging its shadow, the frame must lay out exactly in that rectangle. The shadow sends the floating window **msgWinLayout**, with **wsLayoutResize** set false, and the **bounds** are the rectangle indicated by the user.

Another flag in **options** that affects layout is **wsLayoutMinPaint**. If **wsLayoutMinPaint** is not set (the default), then the window system ensures that the window(s) will not repaint during layout. Making windows invisible during layout is faster for complicated layout changes, but means that entire windows must repaint when layout is finished.

The window system handles **msgWinLayout** by figuring out which windows need to lay out, by looking at the window flags of the windows. It sends these windows other layout messages.

The idea is that the window laying out will reposition and resize its child windows as desired. The term **lay out** is somewhat ambiguous here: laying out yourself involves positioning your child windows, but does not necessarily mean changing your own size or allowing your child windows to lay themselves out.

clsWin does not know how the child windows of a given window should be positioned, but many descendant classes do. All the windows in the UI Toolkit know how to lay themselves out, and the **clsCustomLayout** and **clsTableLayout** classes know how to position their child windows using complex relationships and rules.

Since windows may be inserted inside windows inside other windows, re-laying out one window may involve a lot of messages and computation. The Application Framework sends your application's documents **msgWinLayout** when they first appear on-screen. To see an intricate lay out in the system take place, change the system font. The implementation of window layout tries to be very smart about asking windows to lay out, and is quite complex as a result.

The Client Interface to Layout 23.6.4.1

When inserting, extracting, or moving windows, you alter the structure of a window subtree. When you are finished you should probably send **msgWinLayout** to the window you altered. Set **wsLayoutResize** if that window can change its size or specify the required **bounds** for that window.

If you modify several related windows at once, instead of sending **msgWinLayout** to each one, you can instead **dirty** the layout of each one by sending it **msgWinSetLayoutDirty** with **true** as the message argument. When you finish perturbing the window subtree, send **msgWinLayout** to the parent window. The idea is that you set the layout dirty bit when you know the layout is dirty, and later send **msgWinLayout** when you want it too look right.

Many operations, such as **msgWinDelta**, will mark a window's layout dirty automatically.

If you know that a change makes an entire subtree dirty, you can send **msgWinSetLayoutDirtyRecursive** to the parent of the subtree to dirty the layouts of every window in the subtree.

The rest of this subsection talks about what happens internally during layout, and what descendant classes must do to handle layout correctly. (The UI Toolkit classes do all of this for you.)

What Happens in Layout Processing 23.6.4.2

First the window system must figure out how much of the window tree will need to be re-laid out. It goes up the window hierarchy from the receiving window looking for a window which is not shrink-to-fit around its contents. A parent window with either of these constraints true will not cause its own parent to have to lay out, hence it becomes the root of the layout subtree.

A Layout Episode 23.6.4.3

What happens next is the window system goes into a **layout episode** involving every window in the layout subtree. It looks at each window in the lay--out subtree and if necessary sends each window either **msgWinLayoutSelf** or **msgWinGetDesiredSize.** As a result of one window figuring out how to lay out or choose its size, other windows may be perturbed and will require laying out. A window may even have to re-lay out several times. The layout episode ends when every window in the layout subtree has settled on a size and position, at which point the window system actually modifies those windows whose desired size and position are different from before the layout episode.

If you implement a descendant of **clsWin, msgWinLayoutSelf** and **msgWinGetDesiredSize** are the two messages you should respond to in order to lay out nicely. You need not normally respond to **msgWinLayout** itself.

Laying Out Self 23.6.4.4

msgWinLayoutSelf is similar to **msgWinLayout**, but window clients do not send it; instead the window system sends it to windows during layout. **msgWinLayoutSelf** uses WIN_METRICS the same way: if **wsLayoutResize** is set, you can change the window's size; if not, you must use the size in **bounds.size**. Don't send the window **msgWinDelta** to change size; instead, pass back the desired size in **bounds.size** to whomever sent you **msgWinLayoutSelf**.

If your window has child windows, it should position them. For example, your class might tile windows, or allow them to overlap. To position the child windows, send them **msgWinDelta**. Because the entire window layout subtree is in a layout episode, **clsWin** intercepts the **msgWinDelta** and caches the size and position.

Some window classes ask child windows what size they would like to be. For example, a window class which lays out child windows in a single row might fix the height of the child windows, but be flexible as to the width of each child window according to how wide the child would like to be. If your window class cares about the size of child windows, send them **msgWinGetDesiredSize**. This too takes a WIN_METRICS structure. The child should pass back its desired size in **bounds.size**.

Getting Self's Desired Size 23.6.4.5

Your class should respond to **msgWinGetDesiredSize** by figuring out what size the window should be.

Shrink-to-Fit 23.6.4.6

clsWin responds to **msgWinGetDesiredSize** by checking self's **wsShrink-WrapWidth** and **wsShrinkWrapHeight** flags. If these aren't set, then it assumes that the window is not going to return a desired size, so it passes back the window's current **bounds.size**. For this reason, it's important to be accurate about your windows' shrink-to-fit flags: if your class' windows ever change size in response to **msgWinGetDesiredSize**, set one or both of these flags.

If one or the other of the shrink-to-fit flags is set, then **clsWin** sends self **msgWinLayoutSelf**, allowing it to change size.

Caching Desired Sizes 23.6.4.7

The window system usually caches desired window sizes during a layout episode, so that it doesn't have to repeatedly send **msgWinLayoutSelf** to windows to get their desired sizes. If your window's desired size is dynamic, your class should set the **wsLayoutNoCache** flag in the **options** field of WIN_METRICS in response to **msgWinLayoutSelf** to turn off this caching.

Baseline Alignment 23.6.4.8

The UI Toolkit's layout classes allow clients to ask that child windows be aligned on their baselines. This may not be the same as the bottom of the window. For example, the baseline of a boxed text label in a large font is several pixels away from the bottom. Hence sophisticated parent windows may send **msgWinGetBaseline** to their child windows. This takes WIN_METRICS; classes should set the **bounds.origin** to reflect the child's desired position.

The baseline also applies in the vertical direction. For example, in option sheets choices and toggle tables should align vertically on their vertical lines, **not** on the left-most area where the checkmark appears. Hence **bounds.origin.y** is also significant.

clsWin sets both **bounds.origin.x** and **bounds.origin.y** to 0.

Layout and Geometry Capture 23.6.4.9

At the end of the layout episode, the window system actually moves those windows which ended up with a different position and location. If a window is capturing geometry and changes bounds in response to **msgWinDeltaOK**, this may result in altering the window positions. The window system detects this and goes back into the layout episode.

Since layout assumes that windows are cooperating, it rarely makes sense to turn on **wsCaptureGeometry** or **wsSendGeometry** on while using **msgWinLayout**.

Window Management Messages 23.7

clsWin defines a variety of messages to facilitate the effective use of windows in an application.

Sending Messages to a Window Hierarchy 23.7.1

Sometimes you know only that some ancestor window will respond to a message. You can send a message and its message arguments to a window using **msgWinSend**. If that window's classes do not respond to the message, the message arrives at **clsWin**. **clsWin** responds to **msgWinSend** by forwarding the **msgWinSend** message onto self's parent window using **ObjectSendUpdate**. If the message reaches the root window, then **clsWin** returns **stsMessageIgnored**.

msgWinSend takes a pointer to a WIN_SEND structure. In this you specify:

lenSend the size of the data to send.

flags some options to the way the message is sent (**wsSendIntraProcess** is currently the only flag used).

msg the message you're packaging inside the **msgWinSend**.

data an array containing the data for the message.

If the **wsSendIntraProcess** flag is set, then the message will not be propagated between processes (based on the owner of the window object) and **clsWin** returns **stsMessageIgnored.**

lenSend must be at least **SizeOf**(WIN_SEND), but may be larger to move more data to a window owned by another process. You can move 32 bits of data by storing it in **data**[0]. If you have more data, declare a larger structure with WIN_SEND as its first field.

Note that **msgWinSend** goes up the window hierarchy, whereas **msgWinEnum** and **msgWinFindTag** go down the hierarchy.

Sorting Windows 23.7.2

You can sort a window's child windows, thereby reordering their placement in front of or behind each other, by sending **msgWinSort**. This is used by the UI Toolkit to sort tabs in the tab bar. **clsWin** doesn't know how to sort the windows: you must supply a callback routine which can compare two windows.

msgWinSort takes a pointer to a WIN_SORT structure for its message arguments. In this you specify:

- The callback routine which compares windows (**pSortProc**).
- A parameter which **clsWin** passes to your callback routine (**pClientData**).

clsWin passes your comparison routine (**pSortProc**) two windows at a time, together with whatever **pClientData** you specified. Your comparison routine must match the function prototype type P_WIN_SORT_PROC:

```
typedef S16 (FAR * PASCAL P_WIN_SORT_PROC)(WIN        winA,
                                           WIN        winB,
                                           P_UNKNOWN  pClientData
                                           );
```

It should return –1 if **winA** comes before **winB**, +1 if **winB** comes before **winA**, and 0 if **winA** compares the same as **winB**.

Typically your comparison routine will look at some feature of the two windows to compare them, such as the window tags, or the strings in label windows. You can pass arbitrary instructions to the routine in **pClientData**, such as instructions to sort alphabetically, in descending order, etc.

Debugging Windows 23.7.3

You can send **msgDump** to a window to get a dump of its metrics. If you send **msgWinDumpTree** to a window, it dumps a dense subset of the information about the window and all its children, recursively. If you set the **/DW0002** debug flag, the input flags for the windows are printed along with the window style flags.

Both of these messages only work if you have loaded the debugging version of WIN.DLL, the PenPoint windowing dynamic link library.

Filing Windows 23.7.4

When a window receives **msgSave**, it files its state. One vital piece of state information is all the child windows inside that window. If a child window has **wsSendFile** set, then it is filed as part of its parent filing. **clsWin** sets **wsSendFile** by default; some descendants of **clsWin** clear this style flag, but it is still true that filing one window may result in many child windows being filed.

Details of Window Filing 23.7.4.1

Windows file their position and size (**bounds** in window metrics), unless **wsFileNoBounds** is set. When a parent window is restored, if its new size is the same as its old size, it doesn't need to be sent **msgWinLayout**, and consequently all its child windows do not have to take part in a layout episode either.

Window layout is usually affected by the orientation and pixel size of the windowing device (windows are restored onto a different windowing device when printed). Window layout is also affected by the default system font and system font scale.

The window system saves this **window environment** information for the root of a tree of windows so that when the windows are restored it can decide what needs to change. The window system uses the **root** and **resId** fields in OBJ_SAVE to figure out whether it's saving the root or not. During **msgRestore** processing, the same **root** and **resId** fields in OBJ_RESTORE tell the window system whether this window filed the environment information or not. If you're sending **msgSave** or **msgRestore** yourself, set **root** to **objNull**, and **resId** to the resource ID for the object being saved or restored.

(The window system provides a message to get the current window environment, **msgWinGetEnv**.)

If **wsFileInLine** is set in a child window's style flags, the child window is not filed with an object header. Although this conserves storage space, this prevents someone using a resource file to read in the child window independently.

Re-Layout of Filed Windows 23.7.4.2

If **wsFileNoBounds** is set in a window's style flags, then the window's position and size are not saved. This means that on restore, the window will need re-layout, so **clsWin** sets **wsLayoutDirty** for the window upon restore.

You can also force a window to have dirty layout (**wsLayoutDirty**) when it is restored by setting **wsFileLayoutDirty**.

However, if neither wsLayoutDirty or wsFileLayoutDirty is true when the window is filed, the window is restored with **wsLayoutDirty** set to false, so it doesn't need to be laid out.

Summary

23.8

clsWin provides basic window behavior. Though it isn't practically useful by itself, it provides a common foundation for useful subclasses such as the User Interface Toolkit classes (described in *Part 4: UI Toolkit*). The primary purpose of windows is to serve as a canvas for drawing contexts, described in *Chapter 26, The Drawing Context Class.*

Window metrics, encoded in the WIN_METRICS structure, define what makes each instance of **clsWin** unique. The WIN_METRICS structure is the common argument for most messages **clsWin** defines, although most of the messages pay attention to only a few fields of the structure.

The window **style flags**, part of the window metrics, define the display style of a window. Windows also include **input flags**, but only to support **clsWin** subclasses that handle input events.

clsWin defines a variety of messages for setting and getting window metrics, handling painting in the window, implementing a protocol for laying out child windows, and managing windows within an application.

Chapter 24 / Window Device Classes

Every window is associated with **a windowing device**. The one you are most familiar with is **theScreen**. However, there are other kinds of windowing devices, including printers. In particular, there are **image devices** which you create to draw in off-screen windows.

This chapter describes windowing devices and then image devices. Because **theScreen** and printer windowing devices are managed by the window system, you rarely interact directly with **clsWinDev**. Image devices, window devices in memory without an associated display, are more common. **clsImgDev** inherits from **clsWinDev** and you use several **clsWinDev** messages with image devices.

Windowing Devices 24.1

When you create a window, the window system must know what windowing device it is intended for, so at window creation you either specify a device for the new window or a parent window from which the window system can figure out the target windowing device. The latter is much more common, since you usually nest windows in other windows.

Creation 24.1.1

Application code should rarely need to create a windowing device. The window system creates a windowing device, **theScreen**, during initialization, and creates a transient windowing device on the printer during printing.

Root Window 24.1.2

When it creates a windowing device, **clsWinDev** creates a **root window** (an instance of **clsWin**) on that device.

The message **msgWinDevGetRootWindow** passes back the UID of the root window on a windowing device. The root window on **theScreen** is another well-known object, called **theRootWindow**.

Image Devices 24.2

For drawing to appear on the screen or printer, it must take place in a window. Often this is all that applications need: they draw what they want to appear in their windows, and the window system colors in the visible pixels of these windows on the screen or printer.

Unlike some other window systems, there is no backing store in PenPoint™ operating system for windows. If a screen window is not on-screen and you draw on it, the pixels aren't saved somewhere.

In some situations it is useful to create an image off-screen

- Drawing a complex image over and over.
- Drawing an image through a mask or stencil.
- Storing window contents to speed repainting.
- Creating bitmap images such as icons in advance.

To speed these operations, you can use an image device. **clsImgDev** inherits from **clsWinDev**. An **image device** is a windowing device where the image memory is under the control of the client. All the things you can do on the screen you can do on an off-screen image device: create trees of windows, bind a DC to a window, draw in a window, etc. The differences with the screen or a printer are that you must create an imaging device yourself, and that you can access the memory in which the window system sets pixel values (the **pixelmap**).

The contents of windows on an image device can be copied to a window on another device using pixel copy operations defined by **clsSysDrwCtx. Unlike** a windowing device, an image device is not designed to be shared, so no automatic locking takes place when drawing into one of its windows.

Creating an Image Device 24.2.1

Sending **msgNew** to **clsImgDev** creates an image device and automatically creates a root window on it.

clsImgDev has no **msgNew** arguments of its own. In the WIN_DEV_NEW_ONLY structure of its ancestor **clsWinDev**, you specify the number of windows on the device (**winDev.initialWindows**). The default is 100. This is a soft limit: if you create more windows on the device, the window system will silently allocate more memory. However, if you know that you will be creating, say, exactly one window on your image device, set this to 1.

Accessing Image Devices 24.2.1.1

Since you draw using a DC bound to a window, the UID of the image device isn't very useful. Instead of referring to an image device by its UID, you can send it **msgWinDevGetRootWindow** to retrieve its root window, and then send windowing device messages to its root window. When this root window receives **msgDestroy**, it will destroy the image device along with itself.

You can also send windowing device messages to a DC bound to a window on the image device.

Binding an Image Device to a Pixelmap 24.2.2

At creation, the image device has no notion of the size or depth of its pixels, or of the size of its pixelmap. Also, it has no memory associated with it to store the pixelmap; attempts to draw on it will fail, because there's nowhere to hold the pixel values. You specify all this information by sending **msgWinDevBindPixelmap**. This takes a WIN_DEV_PIXELMAP structure, which includes:

device the device with which the image device should be compatible.

size the width and height to allocate for the image device.

planeCount the number of planes to allocate for the image device.

pPlanes a pointer to memory for the planes in the image device.

As with all windowing device messages, you can send **msgWinDevBindPixelmap** to a window on the device. Moreover, you can send this message to a drawing context bound to a window on the image device, in which case **size** is interpreted in LUC—the units and scale of the DC.

Pixel and Pixelmap Information 24.2.2.1

You tell the image device what kind of pixels it has by specifying in **device** a target device with the same kind of pixels. For example, if you're going to use the image device to store images copied **from theScreen**, or if images drawn into the image device will be copied **to theScreen**, the image device will be trading images with **theScreen**.

Instead of specifying a windowing device to be compatible with in **device**, you can specify a window UID. **clsImgDev** figures out the window's device. Thus, you could specify **theRootWindow** instead of **theScreen** for **device**.

Also, you need to specify the width, height and depth of the pixelmap that is to be allocated or provided by the application. You can specify the size in LWC, or you can specify it in LUC by sending the message to a DC bound to a window on the image device. The DC figures out how many pixels on the target device correspond to the size you want.

When you send **msgWinDevBindPixelmap**, **clsImgDev** does several things:

- It sets up the pixelmap with pixels like those of the specified **device**.
- If you sent **msgWinDevBindPixelmap** to a DC, it figures out the number of pixels needed by translating **size** into the right number of pixels for **device**.
- It resizes the root window of the image device to conform to the dimensions of the pixelmap; it and any other windows will be marked dirty.
- It allocates the number of planes specified in **planeCount**.

If you set **planeCount** to zero, **clsImgDev** creates a number of planes appropriate for the **device** the image device is to trade with.

Accessing Memory 24.2.2.2

An image device has no pixelmap at first. You use **msgWinDevBindPixelmap** to associate the image device with memory for its pixels' values. There are two ways to manage the memory for the pixels.

The first is to let the device itself allocate and hold the memory needed. With this method you can't directly access the memory. To get the image device to allocate pixelmap memory, set **pPlanes** to **pNull** in the message arguments to **msgWinDevBindPixelmap. clsImgDev** allocates enough memory for the number of planes and number of pixels.

The second way is for you to allocate the memory yourself and pass a pointer to it to the image device. This method is described in the next section.

Allocating Your Own Pixelmap 24.2.2.3

If you want to allocate the pixelmap memory yourself, then the first step is to figure out how many bytes each plane requires. Instead of computing this yourself, it's better to let the window system compute the size. To do so, you send **msgWinDevSizePixelmap** to the image device. This takes a WIN_DEV_PIXELMAP structure, as does **msgWinDevBindPixelmap.** You specify the same parameters for target **device** and **size. msgWinDevSizePixelmap** passes back in **planeSize** the number of bytes of memory for each plane, and in **planeCount** it passes back the number of planes to allocate to match the plane count of the target device.

You should then allocate **planeSize** bytes of memory for each plane. To bind the image device to the pixelmap, send it **msgWinDevBindPixelmap.** In this case, you should make **pPlanes** point to an array of pointers; one for each plane specified in **planeCount.** You don't have to allocate a pixelmap for each plane in the target device; if you're using the image device to create stencils or black and white images, you would allocate one plane, and set **planeCount** to 1.

Example 24-1
Allocating a Small Bitmap

This example establishes a one-bit deep plane on the stack in the buffer **plane0**.

```
U8              plane0[200];
P_UNKNOWN       ppp[1];

ppp[0] = plane0;
pm.device     = id;
pm.size.w     = 72;
pm.size.h     = 72;
pm.planeCount = 1;
pm.pPlanes    = ppp;
ObjectCall(msgWinDevBindPixelmap,aDc,&pm);
```

Dirty Windows 24.2.3

After binding an image device to a pixelmap, the root window of its image device is dirty. Also, windows on image devices can overlap, be resized, inserted, and extracted, all of which cause the windows to be dirtied.

However, windows on image devices *do not* automatically receive **msgWinRepaint** from the window system as do windows on other types of devices. To make them receive **msgWinRepaint**, you must send them **msgWinUpdate**.

The root window on an image device paints itself white in response to msgWinRepaint.

Drawing on an Image Device 24.2.4

You can just paint directly on the root window; or you can create one or more windows as children of it and build up a window tree in the usual manner.

Accessing Pixels in an Image Window 24.2.5

Having created an image in a window on an image device, you'll probably want to use it with another window at some point.

Remember that to draw correctly on the destination window, it must be within a **msgWinBeginPaint**/**msgWinEndPaint** or **msgWinBeginRepaint**/**msgWinEndRepaint** pair.

Getting and Setting Pixel Values 24.2.5.1

msgDcGetPixel gets the value of a pixel, **msgDcSetPixel** sets its value. Both take a pointer to a SYSDC_PIXEL structure for their message arguments, which includes:

- **rgb** whether the value should be an RGB value or a hardware-dependent palette color.
- **color** the color of the pixel.
- **xy** the location of the pixel, in LUC.

When you send **msgDcSetPixel**, you specify **color**; when you send **msgDcGetPixel**, the current value of the pixel is passed back in **color**. If **rgb** is set, **color** is interpreted as an RGB value, otherwise it is a SYSDC_COLOR (a hardware color palette index).

Copying 24.2.5.2

To copy the pixels in one window to another, send **msgDcCopyPixels** to a DC bound to the **destination** window. This takes a SYSDC_PIXELS structure for its message arguments in which you specify:

- **srcWindow** the source window on the image device.
- **pBounds** a pointer to the bounds of the area to copy in the source window.
- **xy** the location in the destination window.
- **dstDirty** whether pixels in the destination window should be marked dirty if the corresponding source pixels are dirty.

msgDcCopyPixels copies the rectangle of pixels in the source window at **pBounds** to the destination at location **xy**. If you specify a **pBounds** of **pNull**, then the entire image window is copied to the destination.

It's possible for windows in an image window to overlap, or be clipped by their parent. This may result in some or all of the pixels in the source rectangle not being part of the source window. If **dstDirty** is set, then the pixels in the destination window that correspond to dirty pixels in **srcWindow** are marked dirty. The destination window will then get a **msgWinRepaint** and can paint the dirty pixels some other way. This allows an image device to capture an image from **theScreen** where some of the pixels may be dirty or covered up by other windows. When those pixels are copied, the copies are marked dirty.

Remember that image windows are created in a dirty state. Thus, if you never cleaned up the damage and set **dstDirty**, the destination window will be marked dirty. You can clear the dirty state of an image window using **msgWinUpdate** or **msgWinCleanRect**.

Note that the dirty pixels are copied **first** and are then marked dirty. The source pixels are copied to the destination regardless, whether dirty or not.

Landscape and portrait mode rotation is handled correctly; however, axis flipping and rotation in the DC LUC space will work less intuitively than one might hope.

When pixels are copied from the image device to a visible window device (such as **theScreen**) using **msgDcCopyPixels**, the meaning of the pixels is determined by the visible device. For example, on a two-plane device, black is **00**, and white is binary **11**. If you draw with RGB colors you should not have any surprises copying images to other devices.

Stenciling 24.2.5.3

You can also use a one-plane image device as a **stencil** through which the DC renders the current foreground and background colors. To do this, send **msgDcDrawPixels** to the DC of the destination window. This takes the same SYSDC_PIXELS message arguments as **msgDcCopyPixels**. The difference is that instead of copying the pixels in the source to the destination, instead the pixels in the source determine which pixels in the destination get the foreground and background colors.

When using an image device as a stencil, it is important for the stencil to have a 1 bit where foreground color is to be applied and a 0 bit where background color is applied (the background color can be transparent). To ensure this, it's easiest to set the **colors** with **msgDcSetForegroundColor** and **msgDcSetBackgroundColor**. Usually you set RGB colors to be device-independent, but here the meaning of the stencil's pixels are independent of its device. You would do it as follows (**theDc** is the DC bound to the stencil window on the image device):

```
ObjectCall(msgDcSetForegroundColor,theDc,(P_ARGS)1);
ObjectCall(msgDcSetBackgroundColor,theDc,(P_ARGS)0);
```

msgDcDrawPixels does not pay attention to the **dstDirty** flag. When drawing images with a stencil, the window system assumes that the stencil is completely constructed by the application and is not a snapshot of the screen.

Example 24-2
More Complex Use of an Image Device

The following code creates an image device, allocates memory for it, draws in it, then copies its pixels to another window.

```
IMG_DEV_NEW idn;
OBJECT         id;
ObjectCall(msgNewDefaults,clsImgDev,&idn);
ObjectCall(msgNew,clsImgDev,&idn);
id = idn.object.uid;
ObjectCall(msgWinDevGetRootWindow,id,&id);
```

Notice that the **msgWinDevGetRootWindow** line is trading in the UID of the image device for the UID of the image device's root window. From now on your code can forget about the image device itself, and treat it as a window.

Also, it is necessary to specify the width, height and depth of the pixelmap that is to be allocated or provided by the application. As usual we want to be able to send these messages to a DC to obtain coordinate transformation into device units; so the first thing we need to do is bind a DC to the window with which the image device will be trading images.

```
WIN         aScreenWindow
SYSDC       aDc;
// create the DC...
ObjectCall(msgDcSetWindow,aDc,(P_ARGS)aScreenWindow);
```

To get the image device to allocate pixel map memory, we fill out the parameters to **msgWinDevBindPixelmap** like this:

```
WIN_DEV_PIXELMAP  pm;
pm.device      = id;       // really "image device" root window
pm.size.w      = 72;       // 72 points
pm.size.h      = 72;       // 72 points
pm.planeCount  = 0;        // use default #
pm.pPlanes     = pNull;    // I'm not providing memory
ObjectCall(msgWinDevBindPixelmap,aDc,&pm);
```

Note that we are sending this message to **aDc**, which is bound to **aScreenWindow**, so the units are in LUC (points, by default), not device units.

If we want to allocate the memory then the first step will be to find out how many bytes each plane must be. The following message:

```
ObjectCall(msgWinDevSizePixelmap,aDc,&pm);
```

(with the same parameters in **pm** as before) will pass back in **pm.planeSize** the number of bytes of memory each plane should be for a 72x72 image; and it will return in **pm.planeCount** the number of planes to allocate.

Assume we simply want to draw on the root window of our device and then copy the image to **aScreenWindow**. We can paint on the window returned by **msgWinDevGetRootWindow** in the usual manner:

```
RECT32  r;
WIN     win;
ObjectCall(msgDcSetWindow,aDc,(P_ARGS)id);
ObjectCall(msgWinBeginPaint,aDc,&r);
ObjectCall(msgDcFillWindow,aDc,pNull);
ObjectCall(msgDcDrawEllipse,aDc,&r);
ObjectCall(msgWinEndPaint,aDc,pNull);
```

continued

To copy the image in id to **aScreenWindow** use **msgDcCopyPixels** as follows:

```
SYSDC_PIXELS      cp;
cp.srcWindow = id;
// copy from window "id"
cp.pBounds   = pNull;    // copy entire window
cp.xy.x      = 72;       // copy to 72,72 in the
cp.xy.y      = 72;       // destination window (aScreenWindow)
cp.dstDirty  = FALSE;    // see discussion
ObjectCall(msgDcSetWindow,aDc,(P_ARGS)aScreenWindow);
ObjectCall(msgWinBeginPaint,aDc,pNull);
ObjectCall(msgDcCopyPixels,aDc,&cp);
ObjectCall(msgWinEndPaint,aDc,pNull);
```

The lower left hand corner of **id** will be copied to 72,72 in **aScreenWindow**.

Multiple Pixelmaps 24.2.6

After an image device has been created you can send it **msgWinDevBindPixelmap** many times to create new pixelmaps. or to bind to old ones. If the window system allocated the memory for the image device, it will free it. Thus, a single image device can be used to handle a larger collection of pixelmap data.

Destruction 24.2.7

When you are finished with the image device itself, destroy it by sending it **msgDestroy**; this frees it and any pixelmap it was holding at the time (unless you supplied the memory). You can send **msgDestroy** to the root window on the image device and it will destroy the image device as well.

Landscape and Portrait Mode 24.2.8

Image devices handle landscape and portrait modes correctly; the pixelmaps are inherently device dependent and **clsImgDev** adjusts their notions of width and height accordingly. However, it is your responsibility to flush and rebuild pixelmaps when the user switches the orientation of **theScreen**. You can receive notifications of changes in screen orientation by observing the well-known object **theSystemPreferences**.

Performance Tips

24.2.9

If you use bitmap images repeatedly in your application, there are a variety of ways to display them:

- Use **msgDcDrawImage** as necessary to draw the bitmaps.
- Create one image device, and draw the various bitmaps in its root window so that they don't overlap, and copy the right pixels by specifying the right **pBounds** in **msgDcCopyPixels**.
- Create one image device, create several child windows on it of the right sizes for the bitmaps, and use **msgDcCopyPixels** with a **pBounds** of **pNull**.
- Create one image device, allocate memory for each bitmap, and bind the image device to each pixelmap as needed.

All of these are appropriate in different situations.

Chapter 25 / Graphics Concepts

This chapter provides a detailed description of the PenPoint™ operating system standard imaging model, **ImagePoint**™, as well as a conceptual overview of its implementation as **clsSysDrwCtx** (the system drawing context class). You'll find a more detailed description of graphics-related classes in the remaining chapters of this part.

If you plan to use the standard User Interface Toolkit classes (described in *Part 4: UI Toolkit*) to build your user interface, you may be able to skip the remaining chapters in this part and go directly to Part 4. You may nevertheless find the information in this chapter useful, since it provides a framework for understanding the graphics behavior the UI Toolkit classes provide.

Topics covered in this chapter include:

- The relationship between an imaging model and a drawing context.
- The ImagePoint imaging model as PenPoint's system drawing context.
- Coordinate systems and coordinate transformations.
- ImagePoint drawing operations.
- ImagePoint support for text and color.
- Special features of **clsPicSeg**, a subclass of **clsSysDrwCtx.**

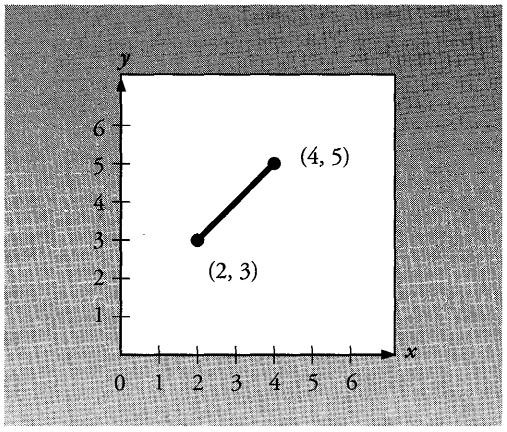
Models and Implementation 25.1

Every computing system that displays graphics has some kind of underlying imaging model. Imaging models provide an abstract method for describing images. Computing systems must implement a programming interface based on the imaging model. PenPoint's system imaging model is called **ImagePoint**. The programming interface based on ImagePoint is the **drawing context.**

Imaging Models 25.1.1

An **imaging model** is a set of concepts and assumptions that supports the description of visual images. Figure 25-1 shows a simple two-dimensional imaging model involving line segments in an x-y coordinate system. The **coordinate system** is defined by an arbitrary point called the **origin** and an arbitrary measure of distance called the **unit**. It is possible to describe any point in the coordinate system by specifying its unit distance from the origin in the x (horizontal) and y (vertical) directions. For example, the coordinate pair (2, 3) specifies a point two units to the right of the origin and three units above the origin. Two such points describe a **line segment**, and you can combine several such line segments into geometric forms.

Figure 25-1
A Simple Imaging Model



PenPoint's system imaging model uses an x-y coordinate system as in the above example, but supports more powerful features such as coordinate transformations, filled and unfilled geometric figures, text, and color.

Drawing Contexts 25.1.2

In PenPoint, graphics appear in windows, rectangular areas of an output device. PenPoint represents the output device internally as an instance of **clsWinDev** (window device), which inherits from **clsPixDev** (pixel device). Each window is an instance of a descendant of **clsWin**. Windows and window devices provide the canvas for application graphics operations, but their graphic ability is limited to defining the pixels a drawing operation can affect. The ability to render an image is separately defined in descendants of **clsDrwCtx** (drawing context).

A **drawing context** (DC) is an implementation of an abstract imaging model. A DC includes a set of **drawing operations** (such as an operation to draw a rectangle) together with a **graphic state** (a set of attributes such as line thickness). The graphic state determines the way in which the DC executes its drawing operations. For example, with the line thickness attribute set to 0.1 centimeters, the DC draws lines 0.1 centimeters thick. If an application changes the line thickness attribute to 0.25 centimeters, the DC draws subsequent lines 0.25 centimeters thick.

To draw an image in a window, your application must **bind** a drawing context and a window together. A drawing context renders images in the window to which it is bound. Binding isn't permanent; your application can share a single drawing context between many windows by binding the drawing context to one window after another.

The System Drawing Context 25.1.3

Because a drawing context based on ImagePoint is the standard for PenPoint systems, an ImagePoint drawing context class is called **a system drawing context**. A system drawing context is an instance of **clsSysDrwCtx**, which inherits from **clsDrwCtx**. The drawing context class, **clsDrwCtx**, is an abstract class. It defines the basic ability of binding to a target window, but does not provide any graphics ability. **clsSysDrwCtx** adds the ability to draw images, according to the underlying ImagePoint imaging model, in the bound window. Because a system drawing context is the standard type of drawing context in PenPoint systems, it is often referred to simply as a **drawing context**.

Coordinate Systems 25.2

The ImagePoint imaging model includes the concept of an x-y coordinate system for specifying location in the drawing space. There are two coordinate systems which you must understand:

- **Logical unit coordinates** (**LUC**) are the coordinates of the abstract ImagePoint imaging model. Drawing contexts use LUC for almost all drawing operations.
- **Logical window coordinates** (**LWC**) are measured in pixels relative to the lower left corner of the window. The window system uses LWC to describe the size of a window.

Drawing contexts use logical unit coordinates (LUC). The window system uses logical window coordinates (LWC). These are the coordinate systems you need to understand to understand the material in this chapter.

Logical Unit Coordinates 25.2.1

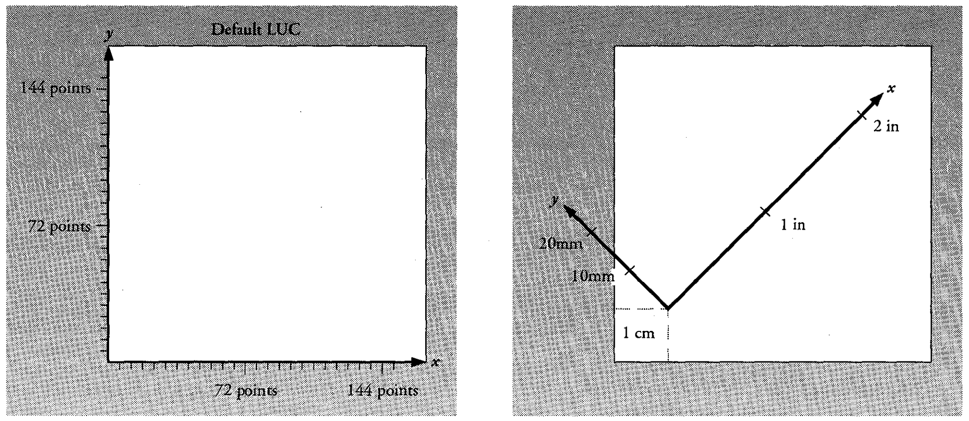
The LUC system holds a special place because it is the abstract coordinate system of the ImagePoint imaging model. LUC's abstract nature keeps it free of dependency on pixel size, allowing flexibility and convenience for use with drawing contexts.

The origin of the logical unit coordinate system initially maps to the origin of the logical window coordinates (the lower left corner of the window). The unit measurement of LUC starts out as one typographer's **point** (1/72 of an inch). Applications use logical unit coordinates when sending messages to drawing contexts. Drawing contexts can receive all **clsWin** messages, and convert from LUC to LWC as needed.

Coordinate System Transformations 25.2.1.1

Because logical unit coordinates are the abstract coordinates of the ImagePoint imaging model, you are free to transform them in any way that is convenient for your application. Transformations include scaling the coordinate units (changing their size), translating (moving) the origin of the coordinate system, and rotating the entire coordinate system about its origin. For example, as shown in Figure 25-2, you could change the LUC system to measure x (horizontal) units in inches and y (vertical) units in millimeters, relative to an origin one centimeter to the right of and above the lower left corner of the window, and rotated to a 45-degree angle from horizontal.

Figure 25-2
Transforming the LUC



Drawing contexts support on-the-fly transformation from LUC to LWC. As a convenience, **clsSysDrwCtx** implements all of the **clsWin** messages. You can send a **clsWin** message to a drawing context with coordinates specified in LUC; the DC will transform the coordinates into LWC for its bound window, then send the message to the window. This allows you to implement all windows and graphics code with a single, flexible coordinate system (LUC) that you customize to be as convenient as possible for your application.

Coordinate Unit Size 25.2.2

To improve performance, drawing contexts use **integral coordinates**. In other words, ImagePoint does not support fractional coordinates. Although this improves graphics performance, it may be difficult to create effective images if your LUC unit is too large. For example, if your LUC unit is one inch (2.54 cm), you cannot specify locations that do not fall on one inch increments from the origin. This can result in unattractive displays, especially when drawing text.

As a result of this implementation, it is important to keep LUC units sufficiently small. Typically, this means keeping the units smaller than the smallest graphic element your window will contain. By default, a new DC has a unit size of one typographer's point (1/72 of an inch), which is small enough for most applications. With this unit size, a rectangle 72 units high by 144 units wide is one inch by two inches on the display. If points are not convenient for your application, drawing contexts supports a variety of convenient unit sizes in addition to its arbitrary scaling support.

Coordinate Rounding Error 25.2.3

The advantage of logical units is device-independent displays. With a unit size of one point, 72 units is one inch, independent of whether the display device offers 72 pixels per inch or 1200 pixels per inch. The trade-off is that, because of rounding error, you cannot specify an exact size or screen location unless you set the unit size equal to the device units. As a rule, the rounding error is never larger than two pixels (usually one pixel or less). Nevertheless, because window sizes and positions are specified in device units, window edges always fall exactly on pixel boundaries. Unless you give up device independence by setting the DC unit to pixels, it is difficult to specify an image that is aligned exactly with the edge of a window.

Rounding error also can cause an image to appear differently depending on whether its location rounds up to the next pixel or down to the previous pixel. One solution to this problem, if it occurs, is use origin translation or some other method to snap the starting coordinate to the pixel nearest the intended location. This guarantees consistent rounding no matter where the image is displayed.

If pixel alignment is absolutely critical to your application, you can use device units as your DC unit. The cost is a complete loss of device independence. For example, on a 72 pixel per inch display, 72 device units is one inch. On a 300 pixel per inch display, the same 72 units spans slightly less than a quarter of an inch. So, unless your application demands exact pixel alignment, you should use an LUC unit size that is not tied to device unit size.

Drawing Context Features 25.3

The remainder of this chapter describes features of ImagePoint as implemented in **clsSysDrwCtx**, as well as the additional features of **clsPicSeg** (picture segment), a subclass of **clsSysDrwCtx**. Drawing context features include:

- **Local clipping** to clip images outside a specified rectangle within the window.
- **Hit detection** to determine whether a specified rectangle intersects with a series of drawing operations.
- **Bounds accumulation** to determine the bounding rectangle of a series of drawing operations.
- **Figure drawing** operations to create open figures (such as lines, arcs, and Bezier curves) and closed figures (such as rectangles, ellipses, and arbitrary polygons).
- **Sampled image** operations to display pixelmaps.
- RGB and palette **color** support.

- Text operations supporting **scalable fonts.**
- A structured **graphic state** that can be stored and retrieved (a single DC can maintain a collection of useful graphic states).

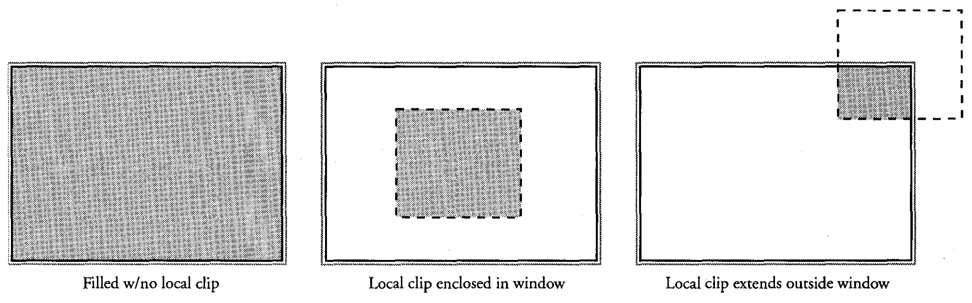
clsPicSeg, which inherits from **clsDrwCtx**, adds the ability to record a series of drawing operations. In addition, picture segments support splines (smoothly connected sequences of Bezier curves) and the inclusion of arbitrary objects in images.

Local Clipping

25.4

In addition to the clipping regions the window system maintains for each window, you can define a **local clipping rectangle** for each drawing context. A local clipping rectangle effectively reduces the clipping region to the intersection of the local clipping rectangle and the standard clipping region. As you can see in Figure 25-3, this can only *reduce* the size of the standard clipping region.

Figure 25-3
Using a Local Clipping Rectangle


Filled w/no local clip
Local clip enclosed in window
Local clip extends outside window

Hit Detection

25.5

PenPoint provides some low-level functions for determining whether one rectangle contains or intersects another. **clsSysDrwCtx** supports the notion of **hit detection** to determine whether an arbitrary drawing operations intersects with or contains a specified rectangle. Hit detection is a special mode of operation for drawing contexts. When hit detection is on, the drawing context does not render images. Instead, it responds to drawing messages by reporting whether the requested figures intersect with or are contained by the rectangle.

Bounds Accumulation

25.6

Bounds accumulation lets you calculate the bounding rectangle of a complex set of figures. Like hit detection, bounds accumulation is a mode of operation during which drawing contexts do not render images. While bounds accumulation is on, the drawing context maintains a rectangle and responds to each drawing message by expanding the rectangle to enclose the requested figures. Your application can get the bounding rectangle while bounds accumulation is on, or get the final rectangle when it turns bounds accumulation off.

For applications whose graphic elements are not static, you can use bounds accumulation to improve the efficiency of window repainting. For example, if the user moves a figure in a drawing application, the application can use bounds accumulation to determine the bounding rectangles of the figure before and after moving it. The application can then use the accumulated bounds to set the dirty region of the window. This precludes the need to repaint the entire window whenever the user moves an object.

Figure Drawing Operations 25.7

ImagePoint supports a relatively simple set of figure drawing operations. By setting the various attributes of the **graphic state** (described later), your application can use these drawing operations to create a wide variety of visual effects.

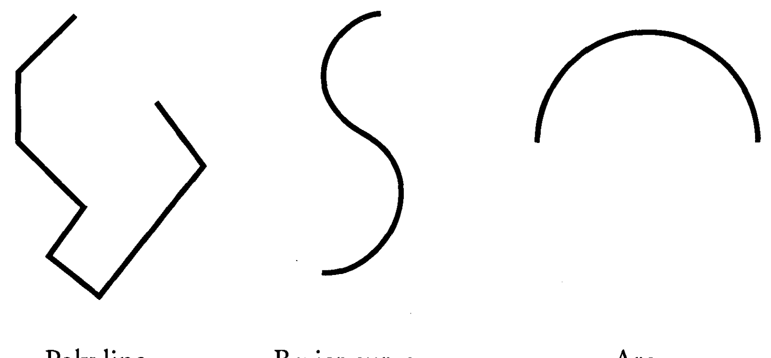
Open Figures 25.7.1

Open figures are composed of lines drawn according to the **line pattern** and other line attributes of the graphic state. ImagePoint supports the following open figures:

- A **polyline** is a series of connected line segments defined by a list of points.
- A **Bezier curve** is a smooth curve defined by four control points.
- An **arc** is a segment of the circumference of an ellipse, defined by an ellipse and two points. The rays from the center of the ellipse through the two points mark the limits of the arc.

Figure 25-4 shows some examples of open figures.

Figure 25-4
Open Figures



Closed Figures 25.7.2

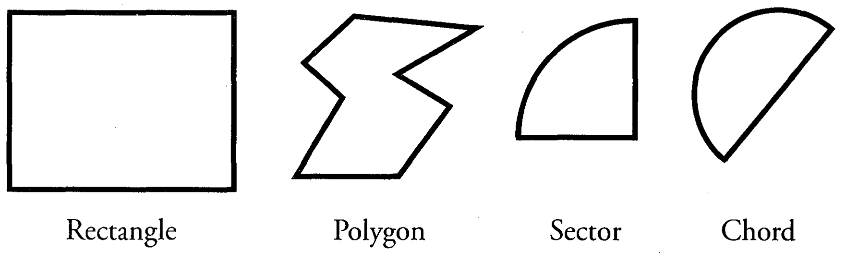
Closed figures are composed of lines that properly encloses a region. The drawing context draws the lines according to the line attributes of the graphic state, just as with open figures, and additionally fills the enclosed region with the **fill pattern** specified in the current graphic state. A transparent fill pattern to prevents the drawing context from filling the region, and a line width of zero prevents the drawing context from drawing the enclosing lines.

ImagePoint supports the following closed figures:

- A **rectangle** is a four-sided figure composed of four lines connected at right angles. A rectangle is defined by a point representing the origin of the rectangle, and a coordinate pair representing the rectangle's size in the x and y directions.
- An **ellipse** is a regular, round figure (such as a circle) defined by an enclosing rectangle.
- A **polygon** is a series of line segments defined by a list of points, like the polyline described above, but with the first and last points in the list connected to close the figure.
- A **sector** is a segment of an ellipse defined by an ellipse and two points, like the arc described above, closed with two lines drawn from the endpoints of the arc to the center of the ellipse.
- A **chord** is a segment of an ellipse defined by an ellipse and two points, like the arc described above, closed with a single line connecting the endpoints of the arc.

Figure 25-5 shows some examples of closed figures.

Figure 25-5
Closed Figures



Sampled Images

25.8

A **sampled image** is an ordered collection of rows of image samples such as the output of an image scanner. Displayed one after the other, the rows recreate the image from which their values were sampled.

clsSysDrwCtx supports the conversion of sampled images into grayscale pixelmaps it can render. It also provides a mechanism for rendering the sampled image once into off-screen memory, and to quickly copy the stored pixelmap into a window. This can improve performance, especially in situations where the drawing context must repeatedly display a single sampled image.

Drawing Sampled Images

25.8.1

A drawing context renders the sampled image into a **destination rectangle** within the window. To prepare the sampled image for rendering, your application must provide a pointer to the sample data in memory. In cases where the sampled image is too large to fit in memory, your application can provide a **callback** function or object that provides sample data to the drawing context, one row at a time, as the DC requests it.

The drawing context scales the sampled image to fit into the destination rectangle, then renders it. You provide the drawing context with information about the sampled image, such as the maximum sample value. Sample values from zero to the maximum sample value represent shades of grey increasing linearly from black to white. A drawing context can reduce the sampled image to a single bit-deep **image mask** which it can render in the current foreground and background color.

Cached Images

25.8.2

The image cache facility is optimized for use with small sampled images.

In rendering a sampled image, a drawing context handles the LUC coordinate transformations, different device resolutions, different pixel aspect ratios, different number of bit planes, dithering, and so on. This is a powerful mechanism, but it can be somewhat slow especially with large images. If your application renders a sampled image repeatedly on the same device at the same scale, you can improve efficiency by performing these transformations once to generate the desired pixelmap, and then copying the pixelmap to the display as necessary.

Rather than directly rendering a sampled image, a drawing context can create a **cached image**. The DC creates a memory buffer where it stores the pixelmap. It is up to the controlling application to maintain and eventually free the cached image buffer after the drawing context creates it. When the application wishes to display the cached image, the it provides the drawing context a pointer to the cached image and an x-y position in LUC. The drawing context quickly copies the preprocessed pixel image to the window, aligning the image's **hot spot** (see below) with the specified x-y position.

A cached image mask can be any arbitrary bitmap that has the same width and height as the cached image.

A cached image can have an associated **hot spot** and a **mask**. The hot spot is a position offset in LUC. If the image has a nonzero hot spot, the drawing aligns the hot spot with the x-y position the application supplies (rather than aligning the lower left corner of the image with the x-y position). The image mask is a bitmap of the same width and height as the cached pixelmap. If a cached image has an associated mask, the drawing context renders only those pixels in the cached image that correspond to 1 bits in the mask.

Cached images are optimized for the current window device when they are created. They are inherently device-dependent. The application must free and recreate the cached image whenever the window device changes pixel aspect ratio, orientation, plane depth, and so on. Furthermore, you cannot render anything but sampled images into a cached image buffer. If you need to draw synthesized images that a drawing context can quickly copy to an on-screen window, use a window on an image device. Image devices, which are optimized for use with large windows and windo trees, are described in Chapter 24, Window Device Classes.

Color

25.9

Drawing contexts support a foreground color and background color. Drawing context operations normally draw in the foreground color. Some draw in the foreground and background colors simultaneously, such as when filling a closed figure with a two-color pattern. The standard method for specifying colors is the device-independent **RGB** (red-green-blue) method. While the use of palette colors can result in slightly better graphics performance, it is highly device-dependent and therefore not recommended for writers of portable applications.

RGB Color Values

25.9.1

An **RGB** (red-green-blue) color value is a combination of three values: red, green, and blue. Each part of an RGB value can range from zero to 255. The higher the value, the brighter the corresponding color component. For example, a red value of 255 and blue and green values of zero yields a bright red. Red and blue values of 75 and a green value of zero yields a muted magenta. If the red, green, and blue values are equal, the resulting color is a shade of gray, from black (all zero) to white (all 255).

For the background color only, drawing contexts support a transparency value in addition to the red, green, and blue values. A transparent background means that the DC will not paint background pixels; whatever is behind the bacground will show through. Like the RGB values, transparency can range from zero to 255. A transparency value of zero yields a completely opaque background color, while a transparency of 255 makes the background completely transparent. At present, ImagePoint supports only these two levels of transparency, and only the background color can be transparent.

When a drawing context's foreground and background colors are specified using the RGB model, the drawing context automatically finds the best color match independent of the display device to which it is bound. Whether it is drawing on a black and white LCD or on a full-color printer, the drawing context will do its best to render in the specified colors.

Hardware-Dependent Palette Colors

25.9.2

In almost all cases the use of palette colors makes an application difficult to port to a hardware platform other than the one on which it was developed.

Some hardware platforms support a **palette**, or numbered list, of colors. Each index into the palette corresponds to the color stored at that location in the list. It is possible to specify a drawing context's foreground and background colors as indices into the palette, but this is extremely device-dependent. The only advantages to using this technique for specifying colors is a slight performance improvement, particularly when repeatedly and rapidly changing the foreground and background colors. If you specify either the foreground or background color as a palette color, you must specify both as palette colors. Palette colors and RGB colors are not compatible with one another.

Text 25.10

Drawing contexts support a sophisticated model for the creation and display of text. The programming interface, however, is not too complex: the drawing context **opens** a font, **scales** the font to the appropriate size, and **draws** text just as it draws other synthesized images such as rectangles and ellipses. Some features of the ImagePoint text model include:

- Device-independent, user-installable **outline fonts**.
- On-the-fly generation of **font bitmaps** (cached for improved performance) from font outlines, for any resolution device.
- Automatic selection of a **closest match** from the installed fonts when a requested font is not available.
- Automatic **transformation** of font attributes (for example, transforming a roman font to italic) when requested fonts are not available.
- Automatic **substitution** of glyphs from other fonts for characters not available in the current font.

This section provides an overview of the technical concepts involved in the ImagePoint font model. See Chapter 26, The Drawing Context Class, for more detailed information.

Fonts 25.10.1

Every ImagePoint font has a **font ID**, a set of **font metrics**, and a set of glyph **outlines**. The font ID is a unique code which GO Corporation assigns, so a given font ID identifies the same font on all PenPoint systems for all time. Font metric information includes size information such as the x height, em size, space width, ascender height and descender depth, and largest and smallest character sizes for the font. In addition, the font metrics provide a set of **font attributes** that describe the general appearance of the font. Font attributes include information such as the font group (*modern Roman* or *sans serif,* for example), weight or boldness, the aspect or relationship between character width and height, whether the font is italic, and whether it is monospaced.

The glyph outlines define the shape of each character, or glyph, in the font. All ImagePoint fonts scale to any size, so the outlines do not include absolute size information. Fonts can include bitmaps tuned for specific sizes and resolutions. When a drawing context draws text in a font size that has a tuned bitmap for the particular window device's resolution, it will use the tuned bitmap rather than generate a bitmap from the font outline. This improves legibility at low resolution or in very small font sizes.

Opening a Font 25.10.2

Before a drawing context can draw text in a particular font, it must **open** the font. Because fonts are user-installable, there is no guarantee that a particular font will be available when a drawing context tries to open it. For this reason, in addition to specifying a font ID for the font to open, you must also specify the desired attributes of the font (bold, italic, and so on). The drawing context opens the closest-match font and synthesizes any missing attributes.

For example, suppose you try to open a font ID corresponding to the serif font Palatino Bold, with the group attribute set to **modern Roman** and the weight attribute set to bold. If Palatino Bold is one of the installed fonts, the drawing context will open it. If Palatino Bold is not installed and Palatino Roman is the closest match, the drawing context will open it and alter it to synthesize the bold attribute. If no Palatino font is installed and the closest match is Times Roman, the drawing context will use Times Roman and alter it to synthesize the bold attribute.

The important thing to remember about opening a font is that you must supply a font ID *and* attributes.

Scaling a Font

25.10.3

When a drawing context opens a font, it scales the font so that the point size of the font (its **em height**) is equivalent to one unit in the DCs current logical unit coordinates. By default, the LUC unit is the point (1/72 of an inch), so the default font size is one point, much too small to be legible. Applications therefore need to scale the font before drawing text with it. The font scaling factors describe a multiple of the LUC unit.

For example, in the default case described above, the font is one point high when the drawing context opens it. If you set the font scale to 12 in both the x and y directions, the font scales up to 12 points (12 times the LUC unit of one point). If you then scale the LUC so that the x unit is 0.1 inch and the y unit is one millimeter, the font size for subsequent drawing becomes 1.2 inches in the x direction and 12 millimeters in the y direction. The LUC scale affects the font scale, but font scale does not affect the LUC scale.

If the LUC x and y scales are radically different, it requires radical compensation in the font scale. Sometimes it is appropriate to switch between a drawing context for text and a drawing context for all other graphics.

Drawing Text

25.10.4

After a drawing context opens and scales a font, it can draw text in that font. An application instructs the drawing context to draw a specific strings of text beginning at a specific LUC origin. The drawing context generates bitmaps for each character of the font, based on the font's scaled glyph outlines and the resolution of the window device. To improve performance, the drawing context generates the bitmaps for a particular font size and device resolution only once, caching the bitmaps for later use.

The drawing context renders the character bitmaps in its bound window, filling them with the current foreground color. The application may modify the way the drawing context draws text with a number of drawing format attributes including underline, strikeout, and modifiers for word spacing, letter spacing, and font alignment. Underline and strikeout line thickness is defined in the font metrics, independent of the current drawing context line thickness, to achieve an attractive line weight. Alignment sets the ascender height, midpoint of x height, baseline, or descender depth of the font equal to the y coordinate of the specified drawing origin.

Character Encoding and Missing Glyphs 25.11

Text strings exist in the system as strings of byte-encoded characters. The *encoding* attribute with which the drawing context opens the font determines which glyphs correspond to which character bytes. Most text encodings have the same glyphs for the printable ASCII characters, but different encodings produce different glyphs for control characters and ASCII characters beyond ASCII DEL (decimal 127). If a character in a text string corresponds to a glyph that is not defined by the current font, the drawing context will try to locate the glyph in another installed font. The replacement glyph may not look like part of the opened font (it isn't), but at least it appears in the rendered text.

Graphic State 25.12

Every instance of **clsSysDrwCtx** supports the same methods for drawing figures and text in a bound window. It is information such as logical unit coordinate scaling, translation, and rotation, line thickness, foreground and background color, and so on that differentiates one instance of **clsSysDrwCtx** from another. This differentiating information, collectively, is a drawing context's **graphic state.**

Drawing contexts provide limited support for **graphic state storage. clsDrwCtx** defines messages for temporarily storing one or more graphic states while creating a new one for a special purpose, and for restoring a stored graphic state. You must implement your own storage mechanism, such as a stack.

The most important elements of a graphic state, for purposes of rendering images, include:

- The LUC unit (default is one point). The logical unit coordinate (LUC) system is the coordinate system by which a drawing context interprets coordinates for drawing operations. By default, a new drawing context provides an LUC system whose units are one point (1/72 of an inch) in both the x (horizontal) and y (vertical) directions. Drawing contexts provide mechanisms for scaling the size of the LUC unit indepentently in each direction. Logical unit coordinates are also discussed in "Coordinate Systems," earlier in this chapter.
- Local clipping rectangle (default is entire window). The local clipping rectangle restricts the area of a window which drawing operations affect. For example, if the local clipping rectangle covers the upper left quarter of a window, an operation to draw a line from the upper left corner of the window to the lower right corner will draw only the portion of the line from the upper left corner to the center of the window. The remainder of the line, which falls outside of the local clipping rectangle, is not rendered. The concept of the local clipping rectangle is discussed in "Local Clipping," earlier in this chapter.

- Line thickness (default is one LUC unit). The drawing context maintains a line thickness value. Initially, the drawing context draws lines that are one unit thick (as mentioned above, the default unit is one point). If you change the line thickness, the drawing context draws subsequent lines with the new line thickness. The line thickness determines the thickness of all lines the drawing context draws, including the outlines of closed figures.
- Line cap and join, which determine how line segments join together (default is butt caps and mitre joins). The line cap determines the shape of the end of a line segment that does not join with another line. A **butt** line cap simply cuts off the line segment at its endpoint, perpendicular to the line's direction. A **square** line cap has the effect of drawing a square as wide as the line thickness, centered around the enpoint, with a center line parallel to the line segment. A **round** line cap has the effect of drawing a circle whose diameter is the line thickness, centered around the endpoint of the line.
- Foreground and background color (default is black foreground, white background). Initially, the drawing context draws lines in the foreground color, and fills closed figures with the background color. While it is possible to *display* as many colors as the hardware supports on screen at one time, the drawing context *draws* in only the foreground and background color at one time.
- Line and fill pattern (default is foreground color lines, background color fills). You can change the foreground and background color, as described above, but the lines initially are solid foreground color, while fills are solid background color. You can change the line pattern and fill pattern independently to change the way the drawing context combines the foreground and background color to draw lines and fills. For example, you can change the line pattern so that the drawing context draws lines in a color that is 75% foreground color and 25% background color, while it draws fills as alternating diagonal lines of foreground color and background color.
- Font (default is system font, sized to one LUC unit). Graphic states implement the ability to render text with a scaleable, outline font. In order to do this, they maintain information about font with which to render text, and the size at which to draw the font. It is a simple matter to change the font family, the size, and a variety of other attributes of the font.

Chapter 26, The Drawing Context Class, describes the elements of the graphic state in more detail.

Picture Segments

25.13

A **picture segment** is an instance of **clsPicSeg**, which inherits from **clsSysDrwCtx**. Picture segments have all of the capabilities and features of drawing contexts, but add the notion of the **grafic**, a record of a drawing message that the picture segment can redraw at a later time. A picture segment maintains a list of grafics recording the drawing messages the picture segment has received, in the order it received them. You can retrieve, alter, reorder, and delete individual grafics. The picture segment can redraw all of the grafics, or just one, at any time, and it can add and alter grafics with or without affecting the image in the picture segment's bound window.

Picture segments also support splines (smoothly connected sequences of Bezier curves), adding them to the suite of drawing context primitives such as polygons and text. Furthermore, with minimal assumptions, picture segments support the inclusion of arbitrary objects other than the standard DC primitives and splines into their images. Chapter 27, The Picture Segment Class, describes picture segments in more detail.

Chapter 26 / The Drawing Context Class

System Drawing Context Messages 26.1

Here are the messages defined by **clsSysDrwCtx**. Many are described here; some are described in later chapters.

Table 26-1
clsSysDrwCtx Messages

Message	pArgs	Description
		Class Messages
msgNew	P_SYSDC_NEW	Creates a system drawing context.
msgNewDefaults	P_SYSDC_NEW	Initializes the SYSDC_NEW structure to default values.
		Associating DCs with Windows
msgDcSetWindow	new WIN	Binds a window to the receiver and returns the previously bound window.
msgDcGetWindow	pNull	Gets the window to which the drawing context is bound.
		Graphics State Messages
msgDcInitialize	pNull	Sets graphics state to initial values.
msgDcPush	P_SYSDC_STATE	Gets the graphics state and stores it.
msgDcPop	P_SYSDC_STATE	Sets the graphics state from one saved by msgDcPush.
msgDcPushFont	P_SYSDC_FONT_STATE	Gets the font state and stores it.
msgDcPopFont	P_SYSDC_FONT_STATE	Sets the font state from one saved by msgDcPushFont.
msgDcSetMode	new SYSDC_MODE	Sets the drawing mode and returns the old SYSDC_MODE.
msgDcGetMode	pNull	Gets the drawing mode.
msgDcSetPreMultiply	BOOLEAN	Sets the pre-multiply state and returns the old state.
msgDcSetRop	SYSDC_ROP	Sets the raster op and returns the old rop.
msgDcPlaneNormal	nothing	Sets the plane mask to the normal plane(s), returning the old mask.
msgDcPlanePen	nothing	Sets the plane mask to the plane(s) for pen ink, returning the old mask.
msgDcPlaneMask	SYSDC_PLANE_MASK	Sets an arbitrary plane mask, returning the old mask.
msgDcGetLine	P_SYSDC_LINE	Gets all line attributes if pArgs is P_SYSDC_LINE. Returns line thickness.
msgDcSetLine	P_SYSDC_LINE	Sets all line attributes. Returns old line thickness.
msgDcSetLineThickness	COORD16	Sets line thickness to new value; returns old line thickness.
msgDcHoldLine	BOOLEAN	Turns hold line thickness mode on/off; returns old hold mode.

continued

Table 26-1 (continued)

Message	pArgs	Description
		RGB Color Messages
msgDcSetForegroundRGB	U32	Sets foreground color using an RGB specification.
msgDcSetBackgroundRGB	U32	Sets background color using an RGB specification.
msgDcInvertColors	pNull	Swaps foreground and background colors.
msgDcGetForegroundRGB	P_U32 or P_SYSDC_RGB	Returns foreground RGB value.
msgDcGetBackgroundRGB	P_U32 or P_SYSDC_RGB	Returns background RGB value.
		Hardware-Dependent Color Messages
msgDcMatchRGB	U32	Returns palette entry that best matches an RGB.
msgDcSetForegroundColor	SYSDC_COLOR	Sets foreground color using a hardware palette index, returning old color.
msgDcSetBackgroundColor	SYSDC_COLOR	Sets background color using a hardware palette index, returning old color.
msgDcSetLinePat	SYSDC_PATTERN	Sets the line pattern; returns old value.
msgDcSetFillPat	SYSDC_PATTERN	Sets the fill pattern; returns old value.
msgDcGetLinePat	pNull	Gets the line pattern.
msgDcGetFillPat	pNull	Gets the fill pattern.
msgDcAlignPattern	P_XY32	Sets the pattern alignment in LUC.
		Matrix Manipulation Messages
msgDcGetMatrix	P_MAT	Returns the LWC matrix.
msgDcGetMatrixLUC	P_MAT	Returns the LUC matrix.
msgDcSetMatrixLUC	P_MAT	Replaces the LUC matrix.
msgDcUnitsMetric	pNull	Sets input units to 0.01 mm.
msgDcUnitsMil	pNull	Sets input units to 0.001 inch.
msgDcUnitsPoints	pNull	Sets input units to points (1/72 of an inch).
msgDcUnitsTwips	pNull	Sets input units to 1/20 of a point.
msgDcUnitsPen	pNull	Sets input units to pen sample units.
msgDcUnitsLayout	pNull	Sets input units to UI toolkit layout units.
msgDcUnitsRules	pNull	Sets input units to the rules associated with the system font.
msgDcUnitsDevice	pNull	Sets input units to device pixels.
msgDcUnitsWorld	pNull	Sets input units to an arbitrary number of device pixels.
msgDcUnitsOut	MESSAGE	Sets output units produced by transformation of input units.
msgDcIdentity	pNull	Sets LUC matrix to identity.
msgDcRotate	ANGLE	Rotates LUC matrix.
msgDcScale	P_SCALE	Scales LUC matrix.
msgDcScaleWorld	P_SIZE32	Creates a world scale of window width/height.
msgDcTranslate	P_XY32	Translates LUC matrix.

continued

Table 26-1 (continued)

Message	pArgs	Description
		Coordinate Conversion Messages
msgDcLWCtoLUC_XY32	P_XY32	Transforms a point from window (device) space to logical space.
msgDcLUCtoLWC_XY32	P_XY32	Transforms a point from logical space to window (device) space.
msgDcLWCtoLUC_SIZE32	P_SIZE32	Transforms a size from window (device) space to logical space.
msgDcLUCtoLWC_SIZE32	P_SIZE32	Transforms a size from logical space to window (device) space.
msgDcLWCtoLUC_RECT32	P_RECT32	Transforms a rectangle from window (device) space to logical space.
msgDcLUCtoLWC_RECT32	P_RECT32	Transforms a rectangle from logical space to window (device) space.
		Clippimg and Hit Detection Messages
msgDcClipRect	P_RECT32 or pNull	Sets or clears clip rectangle.
msgDcClipClear	pNull	Returns clipping to entire window.
msgDcClipNull	pNull	Suspends all clipping (except to raw device).
msgDcHitTest	P_RECT32 or pNull	Turns hit testing on/off.
msgDcAccumulateBounds	P_RECT or pNull	Starts or stops bounds accumulation; retrieve bounds.
msgDcDirtyAccumulation	P_RECT32 or pNull	Marks accumulation dirty; turns accumulation off; retrieves bounds.
msgDcGetBounds	P_RECT32	Retrieves current accumulation bounds rectangle.
		Drawing Operations (Open Figures)
msgDcDrawPolyline	P_SYSDC_POLYLINE	Draws a line; needs at least 2 points. Returns either hit test or stsOK.
msgDcDrawBezier	P_XY32 (array of 4)	Draws a Bezier curve; needs exactly 4 points.
msgDcDrawArcRays	P_SYSDC_ARC_RAYS	Draws an arc using the two rays method. Returns either hit test or stsOK.
		Drawing Operations (Closed Figures)
msgDcSetPixel	P_SYSDC_PIXEL	Sets a pixel with a value.
msgDcGetPixel	P_SYSDC_PIXEL	Gets a pixel value.
msgDcDrawRectangle	P_RECT32	Draws a rectangle. Returns either hit test or stsOK.
msgDcDrawEllipse	P_RECT32	Draws an ellipse. Returns either hit test or stsOK.
msgDcDrawPolygon	P_SYSDC_POLYGON	Draws a polygon. Returns either hit test or stsOK.
msgDcDrawSectorRays	P_SYSDC_ARC_RAYS	Draws a sector (pie wedge) using the two rays method.
msgDcDrawChordRays	P_SYSDC_ARC_RAYS	Draws a chord using the two rays method. Returns either hit test or stsOK.
msgDcFillWindow	pNull	Frames window with a line and fills the window.
msgDcDrawImage	P_SYSDC_IMAGE_INFO	Draws an image from sampled image data. The image will be scaled, rotated, translated, according to the current state.

continued

Table 26-1 (continued)

Message	pArgs	Description
msgDcDrawImageMask	P_SYSDC_IMAGE_INFO	Draws a mask from sampled image data. Similar to msgDcDrawImage.
msgDcCacheImage	P_SYSDC_CACHE_IMAGE	Passes back a cached image in pCache, given a sampled image and an optional mask.
msgDcCopyImage	P_SYSDC_COPY_IMAGE	Copies a cached image to the bound window.
		Text Interface
SysDcFontId()		Takes a 4 byte string font description and returns a 16-bit font id number.
SysDcFontString()		Takes a 16-bit font id number and passes back a 4 char string.
msgDcOpenFont	P_SYSDC_FONT_SPEC or pNull	Opens a font.
msgDcScaleFont	P_SCALE or pNull	Scales font matrix.
msgDcIdentityFont	pNull	Sets font matrix scale to default of 1 unit (LUC).
msgDcDrawText	P_SYSDC_TEXT_OUTPUT	Draws text in the current font.
msgDcMeasureText	P_SYSDC_TEXT_OUTPUT	Computes size of text and advances pArgs->cp accordingly.
msgDcDrawTextRun	P_SYSDC_TEXT_OUTPUT	Like msgDcDrawText, except run spacing applies.
msgDcMeasureTextRun	P_SYSDC_TEXT_OUTPUT	Like msgDcMeasureText, except run spacing applies.
msgDcDrawTextDebug	P_SYSDC_TEXT_OUTPUT	Like msgDcDrawText, except text is drawn with debugging lines around each char.
msgDcPreloadText	P_SYSDC_TEXT_OUTPUT	Preloads pText into cache.
msgDcGetCharMetrics	P_SYSDC_CHAR_METRICS	Gets char metrics information for a string.
msgDcGetFontMetrics	P_SYSDC_FONT_METRICS	Gets the font metrics for the current font.
msgDcGetFontWidths	P_SYSDC_FONT_WIDTHS	Gets the font width table of the current font.
msgDcDrawPageTurn	P_SYSDC_PAGE_TURN	Draws a page turn effect over the bound window.
msgDcCopyPixels	P_SYSDC_PIXELS	Copies pixels from srcWindow to the bound window.
msgDcDrawPixels	P_SYSDC_PIXELS	Draws foreground and background colors in the bound window's pixels using srcWindow's pixel values as a stencil.

In addition, drawing contexts respond to all **clsWin** messages by passing them on to their bound windows. You often send the following window messages to a DC because the DC transforms the specified coordinates from LUC into LWC before passing it to its window.

msgWinDirtyRect	**msgWinCleanRect**
msgWinBeginRepaint	**msgWinBeginPaint**
msgWinGetMetrics	**msgWinTransformBounds**
msgWinDelta	

Creating a DC

26.2

To create a drawing context, send **msgNewDefaults** and then **msgNew** to **clsSysDrwCtx**.

Default Drawing Context State

26.2.1

Here are the defaults for the new drawing context. You can also reset a DC to these values by sending it **msgDcInitialize**. Most defaults are explained in more detail in following sections.

Table 26-2
Default clsSysDC State

Element	Value	Comments
units in	msgDcUnitsPoints	Application specifies units to DC in points (1/72 of an inch).
units out	msgDcUnitsDevice	DC specifies units to windows in pixels.
matrix	identity	No scaling or rotation of LUC.
clipping rectangle	none	No local clipping rectangle.
premultiply	false	Standard matrix concatenation order (post-multiply).
raster op	sysDcRopCopy	Source copied into destination.
drawing mode	sysDcDrawNormal	Keep narrow lines visible.
	sysDcHoldDetail	
plane mask	sysDcPlaneNormal	Don't draw in the pen ink plane.
line cap	sysDcCapButt	Line ends are squared off.
line join	sysDcJoinMiter	Line joins are mitered.
line thickness	1	One unit in (a point, by default).
line miter limit	10	Lines meeting at angles less than 10 degrees don't produce long spikes.
line radius	0	Corners of rectangles are squared off, not rounded.
foreground color	sysDcRGBBlack	Closest to black on every device.
background color	sysDcRGBWhite	Closest to white on every device.
fill pattern	sysDcPatBackground	Fill with background color (white, by default).
fill mode	even/odd	Method used to compute the area to fill.
line pattern	sysDcPatForeground	Draw lines in foreground color (black, by default).
font scale	1	Initial font size is one unit in (one point, by default) tall.
default font	unspecified	It is best to open a font, though text output will find some font.

Should You Create a Drawing Context? 26.3

A system drawing context is about 500 bytes long. You can create dozens of windows without using up a lot of memory, but DC's are much bigger objects. There is no global DC you can borrow. It is reasonable to create a DC per window, if you have a small number of windows; this will also give you maximum performance. Or, you can use one DC for all your windows, and bind it to each window in turn. It is also OK to create a DC for every **msgWinRepaint** message, use it to paint, and then free it; this will reduce the dynamic memory use of your application.

If you have subtasks in your application, and wish to share a DC throughout your process, you'll need to use semaphores to control access to it. (The same is true for any shared object.)

Drawing with a Drawing Context 26.4

Your drawing context is not bound to any window or device when you create it. Use **msgDrwCtxSetWindow** to bind it to a window. Or, use **msgDcSetWindow**; it's the same message with the common SysDC **Dc** prefix. Once bound, drawing via the DC occurs on the bound window.

Drawing Coordinates 26.5

When you issue drawing commands to your drawing context, you do so in LUC (Logical Unit Coordinates). These go through several transformations before finally ending up on the device. Unlike the other coordinate systems at work in PenPoint™ operating system, you can set LUC to suit your drawing:

- You can set the size of LUC units (so that one unit is one typographer's point, for example).
- You can scale LUC units (so that one unit equals one inch, for example).
- You can change translate the origin (0,0) to some point other than the lower left hand corner of the window.
- You can rotate the coordinate system.

Other levels of scaling/translation/rotation are going on before your drawing finally fills in the screen pixels. Your output window is probably not at the screen origin, the hardware pixels may not be square, the hardware coordinate system may start in a different quadrant, etc. If you need to use screen coordinates or device units, send messages to your DC to convert back to these.

Defaults

26.5.1

By default, when you create a new DC, one unit in LUC is one **point**. One point is 1/72 of an inch. If you draw a box 72 units on a side, it will be one inch square on the physical device with which your DC is bound. Also, by default the origin is in the lower-left corner of the window to which your DC is bound. So if you draw the square at (72, 144), it will be one inch to the right and two inches above the lower-left corner.

Example 26-1
Drawing a Box

```
SYSDC_NEW    dcn;
SYSDC        dc;
WIN          myWin;
RECT32       rect;
STATUS       s;

ObjCallRet(msgNewDefaults, clsSysDrwCtx, &dcn, s);
ObjCallRet(msgNew, clsSysDrwCtx, &dcn, s);

myRect.origin.x = 72;
myRect.origin.y = 144;
myRect.size.w = myRect.size.h = 72;

ObjectCall(msgDcDrawRectangle, dc, &myRect);
```

Units

26.5.2

You can initialize the mapping of LUC units to physical dimensions, by sending your DC one of:

Table 26-3
Messages to Set LUC Units

Message	Sets One LUC Unit to...
msgDcUnitsPoints	one point, or 1/72 of an inch (this is the default)
msgDcUnitsMetric	0.01 millimeters, or 10 microns
msgDcUnitsMil	one mil, or 0.001 inch
msgDcUnitsTwips	one twip, or 1/20 of a point
msgDcUnitsDevice	one device pixel
msgDcUnitsLayout	1/8 of an em in the system font (not the open font); this is the unit the UI Toolkit classes use
msgDcUnitsWorld	a division of the bound window's width and height (msgDcScaleWorld specifies the number of divisions)
msgDcUnitsPen	(obsolete) one pixel of the pen tracking sensor

Scale

26.5.3

After the unit system is initialized you can send **msgDcScale** to further scale your coordinate system. You specify scale using 32 bit **fixed-point numbers.** Fixed-point numbers are special numbers which encode 16 bits of integer and 16 bits of fraction in 32 bits. You create and manipulate fixed-point numbers using special routines as explained in *Part 8: System Services.*

For instance, if you send **msgDcScale** to a new DC as follows:

```
SCALE   scale;
SYSDC   dc;
scale.x = FxMakeFixed(2,0);
scale.y = FxMakeFixed(3,0);
ObjectCall(msgDcScale, dc, &scale);
```

Then a 72-point square will appear two inches wide and three inches high.

Rotation

26.5.4

You can send **msgDcRotate** to rotate LUC. This takes an **ANGLE** in degrees. The angle must be an integral number of degrees from zero to 359.

Translation

26.5.5

You can send **msgDcTranslate** to move the origin in LUC to any point. Thus instead of drawing the square at (72, 144), you could achieve the same effect by translating the origin (0,0) to (72, 144) and then drawing a 72-point square at (0,0).

Resetting LUC

26.5.6

You can send **msgDcIdentity** to the DC to set the LUC matrix to identity; this will set the scale to 1:1, the rotation to 0, and the origin to (0,0). The LUC units remain the same.

Scaling to your Window (World Coordinates)

26.5.7

Often you want to match your units to your window. For example, suppose you want to draw a symbol which fills your window, and you have code to draw it 100 units across by 200 units tall. You can do this in a two-part operation. First you send **msgDcUnitsWorld** to your DC. Then, you must send **msgDcScaleWorld** to scale (100,200) up to match the **current** size of the window. Note that each unit in LUC will not necessarily be square. **msgDcScaleWorld** takes a SIZE32 as its message arguments, so in this example if you pass it (100,200), then (50,100) in LUC will be the center of your window (assuming you haven't sent other coordinate transformation messages.)

To keep the world-scaled coordinates accurate, you must recalculate them whenever your window changes size. Because msgDcUnitsWorld does not reset the scaling matrix, you should normally send **msgDcIdentity** to the DC before sending **msgDcScaleWorld** a second time. Also, you should not set any of the

wsGrow window flags, or some pixels from the previous image will be preserved when the window changes size.

Transformation Matrices 26.5.8

You can get and set matrices corresponding to the transformations of scaling, rotating, translating, etc. Working with these matrices is more complicated than using transformation messages defined by clsSysDrwCtx, but is potentially faster than sending messages to your DC. Discussions of transformation matrices is available in most textbooks on computer graphics.

You can also send positioning messages to a DC, and the DC will convert LUC to LWC before forwarding the messages to the window to which it is bound.

msgDcGetMatrix passes back a matrix which transforms LUC space into LWC space. Since LWC space uses pixel units, this transformation includes information about the device, its orientation, and the units (Points, TWIPS, etc.) You can use this matrix to generate coordinates for positioning windows instead of sending **msgDcLUCtoLWC_RECT32**, **msgDcLUCtoLWC_XY32**, and **msgDcLUCtoLWC_SIZE32**. There is no message to set this matrix—you must
use **msgDcScale**, **msgDcRotate**, **msgDcUnitsTwips**, etc.

msgDcGetMatrixLUC returns a matrix which indicates transformations to LUC space as a result of translations, scaling, and rotation, including **msgDcScaleWorld**, but **not msgDcUnitsPoints**, **msgDcUnitsMils**, and other unit-specific scalings. The matrix is a concatenation of these transformations. For a default DC, or one which has been sent **msgDcIdentity**, the matrix is identity.

The LUC matrix represents transformations to an ideal, device-independent, first-quadrant coordinate system with device independent units established separately by the various **msgDcUnits** messages. You can set this matrix using **msgDcSetMatrixLUC**.

If you need to control a complex pipeline of transformations, you can save and restore the LUC matrix instead of sending the various scale/rotate/transform messages. You can also use the matrix manipulation functions in \PENPOINT\SDK\INC\GEO.H to modify this matrix directly.

Sending Window Messages to Drawing Contexts 26.6

Drawing contexts respond to all of the messages defined by **clsWin**. The drawing context passes the message on to the window to which it is bound. This lets you use the same device-independent coordinate system of your DC for window operations. For instance, **clsSysDrwCtx** responds to **msgWinDelta**, the **clsWin** message to position and/or resize a window. Since **clsSysDrwCtx** gives you an arbitrary coordinate system, it is inconvenient to have to convert DC coordinates into device coordinates in order to size and position windows. Instead, the DC behaves as if it were a window. You send it window messages but specify positions and sizes in DC coordinates (LUC); it translates the coordinates to logical window coordinates (LWC), and sends the same messages with the transformed positions and sizes to the window to which it is bound.

Another example of the tight coupling between DCs and windows is **msgDcFillWindow**. The DC determines the size of the window to which it is bound, fills that window then strokes its border.

Graphic State 26.7

Many elements in the drawing context state affect drawing operations. These elements, collectively called the graphic state, and the messages you send to set them are described below. Color and text, because they are complex topics, are covered separately.

Filling and Stroking 26.7.1

Some drawing operations create a closed geometric figure which is **stroked** with a line and is also filled. The line is drawn with the line characteristics specified in the DC, and the enclosed region is filled with the current fill pattern in the DC. (The stroke and the fill do not overlap—a pixel is never touched twice by one drawing primitive.) If the line pattern is null but the line width is non-zero, the fill pattern still avoids where the surrounding line would be. If you want an area without an edge that is completely filled, you must set the line width to zero.

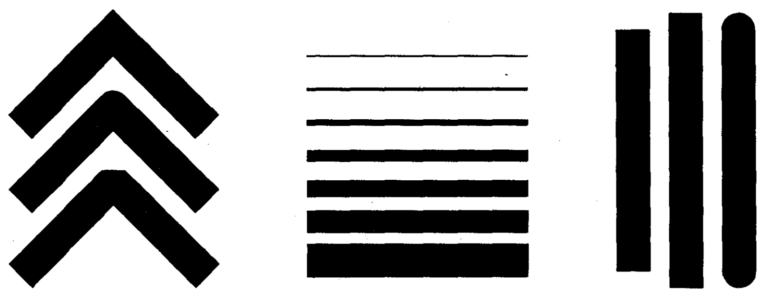
Line Styles 26.7.2

The DC specifies several characteristics for lines drawn:

- Thickness.
- End style.
- Miter limit.
- Rectangle radius.

You can also specify patterns for lines. You can tinker with the DrawingPaper™ application (on the SDK *Goodies* disk) to get a sense for the handling of these characteristics. Figure 26-1 shows some combinations.

Figure 26-1
Line Styles



If you want to get the current line state, send **msgDcGetLine**, specifying a pointer to a SYSDC_LINE structure as the message argument. **msgDcGetLine** returns the current line thickness; if all you want is the current line thickness, send **msgDcGetLine** with a message argument of **pNull**, and cast the return value from **ObjectCall** to a U16.

To change the line state, send **msgDcSetLine.** If you only want to set the line thickness you can send **msgDcSetLineThickness**. Both messages return the old line thickness.

Thickness and Modes

26.7.2.1

By default, line thickness is affected by the units and scale chosen. Thus the stroked outlines of figures and other lines get thicker as you scale up and thinner as you scale down. If the scaling is different in the x and y directions, the line thickness will be averaged. This is usually what you want, but not always:

- When you decrease the scale, at some point lines become invisible as their thickness drops below half a pixel (thickness rounds down to zero).
- As you change the scale, lines get fatter or thinner.

The former is bad when you want to keep lines from disappearing. The latter is bad when the lines should not change size, for example when drawing a grid or drawing annotation lines over a figure.

You can control both of these using the SysDC mode flags **sysDcHoldDetail** and **sysDcHoldLine.**

The **sysDcHoldDetail** mode flag stops lines from vanishing. You send **msgDcHoldLine** with message argument of **true** or **false.** Setting **sysDcHoldLine** using **msgDcSetMode** causes the current line thickness to be held so that it won't be affected by subsequent scaling and units changes. You can use this to set a particular line thickness that won't change as you scale your picture.

Sending **msgDcHoldLine** with an argument of **False** causes the window system to recompute the correct line thickness relative to the current scale and units.

Note that line thickness is independent of device pixel size, shape, and resolution. Note also that underline and strikeout lines drawn by the **clsSysDrwCtx** text messages are unaffected by these line modes.

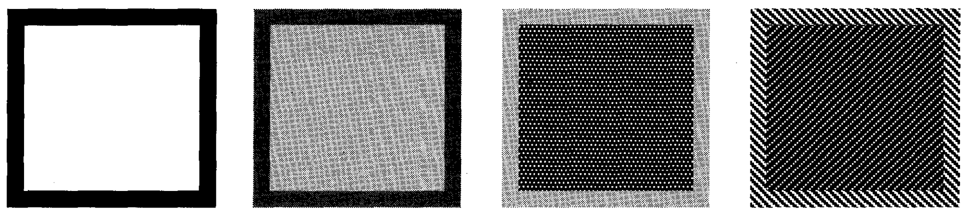
Line and Fill Patterns

26.7.3

PenPoint does not currently support the creation of custom fill patterns.

The DC specifies a pattern for both lines and fills. The messages **msgDcSet-LinePat, msgDcGetLinePat, msgDcSetFillPat,** and **msgDcGetFillPat** all take a SYSDC_PATTERN. This is a U16 which specifies a pattern mixing the foreground and background colors. The pattern determines which pixels will be set to the foreground color and which will be set to the background color. There are many predefined patterns of foreground and background in sysgraf.h, some set on the diagonal. The following screen shot shows some combinations.

Figure 26-2
Fill and Pattern Styles



Fill Pattern Alignment

26.7.4

ImagePoint uses **tiling** to fill closed figures. In other words, it maintains a small rectangle, or **tile**, of the fill pattern and copies it again and again to fill an area. Each tile lines up with the tiles adjacent to it to create a seamless, repeating fill pattern. To calculate the origin of a tile in the fill, ImagePoint measures from the LUC origin in multiples of the tile width and height. That way, if your application scrolls by translating the LUC origin (as most applications do), the fill pattern alignment will move along with all the other rendered objects.

If you determine for some reason that your application needs to scroll by actually moving rendered figures relative to the LUC origin, then the fill pattern alignment will not move with the figures. The result is that the pattern alignment will remain stable relative to the LUC origin, but will change relative to the outlines of the filled figures. If you need to keep the pattern alignment stable relative to the figures, you can move the pattern alignment origin along with the figures with **msgDcAlignPattern**. This will tile the pattern relative to the LUC coordinate you specify, rather than to the LUC origin.

Determining Filled Areas

26.7.5

For a simple figure such as an ellipse, it is obvious what the filled area should be. However, with a complex irregular polygon of crossing lines, it is not so obvious. There are two ways to determine what falls inside and should be filled. The default for **clsSysDrwCtx** is even/odd fill, but you can set the **sysDcWindingFill** flag in SYSDC_MODE with **msgDcSetMode** to use a winding fill calculation.

Raster Operations

26.7.6

GO strongly discourages the use of the raster op facility. It is documented here for completeness.

clsSysDrwCtx departs from a true stencil/paint imaging model in that you can specify how new drawing operations combine with existing pixels. For any drawing operation, **clsSysDrwCtx** figures out the value of each affected pixel, and then in a separate step combines this value with the current value in that pixel. The way in which pixels combine is called the raster operation, or **raster op**. The default raster op is **sysDcRopCopy**, which replaces the destination pixel's value with the computed (source) value; this is what you would expect a painting operation to do.

Using **msgDcSetRop**, you can set the raster op to combine source and destination pixels in other ways. The possibilities are values of the enum SYSDC_ROP. They are named after the logical operations which they perform.

Dynamic Drawing 26.7.6.1

On displays more than one bit deep, it is difficult to predict graphic behavior with raster ops other than **sysDcRopCopy**. This difficulty makes raster op capabilities most useful for one-bit displays. The XOR raster op provides a non-destructive draw-erase sequence on a one-bit display, but is difficult to set up properly for displays deeper than one bit. Because the XOR behavior is very useful, PenPoint provides a **dynamic drawing** mechanism to achieve the XOR effect independent of display depth.

If you set the **sysDcDrawDynamic** flag in SYSDC_MODE, then the raster op is overridden to XOR **and** the foreground color is set up to XOR properly. This ensures that (if you draw figures using the foreground color) they will be visible no matter what is underneath; if you then repeat the same drawing messages, your drawing will disappear and leave the original pixel values restored. This means you don't have to save the contents of pixels when you draw over them; the only drawback is that colors drawn over others will be different (e.g. black lines on a black background are inverted). If you want to draw dynamically, use the **sysDcDrawDynamic** flag instead of only setting the raster op to XOR.

You can also set the **sysDcDrawFast** mode flag to reduce the time it takes to draw. This gives up certain ImagePoint features such as thick lines, patterns, and so on, in exchange for greater drawing speed. The precise set of features given up in **sysDcDrawFast** mode is device-dependent.

Drawing Operations 26.8

The actual set of drawing messages is quite small. It is by manipulating the DC state that you can achieve a wide variety of effects. There are two kinds of figures, open and closed.

Open Figures 26.8.1

Open figures are made up of lines drawn with the line pattern and line attributes.

msgDcDrawPolyline draws a line made up of multiple segments. It takes a pointer to a SYSDC_POLYLINE, in which you specify a pointer to an array of XY32 points (**points**) and the number of points in the array (**count**).

msgDcDrawBezier draws a single Bezier curve through four control points. It takes a pointer to an array of four XY32 points.

msgDcDrawArcRays draws a single arc of an ellipse. It takes a pointer to a SYSDC_ARC_RAYS, in which you specify the enclosing rectangle of the ellipse, and two points. The arc drawn is the portion of the ellipse demarcated by rays from the center of the ellipse to the two points.

Closed Figures 26.8.2

These are drawn with a line, and filled. You can draw only the line by setting the fill pattern to **sysDcPatNil** (or by having a transparent fill pattern). You can fill without outlining by setting the line width to 0.

msgDcDrawRectangle draws a rectangle. It takes a pointer to a RECT32 which specifies the rectangle. You can change the **radius** in the line style to a non-zero value to get a rounded rectangle.

Note that the lines of a rectangle have thickness. **msgDcDrawRectangle** touches every screen pixel touched by the rectangle's coordinates in LUC. Contrast this to **msgWinDirtyRect**, which simply rounds the LUC coordinates to the nearest pixel. This can sometimes result in **msgWinDirtyRect** dirtying a rectangle that is smaller than the rectangle **msgDcDrawRectangle** draws, even when the specified coordinates are the same.

One way to avoid rectangle rounding problems is to convert LUC to LWC for **msgWinDirtyRect** coordinates, then to increase the size of the rectangle by one pixel in each direction.

msgDcDrawEllipse draws an ellipse. It takes a pointer to a RECT32 which specifies a rectangle enclosing the ellipse.

For both **msgDcDrawRectangle** and **msgDcDrawEllipse**, if the line thickness is non-zero, half of the line will fall outside the rectangle.

msgDcDrawPolygon draws a filled polygon. It takes a P_SYSDC_POLYGON, which is the same structure as the P_SYSDC_POLYLINE described above. It closes the polygon for you.

msgDcDrawSectorRays takes the same P_SYSDC_ARC_RAYS message arguments structure as **msgDcDrawArcRays**, and computes the arc of the ellipse edge to draw in the same manner. It creates a filled pie wedge shape by drawing lines to the center of the ellipse from the end points of the arc.

msgDcDrawChordRays takes the same P_SYSDC_ARC_RAYS message arguments structure as **msgDcDrawSectorRays**, and computes the arc of the ellipse edge to draw in the same manner. It creates a filled shape by drawing a line between the end points of the arc.

Filling a Window 26.8.3

msgDcFillWindow draws a rectangle exactly the same size as a window. If the line thickness is greater than zero, the lines will fall half within and half outside of the window. Thus, if you wanted to get a three pixel border around your window using this message, you must set the line width in the DC to six (assuming you sent **msgDcUnitsDevice** to set LUC to pixels).

Color 26.9

Class **clsSysDrwCtx** draws with a foreground/background color metaphor. Most drawing occurs in the foreground color, a few drawing operations draw in the foreground and background colors simultaneously. The background color can be transparent.

There are two ways to choose colors; as RGB (red, green, and blue) values, or as colors in a hardware-dependent palette. The former style is the default and is compatible with printers and future displays.

RGB Color Values 26.9.1

You can set the foreground and background colors to any color using **msgDcSetForegroundRGB** and **msgDcSetBackgroundRGB**; there are equivalent messages to get the colors. These take a pointer to a SYSDC_RGB structure specifying **red**, **green**, **blue**, and **transparency** values between zero and 255. The higher the value, the brighter the color component. ImagePoint will find the closest available color on the display device. The colors are automatically recalculated if you connect the DC to a different device.

Transparency can have only the extreme values of zero and 255. Use a **transparency** of 0 for opaque colors; a **transparency** of 255 leads to a transparent color (the **red**, **green**, and **blue** values are ignored). You cannot assign transparency to the foreground color.

The macro **SysDcGrayRGB** creates a SYSDC_RGB value for an opaque shade of gray from a single gray value.

Palette Colors 26.9.2

There is a separate mechanism to select a particular palette index, using **msgDcSetForegroundColor** and **msgDcSetBackgroundColor**. These take a 16-bit SYSDC_COLOR. On a four-bit display, all requested colors will map to the following predefined colors: black, white, light gray and dark gray (**sysDcInkBlack**, **sysDcInkWhite**, **sysDcInkGray33** and **sysDcInkGray66**). There is also **sysDcInkTransparent** which stops the background color from painting anything (the foreground color cannot be transparent).

Palette colors are hardware-dependent. You should use RGB color specifications.

Inverting Colors 26.9.3

msgDcInvertColors exchanges the foreground and background colors. This works whether colors are specified as RGB or palette colors. If the background is transparent, **msgDcInvertColors** will cause an error.

Color Compatibility 26.9.3.1

Using RGB values to specify colors is compatible with printers. If you bind your DC to a different device, such as a printer, the DC will automatically recompute the closest match for the current foreground and background RGB values.

Using palette colors is marginally faster than specifying RGB values, but it is highly device-dependent. It is likely on a printer that the palette index of, say, black will not be zero. If you need to change between different foreground and background colors frequently, you can use **msgDcMatchRGB** to return the SYSDC_COLOR palette indices which best match the RGB values you want to use, and then use **msgDcSetForegroundColor** and **msgDcSetBackgroundColor** to switch colors. So long as you redo the matching when you bind the DC to a different device, this should be compatible with any printer.

Planes 26.9.4

A display device may support several bitmap planes in hardware. However, to support certain special effects a DC is normally limited to drawing into a subset of the hardware planes.

The DC is limited to drawing in certain planes by the **plane mask**. It is possible to change the planes you draw in by altering the plane mask, although you should generally avoid doing so because it can result in device-dependent code. **msgDcPlaneNormal** sets the plane mask to the normal drawing plane(s); this is the default.

The Pen Plane 26.9.4.1

msgDcPlanePen sets the plane mask to the plane(s) used for pen ink. This **pen plane** is the plane(s) where pen ink is usually dribbled by the pen tracking software. It is called the **acetate layer** because it acts behaves like a transparent layer of acetate on which the pen tracking software lays down **dribbles** of ink as the user moves the pen, then erases the ink.

You should avoid using the the pen plane unless your window has ink dribbling disabled (**inputInk** in its input flags). Otherwise your drawing in it will conflict with pen tracking. Even so, the pen tracking software in the input system uses the pen plane extensively. It will dribble ink in your window if the user starts writing with the pen tip down in another window which does enable pen tracking, and it will frequently erase the entire pen plane. As a general rule, it is best to adhere to the default of **msgDcPlaneNormal** unless you have compelling reasons not to.

Other Planes 26.9.4.2

msgDcSetPlaneMask gives you precise control over which planes which will be affected by drawing. This takes a SYSDC_PLANE_MASK (an unsigned number) as its argument. Each bit in the plane mask enables a particular plane. If you disable all planes (null value), no drawing takes place.

msgDcPlaneNormal, **msgDcPlanePen**, and **msgDcSetPlaneMask** all return the current plane mask (instead of STATUS) if they succeed.

Manipulating planes is inherently device-dependent, and may cause problems when you port to other PenPoint computers. Not all PenPoint machines will have the same number of planes or plane group divisions.

Sampled Images 26.10

Most ImagePoint drawing operations are device- and resolution-independent. You send a message to draw an idealized polyline, or filled ellipse, or text, and ImagePoint figures out which pixels to turn on in the destination window.

However, sometimes you have to deal with images which have already been broken down into pixels, such as scanner output. Or, you may want to work with pixels for performance reasons or to get the best visual appearance at low resolution. Such images are called **sampled images** rather than pixel images because the image may not be stored as a set of pixel values, but in some other format which produces a set of sample values.

ImagePoint provides several messages which deal with images made of samples.

msgDcDrawImage reduces samples which you supply to gray values and renders the image in shades of gray, without regard for the current foreground and background colors.

msgDcDrawImageMask reduces the samples which you supply to a bitmap of ones and zeros, which it renders in the current foreground and background colors.

msgDcCacheImage renders an image into a chunk of memory so that it can later be quickly put on-screen.

msgDcCopyImage copies a cached image into a window.

Related Messages

ImagePoint also has messages to copy pixels from one part of a window to another, described in Chapter 23, The Window Class.

Another technique to boost performance is to draw into an off-screen window, then copy pixels from this onto a visible window. Off-screen windows live on **image devices**, which are described in Chapter 24, Window Device Classes.

Sampled Image Operator 26.10.1

The image operator **msgDcDrawImage** draws an image from sampled image data (pixel values). You can use this to draw pixelmaps in windows. The TIFF object (**clsTiff**) uses **msgDcDrawImage** to draw TIFF images on screen. **msgDcDrawImage** takes a pointer to a SYSDC_IMAGE_INFO structure as its message arguments. In this you specify:

dstRect the size and position of the destination image.

srcSize the number of source samples.

callback an optional function or object to supply samples one row at a time.

pBuffer a pointer to the sample data.

pClientData an optional pointer to client data to keep track of state if you use callbacks.

flags various bit flags, described below.

msgDcDrawImage can draw images from sample data at different resolutions and different numbers of bits per sample than the destination. Thus you can scale a sampled image to fill an area. The destination can either be a rectangle (**dstRect**) or the entire window (set **sysDcImageFillWindow** in **flags**).

For example, to display an image from 8-bit samples, you would set **sysDcImage8BPS** in **flags**, and pass data, one byte (eight bits) per sample, in which 0 represents black, and 255 represents white.

Filter 26.10.1.1

The **filter** flag controls how **msgDcDrawImage** filters the source samples when reducing the size of the image. The possible values are:

sysDcImageNoFilter no filter, very low quality.

sysDcImageLoFilte faster than sysDcImageHiFilter, but lower quality.

sysDcImageHiFilter high-quality filter.

Use **sysDcImageHiFilter** for the most part. **sysDcImageNoFilter** favors speed over fidelity to the original.

Run-Length Encoding 26.10.1.2

Black and white (1 bit per sample) sampled images can be passed in a simple run-length encoded format to save space (**sysDcImageRunLength**). This encodes runs of black or white pixels, which usually results in space savings. Patterns of alternating black and white pixels may be larger when run-length encoded. **msgDcDrawImage** always converts black and white images to run-length encoding internally, so run-length encoding is always the fastest format to use for black and white images.

Encoding Format

The high bit of each byte indicates whether the run is black or white (0 is black, 1 is white). The other 7 bits is a count of the number of samples of that color. For example, a run of 300 white pixels would be represented by the hexadecimal values FF FF AC (FF hex=128 white, FF hex=128 white, AC hex=44 white). The count is only for the current line—runs of samples don't continue onto the next line.

Drawing 26.10.1.3

Sampled image drawing ignores the raster op, and the foreground and background colors. It looks directly at the windowing device's palette to figure out what to put in each pixel in the destination window to generate colors matching those in the image. It assumes normal drawing planes.

Call Backs 26.10.1.4

You can either supply all the samples in **pBuffer**, or you can have **msgDcDrawImage** call you back to supply the samples. In the latter case you can either have it call a function you supply (set **sysDcImageCallBack**), or send **msgDcGetSrcRow** to an object (set **sysDcImageCallObject**). ImagePoint will ask your function or object to supply the next row of samples by passing it the SYSDC_IMAGE_INFO structure. Your function or object passes back the samples in **pBuffer**; it can keep track of its state in **pClientData**. If **pBuffer** is **null**, that means that the sampled image operator does not in fact need the next line of samples.

Rendering Colors 26.10.1.5

msgDcDrawImage assumes that input sample values from 0 to the maximum sample value map to shades of gray increasing linearly from black to white. It ignores the current foreground and background colors when rendering, using only shades of gray. **msgDcDrawImageMask**, on the other hand, reduces the samples to ones and zeros. By default, **msgDcDrawImageMask** renders ones in the current foreground color and zeros in the current background color. If you set the **sysDcPolarityFalse** flag in the SYS_DC_IMAGE_INFO argument, **msgDcDrawImageMask** reverses its default color scheme, rendering ones in the current background color and zeros in the current foreground color.

Image Model 26.10.1.6

The representation of pixelmaps for sample image data is similar to what Postscript calls an image or a image mask. This is the representation that you should use to import and represent pixel images, and to draw small images (such as icons) on-screen. However, large areas of pixels in this representation cannot be rendered quickly. To create and manipulate large pixelmaps, you should create an image device and maintain windows in its off-screen memory..

Cached Images 26.10.2

When you use **msgDcDrawImage** to draw sampled images on-screen, ImagePoint handles the current LUC transformations, different device resolutions, different pixel aspect ratios, different number of planes, dithering, etc. **msgDcDrawImage** is powerful (see the Fax Viewer), but it's somewhat slow (see the Fax Viewer). If you need to draw a sampled image repeatedly on the same device at the same scale, what you would like to do is go through all these transformations once to arrive at the desired pixelmap, and then copy this pixelmap to the screen.

ImagePoint supports this. You use **msgDcCacheImage** to load a sampled image into a pixelmap in advance. The resulting pixelmap is called a **cached image**. You use **msgDcCopyImage** to quickly copy the pixels in the cached image to a window. **msgDcCopyImage** ignores most transformation and device issues and puts the pixels in a cached image straight into the DC's window. You can think of

msgDcCacheImage as converting a sampled image which draws slowly into a cached image which draws fast.

Cache is somewhat of a misnomer. There is no cache of these images, each is simply allocated by ImagePoint and it is up to the client to manage each one. In other words, it is up to you to cache your images.

A cached image is a rectangular pixelmap, but it can maintain an associated **mask** which controls which parts of the image appear. This is used for icons and cursors, which do not have rectangular appearances. A cached image also has a **hot spot**, which specifies the origin of the image. The move icon uses the hot spot to appear with its center over the pen tip.

The Bitmap Editor creates bitmaps which you can load as cached images. It is described in the *PenPoint Development Tools* volume.

Creating Cached Images 26.10.2.1

msgDcCacheImage creates a cached image from the sampled image you specify. It takes a SYSDC_CACHE_IMAGE structure for its message arguments. In this you specify:

Image an array of two SYSDC_IMAGE_INFO structures, one for the image and one for its optional mask.

hasMask a Boolean indicating if the image has a mask.

hotSpot the hot spot's coordinates relative to the lower-left of the image.

pCache ImagePoint passes back a pointer to the cached image.

The **image** array contains the information for an image, and if **hasMask** is **true**, the information for the image's mask as well. **msgDcCacheImage** shares SYSDC_IMAGE_INFO with **msgDcDrawImage**.

ImagePoint renders the sampled image into a pixelmap which it allocates. The pixelmap is compatible with the windowing device of the window to which the DC is bound. ImagePoint uses **msgDcDrawImage** to generate the image, so the sampled image is scaled and sampled. The **hotSpot** is interpreted in LUC at this point.

Drawing a Cached Image 26.10.2.2

To get the cached image to appear in a window, send **msgDcCopyImage**. This takes a pointer to a SYS_DC_COPY_IMAGE structure for its message arguments. In this you specify:

xy the location in LUC where the cached image's hot spot should be drawn.

pCache a pointer to the cached image.

pCache is the same pointer passed back from **msgDcCacheImage**. ImagePoint draws the cached image so that its **hotSpot** is at **xy** in LUC.

Mask

The mask controls which pixels in the destination are affected. Where pixels in the mask are zero (black), the pixels in the destination are not affected. Only where pixels in the mask are 1 (white) does something appear. If there is no mask, the entire pixelmap of the cached image appears. Of course, the drawing is still affected by the current update region and clipping region.

As with other sampled image operations, **msgDcCopyImage** ignores the current foreground and background colors, and current raster op.

Invalidating a Cached Image 26.10.2.3

Cached images are valid for the current windowing device. When you create a cached image with **msgDcCacheImage**, the current LUC, windowing device pixel aspect ratio, orientation, plane depth, etc. are taken into account. It is up to you to detect that the windowing device has changed (for example, the user changes from portrait to landscape) and to free (with **OSHeapBlockFree()**) and then recreate the cached image. Also, if your LUC transformation changes, and you want the cached image to scale, you should free and re-create it.

Cached Images vs Image Devices 26.10.2.4

The only thing you can render into a cached image is a sampled image. If you want to draw other types of figures (text, for example) into an off-screen image, you must use an image device. If all you want to do is put some sampled pixels on the screen, you can use cached images.

Related Classes 26.10.2.5

clsBitmap stores samples; it includes a message to load a cache from its information. **clsTiff** is an object you associated with a sampled image in a TIFF file; you can send it a message to draw its contents. See Chapter 28, Bitmaps and TIFFs for more information on **clsBitmap** and **clsTiff**.

Printing 26.11

Printers are represented as objects of **clsWinDev** and are similar to **theScreen** device. Drawing on a printer can be exactly the same as drawing on-screen.

Since printers are **clsWinDev** devices, you can either draw on the root window of the printer (the page), or you can create child windows on it. The support for windows on printing devices may seem curious. It exists because windows can be used as drawing tools (viewports), thus, it is possible to create images using several windows that could not be created otherwise. While printer windows can be moved and resized, there is no real point in doing so beyond the usual layout episode.

Application Printing 26.11.1

When the user prints one of your application's documents, a copy of the documented will be created in the Outbox in a queue for the current printer. When the PenPoint computer is connected to that printer, the document will be started up with its application **mainWin** inserted as a child window on the printer.

The printing framework will send the application **msgWinRepaint**. If your application creates a standard set of windows within its frame and paints them in a device-independent way in response to **msgWinRepaint**, then it should print its window on the printer without any further work. The same arrangement of windows will appear on the page as on the screen. Because of memory constraints, the print device may ask each window to paint itself several times in order to produce the page in a series of bands; thus like all windows, printer windows must respond to **msgWinRepaint** on demand.

If you want to print a window differently on the printer, your window subclass can intercept **msgWinStartPage**. This is sent to each window advising it that it is on a printer (as opposed to the screen) and that printing is about to commence. Your window class could set an instance variable to **false** at creation, set it to **true** if it receives **msgWinStartPage**, and when responding to **msgWinRepaint**, it would check this variable and modify drawing accordingly.

ImagePoint Font Support 26.12

Chapter 25, Graphics Concepts, describes some of the features of the ImagePoint font model. This section explains the programming interface to the model.

How You Use the API 26.12.1

Hello World is a sample program that draws text in its window. It is described in the *PenPoint Application Writing Guide*; its source code is in the SDK sample code directory \PENPOINT\SDK\SAMPLE\HELLO.

Here are the steps involved in drawing text:

1 Send **msgDcOpenFont** to your DC, specifying the attributes of the font you want to use (Modern Roman Bold Italic, for example).

2 Send **msgDcScaleFont** to your DC to scale the font to your desired size.

3 Send **msgDcDrawText** to your DC to output a text string.

Text and the Drawing Context 26.12.2

Just as your drawing context includes the current line width, line style, fill pattern, etc., it also includes the current font and current font scale. When you save and restore the graphics state with **msgDcPush** and **msgDcPop**, you save and restore this font information. If all you are doing is changing to a different font, you can use **msgDcPushFont** and **msgDcPopFont** to save and restore only the font information.

What is a Font? 26.12.3

Fonts exist as files produced by the PenPoint font editor FEDIT. At cold-boot time PenPoint loads the fonts in \\BOOT\PENPOINT\FONT into memory; later on the user can install and remove fonts using the Installer. Thus different computers have different sets of fonts installed.

Font IDs and Font Names 26.12.3.1

Each font file contains the instructions to create a specific font—a typeface with a particular look. Each font has a unique 16-bit ID which GO assigns, so that a font ID refers to the same font on all PenPoint computers for all time.

The font ID is a condensed version of a four-character string used to identify fonts. The function **SysDcFontID** performs this algorigthm, returning a 16-bit font ID of the four-character string you pass it. Conversely, **SysDcFontString** takes a pointer to a buffer and a 16-bit font ID, and passes back a null-terminated string.

As an example of a short font name, the font string of GO's Sans Serif is HE55. By convention, the DOS font file name is this four-character string with the extension .PCK. There is no length checking on the buffer; it must be at least 5 bytes long to hold the string.

The user-visible name of the font is the PenPoint file name of the font; in this example, SANS SERIF (URW).

Font Attributes 26.12.3.2

Each font has attributes which indicate its visual appearance. These include:

group	the typeface group (Venetian, Old style, Transitional, Script, etc.).
weight	the font weight (light, normal, bold, extra-bold, etc.).
aspect	the font aspect ratio (condensed, normal, extended, etc.).
angle	the font obliqueness (whether it is italic or not).

The idea is that the font attributes describe the style of the font in great detail. Note that, unlike in some other window systems, the size of the font is not part of its attributes.

Opening a Font 26.12.4

You might expect to open a font simply by supplying its ID. However, different PenPoint computers will have different fonts on them, and users can load and remove fonts. There's no guarantee that the font ID which you want to use exists on a computer.

So you also specify a desired set of font attributes, and ImagePoint will pick the closest font matching those attributes. It can also *synthesize* some font attributes from an existing font. For example, it can create a bold or italic version of a font.

You specify both a font ID and the attributes you desire at the same time that you send **msgDcOpenFont**. If the font ID you request exists on the computer, ImagePoint will use it (even if it doesn't remotely match the attributes you've supplied). If the font ID is not available, ImagePoint finds the font which matches most closely the attributes which you specified.

In both cases, ImagePoint then transforms the font it's using to fit the attributes you have given. If the attributes match those of the font, this step doesn't involve any work.

This scheme guarantees that the user will get the closest match possible, no matter what fonts are installed on his or her PenPoint computer. However, it has some important programming implications which you need to to be aware of:

- If the font ID you request is available and you supply font attributes which do not match it, ImagePoint will alter the font to try to fit the attributes.
- If the font ID is not installed, ImagePoint does not know what kind of font it is, so you must always supply the group attribute.

If you're not too concerned about which font to use, you can leave the font ID field in SYSDC_FONT_METRICS as 0 and only specify the group. ImagePoint will find (and if necessary, forge) a font close to what you want. The essential point is, you must always supply font attributes.

User Choice of Font 26.12.4.1

You can avoid the difficulty of specifying a font altogether by letting the user pick fonts. This also avoids limiting your application to a fixed set of fonts. The UI Toolkit provides two components for this purpose, font list boxes and pop-up font choices. Both of these display descriptive names of the installed fonts. You can control whether they display non-alphanumeric fonts such as the GO symbol and gesture fonts. See *Part 4: UI Toolkit* for more information.

Font Enumeration 26.12.4.2

You can find out yourself what fonts are installed by querying the installed font manager, described in *Part 12: Installation.*

Storing Fonts 26.12.4.3

The combined font ID (a U16) and attributes (a SYSDC_FONT_ATTR structure) form a 32-bit quantity (a SYSDC_FONT_SPEC). You can file this with text to indicate its formatting, and on subsequent occasions just pass the stored value to **msgDcOpenFont**; you are guaranteed to get the best match possible.

Font IDs and Font Strings 26.12.4.4

Font ID numbers are not random. A font ID is an encoded version of a four-character font string, such as HE55. The two letters identify the font family, while the ending two digits indicate the type of the font (extra-bold, oblique, symbol, etc.). Unless you are creating fonts with GO's font editor, you don't need to know the details of the font encoding scheme. Always refer to a font in source code by its four-character name, and use **SysDcFontId** to convert this to the **id** required by **msgDcOpenFont**.

Font Attributes 26.12.5

The attributes of a font are in a SYSDC_FONT_ATTR structure. This contains:

group	the type of the font.
weight	how bold the font is.
aspect	how wide or tall the characters in it appear.
angle	whether the font is italic.
monospaced	whether the font is monospaced.
encoding	the type of encoding map to use.

Group 26.12.6

The group of a font is its broad classification; it categorizes a font according to whether it looks like a newspaper headline, or writing in a book, or handwriting, etc. The font group names are:

sysDcGroupDefault
sysDcGroupUserInput
sysDcGroupVenetian
sysDcGroupOldStyle
sysDcGroupTransitional
sysDcGroupModernRoman
sysDcGroupEgyptian
sysDcGroupSansSerif
sysDcGroupDisplayRoman
sysDcGroupScript
sysDcGroupGraphic
sysDcGroupTypewriter

Many monospace fonts are part of the **sysDcGroupTypewriter** category, irrespective of the appearance of their glyphs.

Default Font 26.12.6.1

If you want to use the same font that is used in the Notebook, you can specify the **attr.group** in the SYSDC_FONT_SPEC as **sysDcGroupDefault**. This is a pseudo-group which the font machinery maps to the current system font. Similarly, **sysDcGroupUserInput** is a group which maps to the font for user input. Note that the binding is set at **msgDcFontOpen**. Thus if the system font changes, your DC will still be bound to the old system font until another **msgDcFontOpen**. Applications which want to respond to changes in the default font need to observe the system preferences (**theSystemPreferences**).

The system and user input fonts and their sizes are system preferences which the user can change using the Preferences application on the Bookshelf. Thus you can also find out the system font by sending **msgResReadID** to **theSystemPreferences**. This returns a SYSDC_FONT_SPEC which you pass to **msgDcFontOpen**.

Weight

The weight of a font indicates the thickness of its characters' strokes. The possible values are:

sysDcWeightLight
sysDcWeightNormal
sysDcWeightBold
sysDcWeightExtraBold

Aspect Ratio

The aspect ratio of a font indicates the height to width ratio of the font; roughly speaking, this determines how tall or wide the characters in it appear. The possible values are:

sysDcAspectCondensed
sysDcAspectNormal
sysDcAspectExtended

Other Attributes

An italic font often has slanted (oblique) characters.

The characters in a monospaced font all have the same width.

Common Fonts 26.12.6.2

There is no default font set in PenPoint. The user can always remove or add fonts. However, there is a standard set of fonts on the PenPoint boot disks:

Table 26-4
Common PenPoint Fonts

PenPoint Name	Short Name	Group
User-Visible Fonts		
Courier	CR65	sysDcGroupTypewriter
Sans Serif	HE55	sysDcGroupSansSerif
Roman	TR55	sysDcGroupTransitional
System Fonts		
Gestures	GS80	none applicable
Dingbats	PI80	sysDcGroupGraphic
Symbols	GO55	none applicable

All the user fonts have normal **weights**, and **aspects**, except that Courier is **sysDcWeightBold** and is monospace.

Encoding

26.12.6.3

Encoding is not a property of the font, it's an indication to ImagePoint of how you are going to use the font. The encoding maps the 8-bit characters in your text strings to the glyphs in the font. In one encoding, character 165 in a text string is the Yen currency symbol (¥), in another it is the Ntilde symbol (Ñ).

PenPoint is migrating to the Unicode 16-bit character encoding scheme. When the Unicode migration is complete in PenPoint 2.0, there will be a single encoding for all the glyphs in use around the world.

The possible font encodings are:

sysDcEncodeLinear
sysDcEncodeAdobeStandard
sysDcEncodeAdobeSymbol
sysDcEncodeIBM850
sysDcEncodeGoSystem
sysDcEncodeHWX850
sysDcEncodeUnicode

Some of the font encodings are documented in the Font Editor chapter of *PenPoint Development Tools* manual.

Transforming Fonts

26.12.6.4

ImagePoint can transform an existing font as necessary to match most of the requested attributes you pass in to **msgDcFontOpen**. It will thicken a font's characters to create a boldface **weight** font, expand or condense a font's characters and character spacing to the requested **aspect**, slant a font's characters if **italic** is set, and make all the font's character widths the same if **monospaced** is set.

ImagePoint will not attempt to change a font so that its appearance is more like the **group** specified.

The **encoding** of a font is not part of its definition, it is just something you specify when you open the font. ImagePoint always honors it.

Font Metrics

26.12.7

After opening a font, you can draw text with it. Often to do this you need to know additional information about the font, such as how wide a space is in it, how much its characters go over or under the base line, and so on. **msgDcGetFontMetrics** returns information about the current font in LUC in a SYSDC_FONT_METRICS structure.

SYSDC_FONT_METRICS contains a SYSDC_FONT_ATTR structure holding the font ID and attributes of the font that ImagePoint actually uses to honor your **msgDcFontOpen** request. If you asked for certain attributes, and ImagePoint had to use another font or synthesize the font, the font attributes returned are the natural attributes of the font it's using. For example, if you ask for Roman condensed (**sysDcAspectCondensed**), and only Roman normal is installed, then the **aspect** attribute passed back by **msgDcGetFontMetrics** will be **sysDcAspectNormal**, even though ImagePoint will synthesize a condensed font. SYSDC_FONT_METRICS also contains additional information:

name the name of the font (up to 80 characters).

spaceWidth the width of a space in the font.

underThickness the best thickness to use for an underline.

underPos the best distance from the baseline to use for an underline.

xPos the height of a lowercase x in the font.

ascenderPos the ascender height for the font.

descenderPos the descender depth for the font.

em the em size for the font.

maxY the highest coordinate touched by any character in the font (relative to the baseline).

minY the lowest coordinate touched by any character in the font (relative to the baseline).

All the dimensions are passed back rounded to the nearest whole number in LUC. To do precise work with font metrics, you need to have small enough units and large enough font scale in effect. **msgDcUnitsTwips** is a good choice (a twip is one twentieth of a point).

Also, all the dimensions are for the synthesized font. To use the same example, if you ask for condensed and get a regular font, the character widths passed back will be the narrower ones which ImagePoint synthesizes.

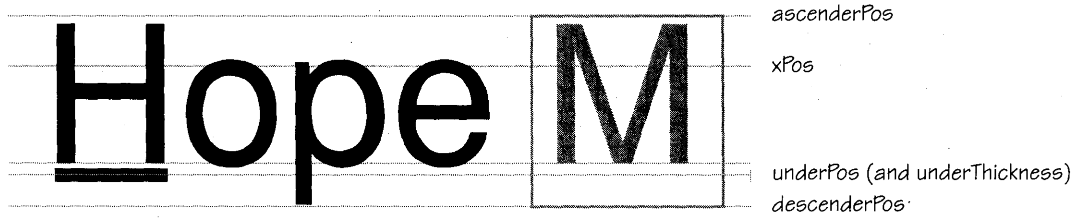
Name 26.12.7.1

This is the font identification for ownership and copyright purposes. It is not the name displayed to the user, that name is the PenPoint name of the font file.

Character Geometry 26.12.7.2

The rest of the parameters are best shown graphically.

Figure 26-3
Font Geometry



The values for these dimensions are for the current x and y scaling of the current font, and are in the current LUC (Logical Unit Coordinates) of your DC. Note that they are integers, hence are subject to gross round-off errors at small scales and coarse units.

descenderPos, **minY**, and **underPos** are **negative** numbers.

ascenderPos and **descenderPos** give the typographic line height. They indicate the guidelines the font designer used in designing the font (similar to **xHeight**). You might use these to draw a box around characters, or to adjust the gap between lines, or **leading**, with different fonts on them.

maxY and **minY** give the height of the tallest character and the depth of the deepest character in the font. You can use these to compute which lines of text fall in an update region in order to minimize repaint.

underPos and **underThickness** indicate the best position and thickness for underlines for characters. If you specify an underline when you draw text, ImagePoint positions and sizes it using this information.

Note that the locations of **xPos**, **ascenderPos**, and **descenderPos** are aesthetic judgements of the font designer, as are **underThickness** and **underPos**.

The **em** is a SIZE16 that indicates what the font is scaled to in the current LUC and font scale. In other words, if you scale a font to 18 and scale LUC by 2 and 3, **em.w** would be 36 and **em.y** would be 54. It's useful if you haven't been keeping track of your LUC transformations and font scale.

Ems and Text Widths

An em is a square whose sides are, roughly speaking, the distance from the lowest descender to the highest ascender in the font. This is often approximately the width of an M in the font, hence the name. Em size is the scale of the font: if the font is 14 point, then **em.h** and **em.w** are both 14 with a default DC. Thus when you open a font with a default DC, its **em.w** and **em.h** are both 1.

As a rule of thumb, the width of a string 20 characters long is about 10 em widths in many fonts. Ten characters are almost guaranteed to fit into a space 10 em-widths wide (or 80 layout units in the UI Toolkit).

Character Widths 26.12.7.3

The rules of thumb relating the em-width of a font to text widths are useful to figure out roughly how wide to make a text region, but if you really care you should add up individual character widths. **msgDcGetFontWidths** helps you do the former; it returns the widths of all 256 characters in the current font (based on the current encoding specified in the font attributes). These widths are the designer's guidelines for the visual widths of each character; it's possible for a character's pixels to extend beyond its widths (for example the top of an italic *T* might extend beyond its nominal width.

The character widths are constants and don't take into account how particular letter combinations look better closer or further apart than their nominal widths would indicate. Adjusting character combinations is called **kerning**. ImagePoint does not currently support automatic kerning.

msgDcGetFontWidths will not work well with future large character sets (such as Unicode), so it's better to use **msgDcMeasureText** or **msgDcGetCharMetrics**.

Character Metrics 26.12.8

You can get width information about particular characters in the current font by sending **msgDcGetCharMetrics**. This message takes a pointer to a SYSDC_CHAR_METRICS structure. You supply a pointer to a text string (**pText**), and the length of it (**len**). Note that the string can have nulls in it, since null may be a valid character. ImagePoint passes back a set of text extents (**pExtents**). An extent is a SYSDC_EXTENTS16 structure which gives the minimum and maximum x-y locations of each character (**min** and **max**, both XY16). The x and y coordinates are for each individual character relative to the origin—the characters aren't rendered next to each other.

Unlike **msgDcGetFontWidths**, which passes back the type designer's aesthetic sense of character widths, **msgDcGetCharMetrics** passes back the actual bounding box of each character. Thus it's possible for any of the coordinates (**min.x**, **max.x**, **min.y**, and **max.y**) to be positive or negative, depending on how the character is designed. For example, an italic *g* might be designed to run slightly underneath the character to its left.

Scaling a Font 26.12.9

When you open a font, ImagePoint sets it up so that the point size of the font (its **em height** is one unit in your DC's current logical unit coordinates (LUC). Hence the size of the current font is affected by the units and scaling of the DC.

msgDcScaleFont takes a SCALE as its argument. This is a pair of fixed point numbers. Fixed point math is explained in \PENPOINT\SDK\INC\GOMATH.H and in *Part 8: System Services*.

You send **msgDcScaleFont** to your DC to scale fonts separately from other drawing operations. For example, if you have sent **msgDcUnitsPoints** to set your DC's coordinates to points, and you then send **msgDcScaleFont** with **x** and **y** of 12, you will set the font size to be 12 points with a normal aspect ratio. If you change the DC scale with **msgDcScale**, the font size will be affected. The font scaling is concatenated with the DC scaling.

Moreover, **msgDcScaleFont** is cumulative. In the previous example, if you sent **msgDcScaleFont** a second time with x and y of 9, you would end up drawing 108-point characters, not 9-point characters.

The message **msgDcIdentityFont** resets the font matrix scale to the default of 1 unit in LUC. Note that **msgDcIdentity** changes LUC (and thereby the size of characters), but doesn't change the font scale itself.

If your scale is very small, obviously characters will be hard to read. Also, if you use radically different x and y scales for your LUC and you do not adjust for them with **msgDcScaleFont**, your text will appear stretched or squashed. Sometimes it's appropriate to maintain two drawing contexts; one for graphics and the other for pleasing text.

Drawing Text

26.12.10

ImagePoint fonts are outlines, but you can't stroke a single glyph outline or fill it with patterns as you can in PostScript.

You send **msgDcDrawText** to your DC to draw text. ImagePoint renders your text by filling the pixels of characters with the current foreground color, using the current raster op. You can set foreground color with **msgDcSetForegroundColor** (the default foreground color is **sysDcRGBBlack**). Characters are not filled with the current fill pattern, only the current foreground color.

msgDcDrawText takes a SYSDC_TEXT_OUTPUT structure as its message arguments. You must initialize the structure before drawing text.

```
typedef struct
{
  U16       alignChr;    // use sysDcAlignChr...
  U16       underline;   // use 0,1, or 2
  U16       strikeout;   // use 0 or 1
  P_U8      pText;
  U16       lenText;     // in (and out for measure)
  XY32      cp;          // in and out, where to place string
  COORD32   stop;        // used by msgDcMeasureText
  U16       spaceChar;   // code for space, usually 32
  COORD16   spaceExtra,  // added to width of space
            otherExtra;  // added to width of every char
} SYSDC_TEXT_OUTPUT, FAR * P_SYSDC_TEXT_OUTPUT;
```

msgDcDrawText draws the text pointed to by **pText** starting at the location **cp** in LUC. You can make the text appear underlined or thickly underlined by setting **underline**, and can make it appear struck out by setting **strikeout**. The size of the underline and strike-out rules comes from the font metrics. It is independent of the current line style in the DC. Spaces between underlined or stuck out words are underlined and struck out.

You specify the number of characters to draw in **lenText**. Characters are drawn from left to right with respect to LUC. You can can make text appear at an angle by rotating your DC. Characters can be null, so you must specify **lenText**.

cp is the starting point for the text.

alignChr determines where characters are positioned vertically relative to the origin specified in **cp**. The possible alignments are:

sysDcAlignChrTop align the **ascenderPos** of the font with the origin.

sysDcAlignChrCenter align the midpoint of the x height of the font (**xPos**) with the origin (this is not the same as half the height of an uppercase letter).

sysDcAlignChrBaseline align the baseline of the font on the origin.

sysDcAlignChrDescender align the **descenderPos** of the font on the origin.

The default alignment is **sysDcAlignChrBaseline**.

Characters in Text 26.12.10.1

Text is composed of encoded characters. The mapping from an encoded character to a glyph in the font is determined by the value you specified for the **encoding** field when you opened the current font. Most encodings have the same glyphs for the standard typewriter ASCII characters, but different encodings produce different glyphs for "control characters" and non-English characters.

PenPoint is migrating to the Unicode universal encoding standard. PenPoint 2.0 will use the 16-bit Unicode encoding standard for all characters in use around the world.

The space character has a width. Displaying a space advances the current point by the font's space width. There are no other carriage control codes in text. ASCII codes such as tab, newline, carriage return, and form feed may have characters in them, but none of them move the current position in any other way. Even character 0 may have a glyph (for example, the happy face in the IBM 850 encoding).

Spacing Text 26.12.11

ImagePoint uses the character widths in the font to determine how much to advance between characters. **otherExtra** is an additional amount of space which it inserts between each character. **spaceExtra** is an additional amount of space which it will add to the space character. You could use these to spread out or shrink lines of text to produce justified right margins; using **otherExtra** stretches out every character, while **spaceExtra** only stretches out the gaps between words.

Moreover, **spaceChar** indicates the character in **pText** to which **spaceExtra** will be added.

otherExtra and **spaceExtra** can be positive (to expand space) or negative (to tighten letter spacing).

Measuring Text 26.12.12

You can ask for the widths of the characters in the current font with **msgDcGetFontWidths** or **msgDcCharMetrics**, and compute the width of a text string using this. ImagePoint computes character locations for text strings in LUC units.

When you send **msgDcDrawText**, you pass in the starting point for the text in **cp**. Upon return, **cp** contains the location of the next character to draw. You can use this to determine more exactly the length of a string after you've drawn it.

If you want to compute the length of a string before drawing it, use **msgDcMeasureText**. This takes the same SYSDC_TEXT_OUTPUT message argument structure as **msgDcDrawText**. However, it draws nothing and only returns the new **cp** value.

Determining How Much Text Fits 26.12.13

A related problem to computing the width of text is computing how much text fits in a line. For **msgDcMeasureText**, you can supply a **stop** coordinate indicating the point beyond which text should not appear. This is in effect the right margin for the text. Upon return from sending **msgDcMeasureText** to your DC, **lenText** will indicate the offset of the last character which entirely fits in the space available. **cp** will be the ending coordinate of the part of the string up to **lenText** which does fit. You can then send **msgDcDrawText** with the original **cp** position and new **lenText** value, and know that the text will not overshoot the right margin.

msgDcMeasureText doesn't handle the space character specially; if you don't want spaces at the start of the new line, you must check yourself to see if the character(s) after the line break are spaces. **msgDcMeasureText** is identical to **msgDcDrawText** except that the former doesn't draw and the latter does not use the **stop** message argument.

Splicing Text 26.12.13.1

msgDrawText and **msgMeasureText** do not include the optional **otherExtra** spacing after the last character. This means that isolated lines of text will have cosmetically correct lengths, and also that underlines and strikeout lines will not extend beyond the last character. However, if you want to splice text together to make continuous runs of characters, use the equivalent messages **msgDcDrawTextRun** and **msgDcMeasureTextRun**. Text views use these when repainting so that they can redraw part of a line of text without leaving any gaps.

Finding a Glyph 26.12.14

When you issue a command to draw or measure text, ImagePoint has to find the glyphs. The meaning of the bytes in the text string depends on the font encoding you specified when you opened the font.

In total, all the encodings call for hundreds of different glyphs, far more than 256. All the standard glyphs have a well-known unique number, the same in all fonts. This allows a font to have all the glyphs in the standard encodings in it. Not all characters for each encoding are present in all fonts; for example, the copyright symbol is not present in the Roman font. However, ImagePoint will search in its system fonts for the missing characters.

PenPoint 2.0 will support Unicode, a single encoding standard that endcodes most alphabets in use around the world.

Font Search Path 26.12.14.1

ImagePoint searches for missing glyphs using a standard path. If it can't find the missing character, it tries to find it in Sans Serif, Courier, and Symbol. If it still can't find the character, it displays the missing symbol glyph (a square with a white diamond in it).

The font search mechanism is very useful. By selecting the appropriate encoding you can open a single font, draw text with glyphs that aren't in that font, and rely on the font machinery to find those characters.

It's also nice when you create your own font, since it only needs to contain the few characters you want to handle specially. The font machinery will find any characters missing from your font: they may not blend aesthetically with your font, but they won't be missing.

Metrics and Encoding

The font metrics passed back by **msgDcGetFontMetrics** do not take into account the sizes of characters which will be substituted from other fonts. For example, if you open Sans Serif using the **sysDcEncodeIBM850** encoding and ask for the font metrics, some of the characters will be very tall and deep on account of the line draw characters, but this won't be accounted for by the metrics because those characters are only available in a monospaced font.

However, **msgDcGetFontWidths** and **msgDcGetCharMetrics** do take into account the characters that are substituted from the font search path.

Loading the Font Cache 26.12.15

ImagePoint creates bitmaps of glyphs at the right size and with the right attributes from font outlines. After rendering a bitmap, the font machinery keeps the bitmap in a **font cache**.

The time it takes to create a bitmap from an outline is noticeable: the time to draw a character from the font cache is much smaller. If you want to get text to appear without delay, you can preload the characters in the font cache. For example, in a presentation program, you might be willing to have a delay between prepared images, but then want text to draw quickly onto the screen.

You do this by sending **msgDcPreloadText** to your DC. **msgDcPreloadText** takes the same SYSDC_TEXT_OUTPUT structure as **msgDcDrawText**. It prepares the text and loads it into the cache, but it doesn't render the characters (nor does it compute the new starting point). If the message arguments or **pText** are null, it preloads a default set of upper- and lowercase Latin characters.

If PenPoint runs low on memory, it discards the font cache. The font machinery will allocate a new font cache the next time it needs to render a character.

Bitmap Fonts 26.12.15.1

Some fonts also have bitmaps of characters for some low resolutions. If a bitmap is available at the right size, ImagePoint will use it instead of the outline. The font machinery still renders the bitmap into the cache.

You can use FEDIT, the PenPoint Font Editor, to add bitmaps to an outline file. You should not modify the built-in fonts. If you're interested in acquiring or modifying other commercial fonts for PenPoint, contact GO Developer Support for more information.

Improving Performance 26.12.16

Font State 26.12.16.1

If you need to switch between different fonts frequently, you can use **msgDcPushFont** and **msgDcPopFont**. These are similar to **msgDcPush** and **msgDcPop**, except they get and restore only the font state (current font and font scale). Open one font, establish the font scale, then store the font state by declaring a SYSDC_FONT_STATE structure and passing its address to **msgDcPushFont**. Repeat this for the other fonts and sizes needed, and then use **msgDcPopFont** to switch to a font. This is faster than sending **msgDcOpenFont**.

Chapter 27 / The Picture Segment Class

When you draw in a window, you send a stream of messages to its drawing context telling it what to draw. Often, to repaint or print your window's contents, you must send the same stream of messages. Picture segments are drawing contexts which remember the drawing messages they receive, thus saving you from much of the burden of redrawing. Picture segments also let you reorder or change their elements. You can store a picture segment for later use, and the same picture segment can be drawn into many different windows.

clsPicSeg inherits from **clsSysDrwCtx**. Thus you bind a picture segment to a window and draw in it exactly as you would with a DC. The picture segment stores certain drawing messages it receives.

The unbundled DrawingPaper™ application uses a component that uses a picture segment to store and redisplay graphic objects, and also to perform some editing operations. The Fax Viewer, another unbundled application, uses a picture segment to draw the FAX image and the user's notations. The FAX image itself in a separate TIFF file maintained by a separate TIFF object, which the picture segment asks to paint. Table 27-1 summarizes the messages **clsPicSeg** defines.

Table 27-1
clsPicSeg Messages

Message	Takes	Description
		Class Messages
msgNewDefaults	P_PIC_SEG_NEW	Initializes a PIC_SEG_NEW structure to default values.
msgNew	P_PIC_SEG_NEW	Creates a new picture segment.
		Attribute Messages
msgPicSegGetMetrics	P_PIC_SEG_METRICS	Passes back the metrics of the picture segment.
msgPicSegSetMetrics	P_PIC_SEG_METRICS	Sets the metrics of the picture segment.
msgPicSegSetFlags	S32	Sets the picture segment flags.
msgPicSegGetFlags	P_S32	Gets the picture segment flags.
msgPicSegDelta	P_PIC_SEG_GRAFIC	Changes the current grafic.
msgPicSegGetGrafic	P_PIC_SEG_GRAFIC	Gets the current grafic.
msgPicSegSetCurrent	S32	Sets the current grafic index.
msgPicSegGetCurrent	P_S32	Gets the index of the current grafic.
msgPicSegGetCount	P_S32	Gets the number of grafics in the picture segment.
msgPicSegSizeof	P_PIC_SEG_GRAFIC	Returns the size of the specified grafic's pData, in bytes.

continued

Table 27-1 (continued)

Message	Takes	Description
msgPicSegScaleUnits	MESSAGE	Scales all coordinates in the picture segment from the old units to the new units, then sets the units of the picture segment to the new units.
msgPicSegTransform	MAT	Transforms all coordinates in the picture segment database with the provided matrix.
		Drawing Messages
msgPicSegPaint	pNull	Redraws all of the grafics in the picture segment.
msgPicSegDrawSpline	P_PIC_SEG_SPLINE	Adds a spline grafic to the end of the picture segment display list and draws it by sending msgPicSegPaintObject.
msgPicSegDrawObject	P_PIC_SEG_OBJECT	Adds an arbitrary object to the picture segment display list and draws it by sending msgPicSegPaintObject.
msgPicSegPaintObject	P_PIC_SEG_PAINT_OBJECT	The picture segment sends this message to its grafics to cause them to draw themselves.
msgPicSegDrawGrafic	P_PIC_SEG_GRAFIC	Draws a specified grafic.
msgPicSegDrawGraficIndex	S32	Sets the current grafic index to the specified value and draws the grafic associated with the index.
msgPicSegDrawGraficList	P_PIC_SEG_LIST	Draws all the grafics referred to by the list.
msgPicSegAddGrafic	P_PIC_SEG_GRAFIC	Adds a grafic to the picture segment and draws the grafic.
msgPicSegErase	pNull	Deletes all grafics.
msgPicSegDelete	S32	Deletes the grafic having the specified index, and sends msgDestroy to the grafic object.
msgPicSegRemove	S32	Deletes a grafic, takes a grafic index. Does not send msgDestroy to the grafic object.
msgPicSegMakeInvisible	S32	Makes the given grafic invisible.
msgPicSegMakeVisible	S32	Makes the given grafic visible.
msgPicSegCopy	OBJECT	Copies the contents of the specified picture segment to self.
msgPicSegHitTest	P_PIC_SEG_HIT_LIST	Passes back the index of the first grafic that intersects a specified rectangle.
msgPicSegChangeOrder	S32	Changes the order of the grafics in the display, moving the current grafic to the given index.

Developer's Quick Start 27.1

You create a picture segment much as you create a drawing context, and bind it to a window as usual using **msgDcSetWindow**. The picture segment's own **msgNew** arguments are flags indicating if the picture segment should paint and if it should store (both are set by default).

Thereafter, just send ordinary **clsSysDrwCtx** messages to the picture segment. They will appear in the window it is bound to, and the picture segment will remember them. When you wish to paint or repaint the picture segment's window, send it **msgWinBeginPaint** or **msgWinBeginRepaint** as appropriate, and then send **msgPicSegPaint** to the picture segment.

Grafics

27.2

A picture segment stores each figure drawing message sent to as a **grafic**. A grafic is a compressed representation of some drawing operation which actually puts something on the screen. Each grafic is composed of an **opcode** identifying the drawing operation, and a pointer to the **data** required by that drawing operation. Different drawing operations require different data, just as different DC messages take different message arguments. Here's the structure of a PIC_SEG_GRAFIC:

```
typedef struct {
    OP_CODE         opCode;
    P_UNKNOWN       pData;
}PIC_SEG_GRAFIC, FAR * P_PIC_SEG_GRAFIC;
```

Since drawing operations correspond to DC messages, for the most part there is a one-to-one correspondence between DC drawing messages and grafics. As a picture segment receives DC drawing messages, it stores them as grafics and passes them to its ancestor (so that they appear in the window). **clsPicSeg** also responds to a few drawing messages of its own. Here are the drawing messages which add a grafic to a picture segment, together with the grafic's opcode and data type:

Table 27-2
Drawing Messages Corresponding to Picture Segment Grafics

Message	Opcode	Storage Data Structure
		clsSysDrwCtx Drawing Messages
msgDcDrawEllipse	opCodeEllipse	P_PIC_SEG_ELLIPSE
msgDcDrawRectangle	opCodeRectangle	P_PIC_SEG_RECT
msgDcDrawPolyline	opCodePolyLine	P_PIC_SEG_POLYLINE
msgDcDrawPolygon	opCodePolygon	P_PIC_SEG_POLYGON
msgDcDrawSectorRays	opCodeSectorRays	P_PIC_SEG_ARC_RAYS
msgDcDrawArcRays	opCodeArcRays	P_PIC_SEG_ARC_RAYS
msgDcDrawChordRays	opCodeChordRays	P_PIC_SEG_ARC_RAYS
msgDcDrawBezier	opCodeSpline	P_PIC_SEG_SPLINE
msgDcDrawText	opCodeText	P_PIC_SEG_TEXT
msgDcDrawImage	not implemented	
		clsPicSeg Drawing Messages
msgPicSegDrawSpline	opCodeSpline	P_PIC_SEG_SPLINE
msgPicSegDrawObject	opCodeObject	P_PIC_SEG_OBJECT

The data storage structure is the way the information is stored in the grafic, not the argument to the drawing message. The drawing messages take the usual arguments. The storage type is interesting if you want to edit picture segments.

The picture segment drawing message **msgPicSegDrawSpline** is a special messages implemented by picture segments to draw splines. This is an enhancement to the drawing messages of ImagePoint™. You can use **clsPicSeg** instead of **clsSysDrwCtx** solely to gain access to the additional drawing capabilities.

Picture segments provide a means to draw other figures besides the various ImagePoint primitives and splines. You can add an object to a picture segment using **msgPicSegDrawObject**, so long as that object responds to **msgPicSegPaint**.

Picture segments do not support **msgDcDrawImage**.

Coordinates 27.2.1

Most grafics require one or more coordinates as part of their data. DC drawing messages take 32-bit coordinates (S32). Picture segments convert these to 16-bit coordinates (S16) to save memory.

If you use small units and scales and computed coordinates, you end up with coordinate values greater than **maxS16** or less than **minS16** (32767 and –32768, respectively). These values won't work as expected if you switch from a drawing context to a picture segment.

DC State 27.3

Messages which change DC state, such as **msgDcSetLineThickness**, **msgDcSetForegroundRGB**, and **msgDcSetFillPat**, are **not** stored as grafics in a picture segment. Instead, every grafic encodes **some** of the graphics state along with its drawing operation. The advantage is that you can reorder grafics and draw individual grafics without having to set up the DC state up for each one. The entire DC state is not stored with each grafic because of the size of the DC state (hundreds of bytes).

Paint 27.3.1

Most grafics encode interesting DC state in a PIC_SEG_PAINT structure:

```
typedef struct {
    U16         linePat,
                fillPat;
    SYSDC_RGB   foregroundRGB,
                backgroundRGB;
    U16             lineThickness;
} PIC_SEG_PAINT, FAR * P_PIC_SEG_PAINT;
```

Note that line parameters such as **join**, **cap**, and **miterLimit** are not in this structure, since they are only relevant for polylines, polygons, splines, and beziers. The data types for these line drawing operations store this information in a PIC_SEG_PLINE_TYPE structure.

Some DC State Not Stored 27.3.1.1

Picture segments don't record several aspects of DC state, including:

- Plane control.
- Raster ops.
- Drawing context mode.

It is not a good idea to use these in the midst of sending drawing messages to a picture segment, since they will not be recorded in the picture segment. The picture segment inherits these parts of the graphic state. You should set these once for the window to which the picture segment is bound, and then leave them alone while drawing. Note that the picture segment stores LUC matrix and units with each grafic, so you can change the LUC while recording grafics.

Colors 27.3.1.2

You should not use hardware color palette indices (SYSDC_COLOR) when setting foreground and background colors. These are hardware-dependent and won't work when printing, so picture segments store RGB values in PIC_SEG_PAINT and not SYSDC_COLORs. In other words, use **msgDcSetForeground/BackgroundRGB** instead of **msgDcSetForeground/ BackgroundColor.**

Text Attributes 27.3.1.3

clsPicSeg does not store all of the text-specific DC state with text grafics. It stores the font spec, alignment, underline, and strikeout, but to save space it does not store more obscure text attributes such as **spaceChar**, **spaceExtra**, **otherExtra.** It uses the default values for these.

Although **clsPicSeg** does not store DC scaling, it does store text scaling set by **msgDcScaleFont** and **msgDcIdentityFont.** It does this by storing the current size (width and height) of the text in LUC at the time of **msgDcDrawText.** It remembers this as a SIZE16, not as an SCALE32; thus the picture segment drops fractional text scales and won't work at all if the scale is below 1.

To help clients display grab handles around text quickly, **clsPicSeg** calculates the bounding rectangle of the text and stores it in the **rectangle** field of PIC_SEG_TEXT.

Picture Segment Storage 27.3.2

A picture segment stores its grafics (both opcodes and data) in the object's heap. You can specify a heap in the **object.heap** of the PIC_SEG_NEW structure when you create a picture segment. By default the heap is the **OSProcessHeap** of the object's owner.

Using Picture Segments 27.4

Creating a Picture Segment 27.4.1

The **msgNew** argument for **clsPicSeg** is a pointer to a PIC_SEG_NEW structure. This includes the **msgNew** fields for **clsSysDrwCtx**, and a PIC_SEG_METRICS structure. The PIC_SEG_METRICS structure contains:

- **flags** flags include:
  - **picSegAdd** whether the picture segment should remember drawing operations by adding grafics (default is true).
  - **picSegDraw** whether the picture segment should paint by passing drawing messages to its ancestor (default is true).
- Many attributes of the DC, including the fill pattern, line pattern, units, foreground and background RGB values, line style, and font spec. The picture segment sets these (remember, it is itself a drawing context), and new grafics will use these values until you change them.

Drawing in a Picture Segment 27.4.2

clsPicSeg passes all **clsSysDrwCtx** messages that it receives to its ancestor. As explained above, it stores drawing operations and keeps track of most the current graphics state.

If you need to paint or repaint the entire contents of a picture segment:

- Send its window **msgWinBeginRepaint** (if you are repainting damage) or **msgWinBeginPaint** (if you are painting outside a repaint handler).
- Send **msgPicSegPaint** to the picture segment.

The picture segment replays its grafics in the order you sent the original drawing messages.

To change the contents of a picture segment, you can send it **msgPicSegErase** to delete all its grafics, then draw new ones. This chapter later describes how you can edit a picture segment rather than erase and start over.

If the window changes size, or if you are drawing the picture segment in part of a window and wish to draw it elsewhere, you can change the scale, translation, and rotation of the DC before redrawing the picture segment.

Picture Segment Drawing Messages 27.4.3

There are a few special drawing messages supported by **clsPicSeg** which aren't implemented by **clsSysDrwCtx**. These end up sending standard DC drawing messages to self, but are more convenient to use.

msgPicSegDrawSpline 27.4.3.1

This message draws a spline in the window. A spline is a series of Bezier curve control points. SysDC's **msgDcDrawBezier** allows you to draw a spline, but is limited to a single curve with four control points; to draw a continuing path with it you must send multiple **msgDcDrawBezier** messages.

Drawing Other Objects in Picture Segments 27.4.4

Picture segments provide a means to draw other figures besides the various SysDC primitives and splines. You can add an object to a picture segment using **msgPicSegDrawObject**, so long as that object responds to **msgPicSegPaintObject**. This takes a PIC_SEG_OBJECT as its message arguments. In the PIC_SEG_OBJECT, you specify:

paint the paint to use.

object the object to draw and store.

rectangle the rectangle in which to draw the object.

The picture segment sends **msgPicSegPaintObject** to **object**, whose arguments include a DC to use to draw itself. If **object** responds to **msgPicSegPaintObject**, it can be stored in a picture segment and will redraw properly.

Of course, if you subclass **clsPicSeg** and you recognize the class of the object, you can manipulate it directly.

Drawing Objects Outside Picture Segments 27.4.4.1

If an object responds to **msgPicSegPaint**, **msgPicSegGetGrafic**, and **msgPicSegDelta**, then you can send it these messages to draw itself outside a picture segment. For example, you can tell a TIFF object to draw in your own window without using a picture segment.

Building up a Picture Segment 27.4.5

It's possible to add grafics to a picture segment **without** drawing them, using **msgPicSegSetMetrics** or **msgPicSegSetFlags** to reset the **picSegDraw** flag. Conversely, you can draw in a window without adding to a picture segment by clearing the **picSegAdd** flag. The latter is useful to draw a grid or background in the window.

Using Picture Segments in Graphics Applications 27.5

clsPicSeg supports several features which enable it to do much of the work needed for a vector drawing application component. The picture segment acts as a display list of the graphic display objects in the drawing, and the drawing program provides a user interface for the addition, reorganization, and modification of these objects.

Editing a Picture Segment 27.5.1

A picture segment is an ordered list of grafics. It's like a stack of cards where each card is a grafic. You can count cards, shuffle cards, move cards, and delete cards. Each grafic has an associated **index**, a signed 32-bit number. You can send **msgPicSegGetCount** to determine how many grafics are in a picture segment.

For all messages which take a grafic index as a message argument, if you supply **picSegTopGrafic**, the message affects the last grafic in the picture segment. **picSegTopGrafic** is a constant with a special meaning to **clsPicSeg**. It is **not** the maximum number of grafics you can store in a picture segment (which is limited only by available memory).

You can repaint a particular grafic by sending **msgPicSegDrawGraficIndex** (afterwards the current grafic is set to that grafic). You can delete a particular grafic by sending **msgPicSegDelete** (afterwards, the current grafic is the topmost grafic again).

The Current Grafic 27.5.2

clsPicSeg always adds new grafics at the end of the display list. However, picture segments keep track of the **current grafic**. You can set the current grafic using **msgPicSegSetCurrent**.

msgPicSegGetGrafic retrieves the current grafic in a PIC_SEG_GRAFIC structure. This includes a pointer (**pData**) to the data structure appropriate for the type of grafic.

Note that **clsPicSeg** allocates the memory for the grafic-dependent data structure from the process heap, but it is up to the client to free it with **OSHeapBlockFree**().

msgPicSegDelta changes the current grafic. It also takes a P_PIC_SEG_GRAFIC as its message arguments.

To edit a grafic you must:

- Send **msgPicSegSetCurrent** to set the current grafic to the one you wish to edit.
- Send **msgPicSegGetGrafic** to retrieve that grafic.
- Cast data pointer (**pData**) into the appropriate type (e.g. P_PIC_SEG_ELLIPSE) and modify it.
- Send **msgPicSegDeltaGrafic**.
- Free the data pointed to by **pData** using **OSHeapBlockFree**()..

If you have a PIC_SEG_GRAFIC, you can paint it by sending **msgPicSegDrawGrafic**. This never adds the grafic to the picture segment, it only paints it in the window (if **picSegDraw** is set). This is useful if you want to redraw a grafic slightly differently.

To replace a grafic, you need not retrieve it, only:

- Send **msgPicSegSetCurrent** to set the current grafic to the one you wish to replace.
- Declare or allocate a data structure of the appropriate type and set it up as desired.
- Send **msgPicSegSetGrafic**, specifying the **opcode** and **pData**, to replace the grafic.

msgPicSegChangeOrder moves the current grafic to the index you specify. This effectively moves a grafic in front of or in back of other grafics.

Drawing by Adding Grafics 27.5.3

You can use **msgPicSegAddGrafic** to add a grafic to a picture segment. This will also draw the grafic, so it accomplishes the same thing as using a SysDC drawing message. **msgPicSegAddGrafic** is useful if you already have the opcode and data for a grafic available and want to add it. For example, you might be duplicating grafics, or copying grafics between picture segments.

Correct Opcode 27.5.3.1

When you use **msgPicSegSetGrafic**, **msgPicSegInsert**, or **msgPicSegAddGrafic**, you must ensure that the opcode and data are correct for each other and that the opcode is valid. If **clsPicSeg** does not recognize an opcode, it ignores it or returns an error.

Hit Testing a Picture Segment 27.5.4

You can send **msgPicSegHitTest** to a picture segment to determine if a grafic falls within a rectangle. You can use this to see if something is selected by a user's pen tap or selection rectangle. **msgPicSegHitTest** takes a pointer to a PIC_SEG_HIT_LIST structure. In this you specify:

rect rectangle for the hit detection.

index the index of the starting grafic.

clsPicSeg traverses the picture segment from top to bottom, starting at the **index** you supply (use **picSegTopGrafic** to start at the very top). It checks each grafic to see if it intersects the RECT32 you supply. It passes back the index of the first grafic it finds that intersects your rectangle. It returns the same status values as do drawing messages when hit testing is on:

stsHitOn if the rectangle intersects the edge of the figure.

stsHitIn if that grafic's fill is non-transparent and the rectangle intersects its center.

stsHitOut if no grafic intersects the rectangle.

You must send **msgWinBeginPaint** to the window before using **msgPicSegHitTest**, and **msgWinEndPaint** after it.

Invisible Grafics 27.5.5

msgPicSegMakeInvisible marks a grafic so that the picture segment does not draw it during **msgPicSegPaint**.

Invisibility is controlled by the **opCodeMaskInvisible** flag bit in the grafic's opcode. To find out if a grafic is invisible, use **msgPicSegGetGrafic** to get it and check the **opCodeMaskInvisible** bit.

Converting to Other Formats 27.5.6

You can convert a picture segment into some other vector drawing file format by getting each grafic from the picture segment in turn and converting it to the other format.

What Picture Segments DON'T Do 27.5.7

clsPicSeg does not do everything needed for a graphics application. Here is an incomplete list of what it does not support:

- Selections.
- Highlighting.
- Selection handles.
- Input processing, gesture translation (these would be up to the window to which you bind the picture segment).

Moving and Copying Picture Segments 27.6

You can move and copy grafics in picture segments using the selection manager and transfer mechanism. **clsPicSeg** does none of the work for this, since it doesn't handle selections. However, if you do provide a way for the user to select, delete, and add grafics in your picture segment, you should probably implement this protocol so that the user can cut and paste between it and drawing paper.

The following sections discuss the selection transfer of picture segment grafics. The discussion describes what the **sender** of the selected grafics and the **receiver** of the selected grafics each must do to implement a move or copy.

There is a special transfer type for picture segments, **xferPicSegObject**. If as sender you are asked for transfer types **msgXferList**, your **XferAddIds()** response should include **xferPicSegObject** as well as any other formats in which you can provide the selection.

Sender Responsibilities 27.6.1

As sender of the selected grafics, you receive **msgXFerGet**. The way to transfer the selected grafics is to pass a picture segment to the receiver. Since the receiver may be in a different process, you need to create a global heap and create a global picture segment which uses that heap. This is the intermediate holder for the transferred grafics.

Set the **id** in **msgXFerGet**'s XFER_BUF structure to **xferPicSegObject**, and set the **uid** field to the UID of the transfer picture segment.

You should put the selected grafics in the provided transfer picture segment. To do this, for each selected grafic send **msgPicSegSetCurrent** and **msgPicSegGetGrafic** to your normal picture followed by **msgPicSegAddGrafic** to the transfer picture segment.

If the operation was a move, the producer will receive **msgSelDelete**, and should delete the selected grafics.

Receiver Responsibilities 27.6.2

As the receiver, you send **msgXferList** to the producer when you receive **msgSelMoveSelection** or **msgSelCopySelection**. You can use **XferMatch**() to do this and to check to see that one of the types is **xferPicSegObject**. Then send **msgXferGet**, specifying an **id** of **xferPicSegObject**. As described above, the producer should pass back a global intermediate picture segment.

You need to scale the transferred grafics to the units of your picture segment. Send **msgPicSegScaleUnits** to the intermediate picture segment, passing in the message indicating your picture segment's units (e.g. **msgDcUnitsPoints**). To perform the copy, self-send **msgPicSegCopy**, specifying the intermediate picture segment as the message argument.

Chapter 28 / Bitmaps and TIFFs

Everything which appears on screen is an instance of **clsWin** or of one of its descendant class. For example, every class in the UI Toolkit is a descendant of **clsWin**. Another popular window descendant class is **clsView**, which is a window which observes another Class Manager object. The UI Toolkit is documented in Part Four, and **clsView** is documented in *Part 2: PenPoint Application Framework.*

This chapter documents some other **clsWin** descendants and other classes which provide additional functionality to the basic window:

- Bitmaps, which store sample values.
- TIFF objects, which display the contents of a TIFF bitmap file.

Bitmaps 28.1

clsBitmap provides a way to store the information used by **msgDcDrawImage** and **msgDcCacheImage**. This information is primarily the samples which these sampled image operators draw. **clsBitmap** also supports a limited range of operations on the bitmap information, mainly to support the PenPoint Bitmap Editor. This tool is on the SDK *Goodies* disk and is documented in the *PenPoint Development Tools* volume.

GO may change the format of the bitmap pixels, so you should not access them in a way that relies on their format.

The image in an icon (a UI toolkit gadget of **clsIcon**) can be specified as a bitmap object. Table 28-1 summarizes the messages clsBitmap defines:

Table 28-1
clsBitmap Messages

Message	Takes	Description
		Class Messages
msgNewDefaults	P_BITMAP_NEW	Initializes BITMAP_NEW structure to default values.
msgNew	P_BITMAP_NEW	Creates a bitmap.
		Attribute Messages
msgBitmapGetMetrics	P_GET_METRICS	Gets bitmap metrics.
msgBitmapSetMetrics	P_BITMAP_METRICS	Sets bitmap metrics.
msgBitmapSetSize	P_SIZE16	Sets bitmap size, resizing heap block if necessary.
msgBitmapInvert	pNull	Inverts the colors of the bitmap.
msgBitmapLighten	pNull	Lightens the colors of the bitmap by 1/4.
msgBitmapFill	RGB	Fills bitmap pixels with specified RGB value leaving mask alone.
msgBitmapCacheImageDefaults	P_SYSDC_CACHE_IMAGE	Prepares argument structure for msgDcCacheImage.

continued

Table 28-1 (continued)

Message	Takes	Description
		Observer Notification Messages
msgBitmapPixChange	P_BITMAP_PIX_CHANGE	Sent to observing objects if a pixel is dirty.
msgBitmapChange	pNull	Sent to observing objects if bitmap has changed.
msgBitmapMaskChange	pNull	Sent to observing objects if bitmap's mask has changed.

Creating a New Bitmap 28.1.1

You send **msgNew** to **clsBitmap** to create a bitmap. This takes a BITMAP_NEW structure which you should initialize with msgNewDefaults. You also specify:

style various style flags.

size the size of the bitmap.

pPixels a pointer to the samples.

clsBitmap copies the samples from **pPixels** into memory which it allocates.

Using a Bitmap 28.1.2

In fact, you rarely create bitmaps yourself. Usually you read bitmaps from resource files, since the Bitmap Editor saves bitmaps as resources. The tag for bitmaps is **bitmapResId.**

Having created a bitmap, you usually want to get it on the screen in some form. The way to do this to send it **msgBitmapCacheDefaults.** This takes a pointer to the SYSDC_IMAGE_INFO structure used by **msgDcDrawImage. clsBitmap** fills in the structure with default values so that you can send it to **msgDcDrawImage,** and the sampled image stored in the bitmap will be drawn in the window.

Modifying 28.1.3

You can change a bitmap's size using **msgBitmapSetSize. clsBitmap** frees the memory for the bitmap.

You can change bitmap metrics by sending **msgBitmapSetMetrics.** This is probably a bad thing to do since it (currently) doesn't resize or reallocate the bitmap.

Bitmaps are not windows. You can't bind a DC to them. However, it is possible to perform some graphic operations on them:

- You can invert a bitmap by sending it **msgBitmapInvert.**
- You can lighten a bitmap by 25% by sending it **msgBitmapLighten.**
- You can fill a bitmap with a color by sending it **msgBitmapFill.**

You can't lighten or fill a one bit per sample (black and white) bitmap.

Notifications

28.1.4

clsBitmap defines several observer notification messages which it sends to the observer of a bitmap when it changes: **msgBitmapPixChange**, **msgBitmapChange**, and **msgBitmapMapChange.** These are mainly used by the Bitmap Editor.

clsTiff

28.2

clsTiff displays TIFF (Tagged Image File Format) images. An instance of **clsTiff** refers to a pathname to a TIFF file, so the file must be in that location in order for the clsTiff object to display its image. The class displays the TIFF image in the file.

TIFF objects are **not** windows. **clsTiff** inherits from **clsObject**, not **clsWin.**

The TIFF specification encompasses many different flavors of TIFF files. **clsTiff** handles many (but not all) variants. It handles Intel and Motorola byte order, packed data (1, 2, 4, or 8 samples per byte), fill order, orientation, photometric interpretation, and dot size. It supports Type 1 (packed data), Group 3 FAX encodings (types 2 and 3), and pack bits run-length encoding (type 32773).

clsTiff assumes the image is black and white or gray-scale; it does not support color images or colormap (pseudocolor) images.

Table 28-2 summarizes the messages clsTiff defines.

Table 28-2
clsTiff Messages

Message	Takes	Description
		Class Messages
msgNewDefaults	P_TIFF_NEW	Initializes a TIFF_NEW structure to default values.
msgNew	P_TIFF_NEW	Creates a new TIFF object, and optionaly opens its associated file.
		Attribute Messages
msgTiffGetMetrics	P_TIFF_METRICS	Passes back the metrics of the clsTiff object.
msgTiffSetMetrics	P_TIFF_METRICS	Sets the metrics of the clsTiff object.
msgTiffSetGroup3Defaults	P_TIFF_SAVE	Sets the clsTiff object metrics to Group 3 compression type 2 defaults.
msgTiffGetSizeMils	P_SIZE32	Provides the actual size of the TIFF image in mils (0.001 inch).
msgTiffGetSizeMM	P_SIZE32	Provides the actual size of the TIFF image in millimeters.
		Drawing and Control Messages
msgPicSegPaintObject	P_PIC_SEG_PAINT_OBJECT	Renders the TIFF image with a specified drawing context object.
msgTiffSave	P_TIFF_SAVE	Saves a the image as a TIFF file.
msgTiffGetRow	U32	Sent to the client of the TIFF_SAVE to get the next row of the image.

Creating a New TIFF Object 28.2.1

You send **msgNew** to **clsTiff** to create a new TIFF object. Before doing this you should probably have a TIFF file around, one that you have created yourself or are importing.

You declare a TIFF_NEW structure. In the usual manner, one of the fields in this is **tiff**, a TIFF_NEW_ONLY structure, in which you specify:

pName	the pathname to the TIFF file.
imageFlags	a subset of SYSDC_IMAGE_FLAGS.
rectangle	the origin and size you want the TIFF image to be.

The only valid SYSDC_IMAGE_FLAGS are **sysDcImageFillWindow** and **sysDcImageLoFilter/sysDcImageHiFilter**. **clsTiff** passes these on to **msgDcDrawImage** when it paints the TIFF object.

By default only **sysDcImageFillWindow** is set in **tiff.imageFlags**, and the origin and size of the image are zero.

clsTiff creates a TIFF object. If **tiff.pName** is not null, it tries to open the named TIFF file. If **sysDcImageFillWindow** is set, **clsTiff** passes back the natural size of the TIFF image in **Mils** in **tiff.rectangle**. (Remember, the TIFF image is not associated with a window or DC, so there's no obvious LUC or LWC coordinates to use.)

TIFF Image Metrics 28.2.2

msgTiffGetMetrics passes back information about the TIFF file. This takes a pointer to a TIFF_METRICS structure. As well as the file name, rectangle, and flags, **clsTiff** also passes back a wealth of information about the TIFF image in the file, including:

- **orientation.**
- **width** and **length.**
- **xResolution** and **yResolution**, and the **resolutionUnits.**

This information is very technical and you'll need the complete TIFF file specification to make sense of it. The TIFF specification is maintained by and available from Aldus Corporation of Seattle, Washington (USA). You can contact Aldus through their forum on CompuServe or their developer's bulletin board on AppleLink.

You can set the metrics of the TIFF object and its image using **msgTiffSetMetrics.** Note that indiscriminately modifying TIFF parameters without changing the TIFF file will undoubtedly cause problems. The only safe TIFF file metrics to change are the **orientation**, **pDocumentName**, and a few others.

Repaint 28.2.3

A TIFF object repaints when it receives **msgPicSegRedraw**. Since a TIFF object isn't a window and isn't bound to one, you must pass in a drawing context as the message argument to **msgPicSegRedraw**. You should bracket the send of **msgPicSegRedraw** with either a **msgWinBeginRepaint/msgWinEndRepaint** or **msgWinBeginPaint/msgWinEndPaint** pair sent to the DC's window.

To paint the TIFF image, **clsTiff** uses **msgDcDrawImage**. It sets **msgDcDrawImage**'s **sysDcImageFillWindow**, **sysDcImageLoFilter**, and **sysDcImageHiFilter** flags to the values you specify. If you set **sysDcImageFillWindow**, the TIFF image will fill whatever window the DC is bound to. Otherwise, the TIFF image will be painted at the location and size you specified in its metrics (**rectangle**). The coordinates in **rectangle** are interpreted in the DC's LUC.

sysDcImageLoFilter and **sysDcImageHiFilter** control how much filtering the system drawing context performs when it draws the pixels of the TIFF image. See Chapter 25, The Drawing Context Class, for more information on **msgDcDrawImage**.

TIFF Images in Picture Segments 28.2.4

You can use TIFF objects with picture segments. **msgPicSegDrawObject** will add and draw a TIFF object in the picture segment. So that it works in a picture segment, **clsTiff** responds to **msgPicSegPaintObject** by drawing itself.

Filing 28.2.5

clsTiff saves and restores its instance data. However, it does nothing with the separate TIFF file. It is up to the client of the TIFF object to maintain this file, copying it as necessary.

Destroying 28.2.6

Likewise, when a TIFF object receives **msgFree**, it does not delete the separate TIFF file. If the TIFF file is in the document's directory, then the PenPoint Application Framework will delete it when the document is deleted from the Notebook.

Chapter 29 / ImagePoint Rendering Details

This chapter discusses some low-level implementation details of the ImagePoint™ rendering mechanism. The information is technical and presented primarily for developers working on graphics applications. The chapter covers the following topics:

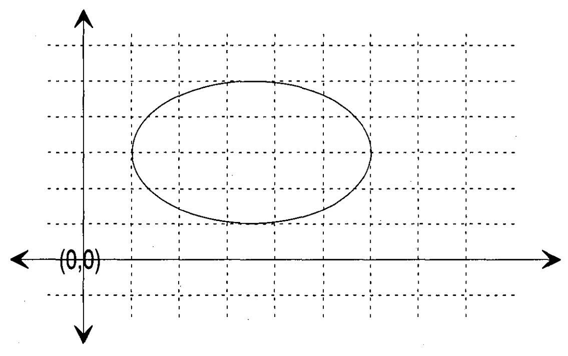
- Logical unit coordinates.
- Logical device coordinates.
- Line, rectangle, and polygon rendering.
- Line thickness issues.
- Differences from earlier releases.

Logical Unit Coordinate (LUC) 29.1

A **logical unit coordinate** system is an integer grid with the integer coordinate pair positioned at the intersection of a pair of gridlines. The gridlines have no thickness. Lengths measured from a given point starts at such an intersection. This model applies to both figure rendering and clipping region construction.

ImagePoint defines an ellipse by the origin and size of its bounding rectangle. Figure 29-1 illustrates drawing an ellipse whose bounding rectangle has origin (1, 1), width 5, and height 4.

Figure 29-1
A Figure in a Logical Unit Coordinate System



Logical Device Coordinate (LDC) 29.2

Throughout this chapter, it will be helpful to consider a coordinate system that is similar to the window system's LWC, but whose orientation is that of the LUC. This system is the **logical device coordinate** system, or LDC. It is obtained by transforming an LUC by the LTM and USC, where:

- ◆ LTM is the logical transformation matrix computed as a result of an application issuing any number of **msgDcIdentity**, **msgDcRotate**, **msgScale**, **msgDcScaleWorld**, **msgDcTranslate**, and **msgDcSetMatrix** to the DC in question.
- ◆ USC is a scaling matrix computed as a result of an application issuing any one of the **msgDcUnits...** messages. The USC establishes the LUC scaling to that of the device, measured by the width of a pixel.

You can think of the LDC as a virtual display surface mapped onto your LUC where one unit equals one hardware pixel. In device unit scaling, the LDC is identical to the LUC.

An LUC not in device units usually produces fractional values when transformed to the LDC. To arrive at an integer LDC value a LUC coordinate is transformed into fractional LDC and then snapped to an integer LDC *in the direction of (toward) the LDC origin.* Put simply, ImagePoint truncates toward the LDC (hence LUC) origin. One can think of the LDC system as one in which the integer coordinates are placed at the the lower-left hand corner of pixel boundaries. More precisely, a pixel at (x,y) is a half-open region containing the points $[x, x+1) \times [y, y+1)$.

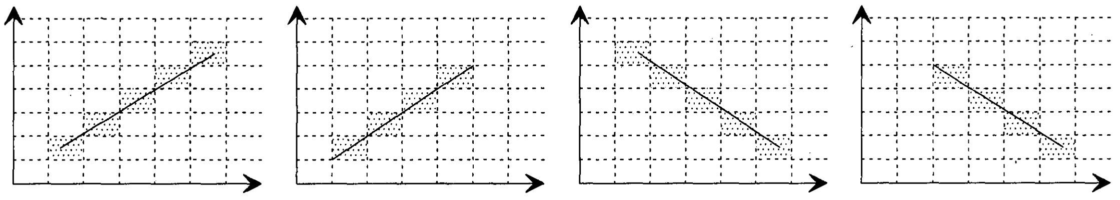
The rendering details discussed in the following sections will use the LDC as the frame of reference. In other words, where a drawing primitive takes LUC parameters, the result figure will be invariant under different rotations of the screen.

A word of caution: ImagePoint uses fixed point arithmetic in the construction of these matrices as well as coordinate transformations. A fixed point, f, is a 32-bit number encoding the real number $\frac{f}{65536}$. Fixed point arithmetic is fast but limited in precision and prone to propagation of errors due to rounding. Use as few steps as possible in the construction of the LTM. For example, suppose you wish to draw a series of squares along the x axis with unit dimensions. You can move the origin of the square from (0, 0), to (1, 0), (2, 0), and so on, or you may choose to translate your coordinate system by (1, 0) at each step with pre-multiplication and always position the origin of the square at (0, 0). However, you will quickly find that the pre-multiplication method results in gaps between the squares after a few translations.

Line Drawing 29.3

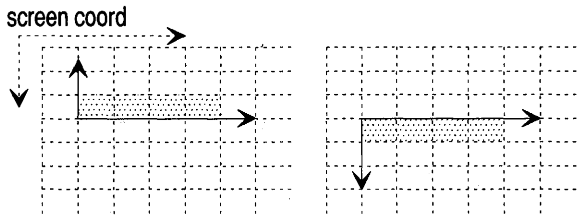
In drawing a line with a thickness of one pixel in LUC, the line is transformed to LDC. In this transformation, the LUC endpoints of the ideal line are not considered. That is, if the LUC endpoint of the ideal line is the only part of the line that intersects an LDC pixel, that pixel is not set, as illustrated in Figure 29-2.

Figure 29-2
End Points in One-Pixel Lines



Horizontal and vertical lines which fall exactly between two LDC pixels set the pixels on the increasing (that is, most positive) side of the LUC. For example, in Figure 29-3, a four-pixel line drawn along the horizontal axis sets the pixels on the increasing side of the horizontal axis. In figure 29-3, the LUC on the left increases its vertical coordinates in the opposite direction of LDC (screen coordinates), while the LUC on the right increases its vertical coordinates in the same direction as LDC.

Figure 29-3
LDC Rounding to Positive Side of LUC



Rectangular Figures Without Borders 29.3.1

Rectangular figures are described by an origin along with a width and a height. They include rectangles, ellipses, sectors, and chords. A rectangular figure without a border is one where the line width is set to zero. During rendering, the origin of the rectangle is transformed to LDC using the procedure described in the previous sections. The device coordinates of the opposing corner are obtained by adding the width and height to the origin in LUC, and only then applying the matrix transformation.

The system draws the pixels bound by the left and the bottom edges and up to but not including the right and the top edges. The terms top, left, right, and bottom are all relative to the LUC, not device space. This holds true for all rotations of the LUC. This scheme allows you to line up adjacent rectangular figures without overlapping pixels.

The pixels on the top and right edges are not drawn.

The implication of this model is that locations are favored over pixel metrics. Consider an LUC in which both axes are scaled 0.35 and draw the rectangle at (0, 0) with width and height 10. The pixels drawn will be the region [0, 2] × [0, 2]. Now draw the same rectangle at (2, 2), the pixels drawn will be the region [0, 3] × [0, 3]. Thus pixel metrics vary with positions (this is a change of drawing semantics from the Developer's Release of PenPoint™).

Clipping rectangles obey the same rule of coordinate transformations and rendering as described above as long as the DC is rotated by one of 0°, 90°, 180°, or 270°. If the DC is rotated by an arbitrary angle, the resulting clipping rectangle is the minimal bounding box of the rotated rectangle (instead of the rotated rectangle itself—this is because ImagePoint does not yet support non-rectangular clipping regions). More precisely, a clipping rectangle with origin (x, y), width w and height h is transformed into the 4 corners using the LUC coordinates $(x + w, y)$, $(x + w, y + h)$, and $(x, y + h)$. The minimal bounding rectangle is then computed using these 4 transformed points in device space.

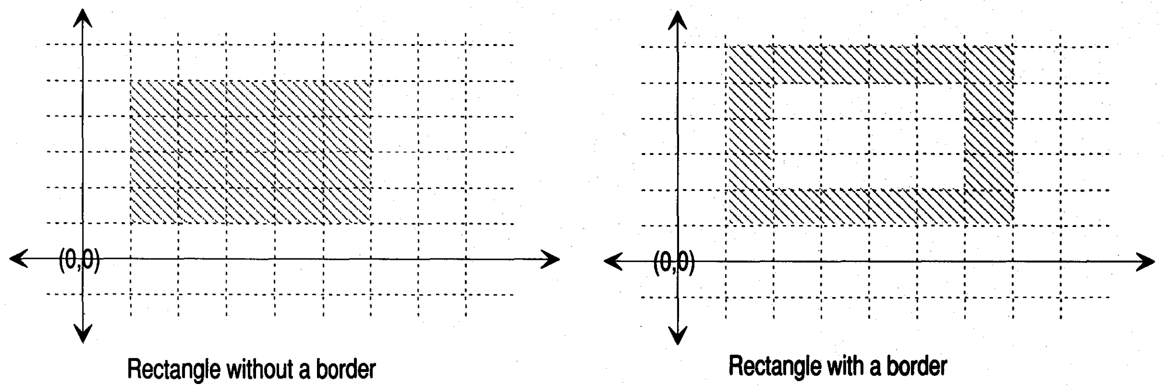
The image operator **msgDcDrawImage** obeys the same semantics. However, in the case of an arbitrarily rotated DC, ImagePoint does not guarantee that rectangles or images adjacent to the image have no overlapping pixels.

Rectangular Figures With Borders 29.4

Rectangular figures fall into three categories: those with no border, with a one pixel border, or with a border of more than one pixel. This section discusses rectangular figures with one pixel borders. "Rendering Geometric Shapes With Thick Borders," later in this chapter, discusses rectangular figures with borders of more than one pixel.

The **border** is the lines connecting the transformed vertices. The same rules of transformations are applied for each, but the pixels hit vary. Figure 29-4 shows the difference between drawing a rectangle without a border and one having a one pixel border.

Figure 29-4
Rectanges With and Without Borders



The origin depicted in both figures would have the *x* in [1...2), and the *y* in [1...2). The opposite corner depicted in both figures would have the *x* in [6...7), and the *y* in [5...6).

Polygons 29.5

The difference between drawing a polygon with and without a border is quite similar to that of rectangles. In the case of drawing a polygon without a border, the "right-hand-side" edges are not drawn. A right-hand-side edge is defined as follows: draw a horizontal line starting at any point on the edge except the two end points, extending to positive infinity. If the edge in question is a horizontal line, we use a vertical test ray extending to negative infinity. If the test ray intersects an even number of edges (or an odd number of edges in the case of a horizontal edge) on the polygon, it is considered a right-hand-side edge. This test is conducted in LUC space.

Figure 29-5
Left-Hand and Right-Hand Edges

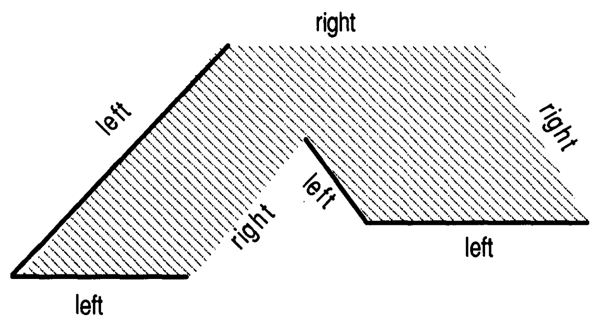


Figure 29-5 illustrates the test. The purpose of this scheme, as in the case of rectangles, is to allow adjacent polygons with common edges to line up without overlapping pixels.

The concept of "right-handedness" breaks down with self-intersecting polygons (such as a star-shaped polygon) because a test ray from an edge intersects a different number of edges depending on where we start the test ray. If you wish to draw such a polygon with predictable results, you should always draw it with a border.

Line Width and Corner Radius Scaling 29.6

The messages **msgDcSetLineThickness** and **msgDcSetLine** set the line width and corner radius for subsequent drawing. This section describes how they are scaled. The scaling algorithm for both drawing parameters are identical, therefore the following discussion refers only to line width.

A DC maintains a logical line width scale which starts out being unity. It is scaled by **msgDcScale** (unless explicitly held by **msgDcHoldLine**). It is reset to unity by **msgDcIdentity**. Other DC transformations such as rotation do not affect the line width. When **msgDcScale** is applied to coordinates, the x and y scaling components are applied independently. However, in the case of line width, the effective scale is obtained by averaging the two scaling components. This aspect of ImagePoint is markedly different from other imaging systems such as Adobe's PostScript, where the line width is indeed scaled independently.

We now give an example to show why ImagePoint's approach is useful. Consider a square drawn in a point coordinate system with some fixed dimensions. Now consider scaling the DC with the factors 2 and 1 for x and y respectively. That is a square becomes twice as wide along the x axis while retaining the same height along the y axis. In a model where the line width is scaled separately for the x and y components, we would also observe that the vertical sides of the rectangle are much thicker than the horizontal sides. While this is mathematically "pure," it isn't particularly useful. We prefer a model in which the line width scales identically in both dimensions, drawing lines with uniform thickness regardless of coordinate transformations—thus the averaging of the scale factors.

The logical line width is multiplied by the logical line width scale to obtain the line width measured by the width of a pixel. This number, called the **physical line width**, is the line width with which the device level imaging system renders geometric figures.

Rendering Geometric Shapes with Thick Borders 29.7

This section pertains to renderings of geometric figures. The messages applicable to this section are **msgDcDrawPolyline**, **msgDcDrawBezier**, **msgDcDraw-ArcRays**, **msgDcDrawRectangle**, **msgDcDrawEllipse**, **msgDcDrawPolygon**, **msgDcDrawSectorRays**, and **msgDcDrawChordRays**. All of these messages take a set of points in LUC as parameters.

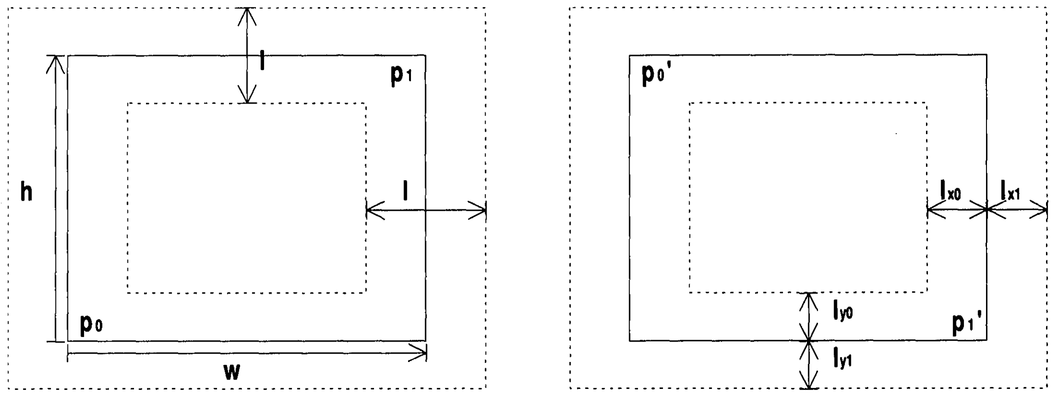
Closed figures rendered with a zero line width are drawn in much the same manner as rectangles without borders, as described above. Figures rendered with a line thickness of one pixel similarly follow the model for rectangles with one pixel borders. In the cases where the line width is bigger than one pixel, we'll discuss the different effects of the line thickening algorithm for the two broad catagories of messages:

- Those described by a bounding rectangle: **msgDcDrawArcRays**, **msgDcDrawRectangle**, **msgDcDrawEllipse**, **msgDcDrawSectorRays** and **msgDcDrawChordRays**.
- Those described by a point path: **msgDcDrawPolyline**, **msgDcDrawBezier**, and **msgDcDrawPolygon**.

Figures Described by a Bounding Rectangle 29.7.1

Figure 29-6 illustrates the line thickening algorithm with a rectangle originating at p_0, with width and height w and h respectively, all in LUC, and with a logical line width of l. Assume the LTM is the identity matrix and the device is not rotated.

Figure 29-6
Line Thickness in a Rectangle



The sequence of computations is as follows:

1 Compute the point $p_1 = \left(p_{0x} + w, p_{0y} + h\right)$ in LUC.

2 Transform p_0 and p_1 using the CTM, yielding p_0' and p_1', which are now the upper left and lower right corners of the rectangle respectively.

3 Transform the logical line width l as described in the previous section yielding l_x—the thickness of the vertical edges in device units.

4 The outer vertical edges of the thickened rectangle is offset from the frame at p_0' by a quantity of $Floor\left(l_x/2\right)$. This is l_{x1} in the figure.

5 The inner vertical edges are offset from the frame at p_0' by $Ceiling\left(1_x/2\right)$. This is l_{x0} in the figure. In other words, where a line width transformed into an odd number of pixels, the inner frame gets the extra pixel.

6 The thickness of the horizontal edges is computed by $Round\left(l_x \times asp\right)$, where *asp* is the aspect ratio of the device.

7 The offsets for the inner and outer horizontal edges are computed similarly to step 4 and 5.

8 The pixels between the two frames, including those on the boundary of the inner frame, are filled with the line pattern. The pixels enclosed by the inner frame, excluding those on the boundary of the inner frame, are filled with the fill pattern.

By offseting each pair of edges with the same amounts for the inner and outer frames, the distribution of thickness is invariant under different rotations of the device.

We will not go into the elaborate mathematics of rendering frames with arbitrary rotations. It is sufficient to assert that the same rule of thickness distribution applies.

Drawing elliptical figures follows the same algorithm above, with the outer and inner frame bounding two ellipses. The pixels between the two ellipses, including those pixels on the boundary of the inner ellipse, are drawn with the line pattern.

Figures Described by a Point Path 29.7.2

Figures with thick line widths traced out by a point path are treated in the same manner as figures described by a bounding rectangle, with the exception that these figures do not possess the symmetry property of a rectangle with respect to line width distribution. As mentioned above, line widths with an odd number of pixels create an unequal distribution of pixels to the two sides of the line. In a rectangular shape, this poses no problem since each edge of the rectangle always has an opposing edge. Point path figures, however, do not necessarily an opposing edge to which to allocate the extra pixel.

In the PenPoint Developer's Release, ImagePoint allocated the extra pixel in the direction of increasing coordinate value in device space. This produced an anomaly in which a thick segment did not have a consistent appearance under different rotations of the screen. ImagePoint under PenPoint 1.0 solves this problem by allocating the extra pixel in the direction of increasing coordinate value in LUC.

Differences from Earlier Releases 29.8

We have described the major ImagePoint rendering details implemented in PenPoint 1.0. Some of the rendering semantics differ from those implemented in the earlier PenPoint Developers' Release. We summarize them as follows:

- For rectangular figures without a border, the image operator, and clipping rectangles, the top and the right edges are excluded from rendering.
- For polygons without a border, the right-hand-side edges are not drawn.
- For polylines, the "ceiling side exclusion" semantics is implemented.
- For polylines with an odd pixel thickness, the extra pixel is allocated in the direction of increasing coordinate value in LUC.

Part 4 / UI Toolkit

List of Figures

List of Tables

List of Examples

Chapter 30 / Introduction

Overview 30.1

The UI Toolkit provides classes that lay out windows to form user interface elements such as buttons, tabs, handwriting fields, labels, icons, menus, frames, and option sheets. These elements are called **UI components**. UI components send messages among themselves and to their **clients** when the user interacts with them.

The UI Toolkit implements the middle layer of the appearance and functionality of the user interface architecture in PenPoint. It calls on the Windows & Graphics subsystem to draw these windows. In turn, the PenPoint Application Framework and the internal classes implementing the Notebook User Interface (**NUI**) use UI Toolkit objects extensively.

You use UI Toolkit components whenever you want to provide these standard user interface components to the user. If you want to provide alternate styles or interactions, you can leverage the UI Toolkit code by subclassing at various class levels.

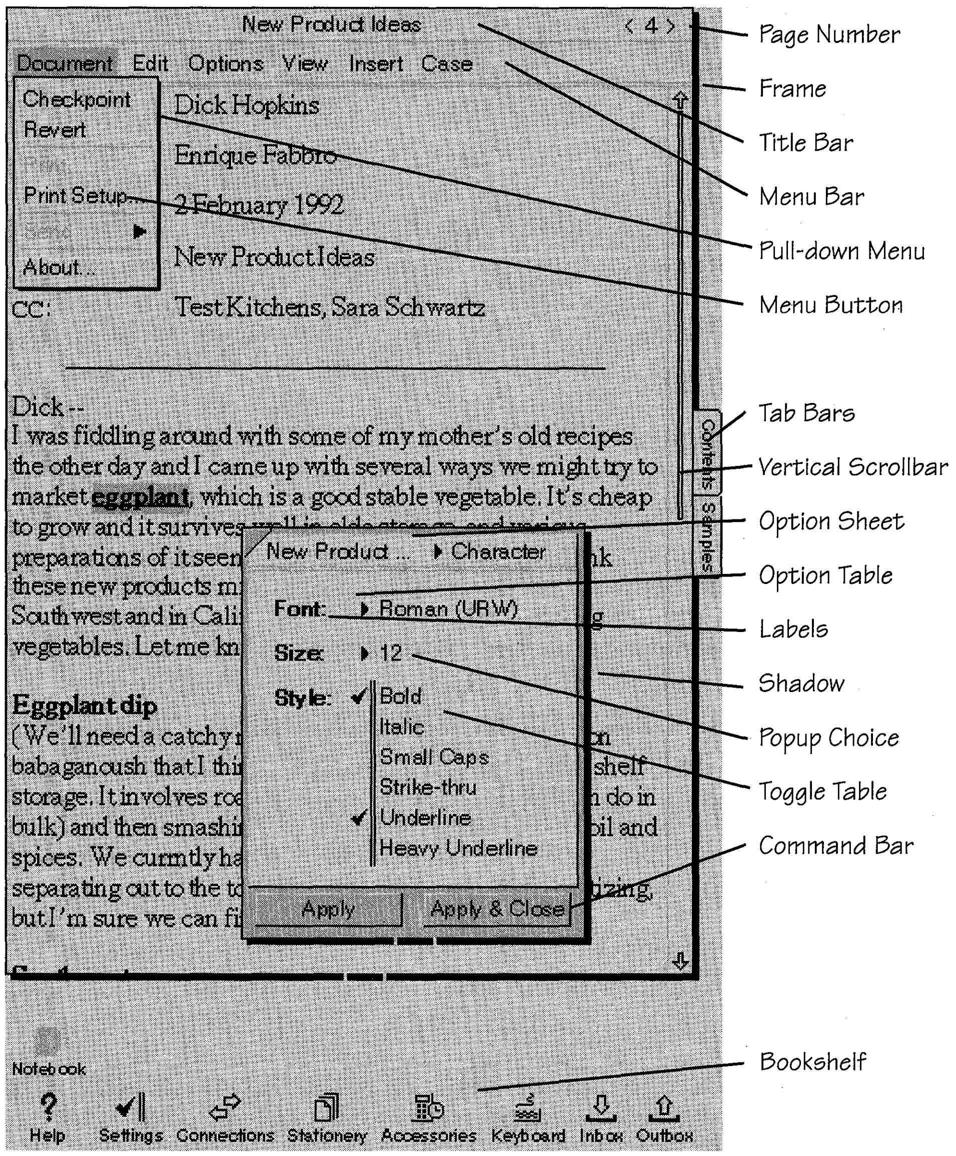
PenPoint uses UI components for menus, option sheets, window decorations, the default application frame, and many application windows. Nearly every window that has a label or responds to the pen is a UI component of some sort.

Usually, you use more than one UI component. You can **lay out** components inside other windows to form tables, control panels, and simple forms. The UI toolkit uses this layout facility to create frames and option sheets.

Menus, command bars, and choices are themselves also UI components that consist of groupings of buttons and labels.

Higher level **application components** built using UI components include option sheets, search and replace, and the spell check dialog box. The overall Notebook user interface appearance is largely the result of using standard UI components.

Figure 30-1
UI Toolkit Components



Dick Hopkins
Enrique Fabbro
2 February 1992
New Product Ideas
CC: Test Kitchens, Sara Schwartz

Dick --
I was fiddling around with some of my mother's old recipes the other day and I came up with several ways we might try to market **eggplant**, which is a good stable vegetable. It's cheap to grow and it survives
preparations of it seen ... nk
these new products m
Southwest and in Cali ... g
vegetables. Let me kn

Eggplant dip
(We'll need a catchy ... n
babaganoush that I thi ... shelf
storage. It involves ro ... do in
bulk) and then smashi ... oil and
spices. We currntly ha
separating out to the t ... zing,
but I'm sure we can fi

New Product ... ▸ Character
Font: ▸ Roman (URW)
Size: ▸ 12
Style: ✓ Bold
Italic
Small Caps
Strike-thru
✓ Underline
Heavy Underline
Apply | Apply & Close

Organization of This Part

30.2

Part 4 provides some simple examples of how to create common user interface combinations.

Chapter 31, Concepts and Terminology, explains the important concepts in the UI Toolkit, and shows how these are implemented by several families and layers of classes in the toolkit class hierarchy.

The rest of the chapters in Part 4 follow the layered implementation of the UI Toolkit. They describe the UI Toolkit classes by functional area in more detail. The toolkit's layered design provides a flexible and powerful toolkit, but it makes the reference documentation quite complex for the beginning reader, since the creation and behavior of a UI component is spread across several classes and, hence, several chapters. You have to read something about the ancestors of a class to understand how you can use their functionality, yet a lot of what an ancestor does is used internally by each class and doesn't need to be touched by the developer.

- Chapter 32, Toolkit Ancestors, explains how UI Toolkit classes use features provided by their common ancestor classes.
- Chapter 33, Borders, covers **clsBorder**, which supports some common features of toolkit window repainting, such as margins, and background and foreground colors.
- Chapter 34, Layout Classes, covers general layout issues, and **clsTableLayout** and **clsCustomLayout** in particular. These classes implement two approaches for positioning and sizing child windows.
- Chapter 35, Controls, covers **clsControl**, which implements the translation of window input messages into messages sent to self and other objects.
- Chapter 36, Labels, covers **clsLabel**, which implements the display of a string or decorative window. Buttons, menu buttons, toggle buttons, and frame title bars all inherit this behavior from **clsLabel**.
- Chapter 37, Buttons, covers **buttons**, labels that the user activates by applying a gesture such as a tap.
- Chapter 38, Toolkit Tables, covers **toolkit tables**. **clsTkTable** supports the initialization, layout, and notification management for groups of toolkit components (such as buttons). The capability to organize components in a group is used by several subclasses: this chapter describes toggle tables and choices, two particular subclasses of **clsTkTable**.
- Chapter 39, Menus and Menu Buttons, covers menus (**clsMenu**) and menu buttons (**clsMenuButton**). Menu buttons are special buttons that display a menu; menus are special toolkit tables that often group several menu buttons.
- Chapter 40, Scrollbars, covers scrollbars (**clsScrollBar**) and **clsScrollWin**, a special descendant of **clsBorder** which handles a lot of the work of scrolling for you.
- Chapter 41, List Boxes, covers **list boxes** (**clsListBox**). List boxes are scrolling windows that support very large numbers of **entries**. Unlike table elements, only those entries currently visible in the list box need have a window. Descendants of **clsListBox** provide scrolling lists specifically for strings (**clsStringListBox**) and for font names (**clsFontListBox**).
- Chapter 42, Fields, covers text **fields** (**clsField**), which are labels that you can handwrite in. It also describes subclasses of **clsField** that have additional semantics to support integer fields, date fields, fixed-point fields, and so forth.
- Chapter 43, Notes, covers **notes** (**clsNote**), which present transient information to the user. **Standard messages** are a set of standard procedural interfaces for displaying error information that use **clsNote**.

- Chapter 44, Frames, explains frames (**clsFrame**), which manages a collection of other UI components and a client window. Most applications use frames for their main windows, dialog boxes, and pop-up windows.
- Chapter 45, Frame Decorations, explains some of the decorations of frames: close boxes, title bars, tab bars, and command bars.
- Chapter 46, Option Sheets, describes the classes that support the option sheet user interface. **clsOption** provides the option **sheet**, while the **cards** in the sheet are usually instances of **clsOptionTable**. Since the user can leave an option sheet on-screen, the interaction between option sheets, option cards, and the selection can be quite complex.
- Chapter 47, Icons, covers icons (**clsIcon**), which show an iconic menu button made up of a bitmap image and a string.
- Chapter 48, Trackers and Grab Boxes, covers **clsTrack**, which grabs input and draws transient rubber-banding figures in response to pen movements. The toolkit uses this to provide feedback when the user drags or resizes items. In particular, grab boxes (**clsGrabBox**) are the resize handles on frames and scrollbars which use **clsTrack** internally.
- Chapter 49, Progress Bars, describes how to use **clsProgressBar**. **clsProgressBar** implements a dynamic, bar-graph representation of a value. You typically use a progress bar to indicate how far a long process has progressed, or to show where a value falls in a range of possible values.

Developer's Quick Start 30.3

Here are the basic steps in creating a typical control panel. They skip a lot of details and aren't applicable to all UI components.

The best approach to take is to try to use toolkit tables (**clsTkTable**) as much as possible. If you can organize your windows in a tabular arrangement, you can create a single toolkit table and statically specify its contents. This saves you from specifying the NEW structures for each component, worrying about the defaults to override, and assembling them. Choices, menus, tab bars, command bars, and option tables are all descendants of toolkit tables.

Creating a Choice 30.3.1

1 Statically define a TK_TABLE_ENTRY array. Each item in this array describes one component in a toolkit table. In the case of **clsChoice**, the components are instances of **clsButton**. The value of the first three fields of each TK_TABLE_ENTRY item varies, depending on the class of component (see \PENPOINT\SDK\INC\TKTABLE.H for details). For **clsButton** components, the first three fields of the TK_TABLE_ENTRY specify the string to appear in the button, the message it sends, and 32 bits of data to send as the message argument.

2 The rest of the fields for each toolkit table entry are a window tag, some flags, and an override class, and an ID for Quick Help. The window tags are important if you want to get to a particular component in the toolkit table after you have created it: you can use 0, 1, 2, . . . or **MakeTag** to define tags. **clsChoice** sets the flags correctly for standard toggles. You can leave **class** as **objNull** since all the buttons have the same class.

Send **msgNewDefaults** to **clsChoice**.

3 In CHOICE_NEW, specify **tkTable.client** as the UID of the client who will respond to button messages.

4 Set **tkTable.pEntries** to the address of the static TK_TABLE_ENTRY array you defined. You don't need to set **tkTable.class** to **clsButton** because that is the default for **clsChoice**. You can also set the value of the choice by setting the "on" button's tag in **choice.value**.

Send **msgNew** to **clsChoice**, with the modified CHOICE_NEW structure as its argument.

Creating a Menu Bar 30.3.2

1 Specify the components of the menu in a TK_TABLE_ENTRY array.

2 However, the components in the menu need not all be buttons; they can also be choices or menu buttons. These entries themselves are toolkit tables, so they take an array of TK_TABLE_ENTRYs. The first two fields for a menu button TK_TABLE_ENTRY are its string and the TK_TABLE_ENTRY array for its pull-down menu.

Define an entire menu tree by nesting static TK_TABLE_ENTRY arrays. The same goes for option sheets, and so on. Chapter 38, Toolkit Tables, discusses toolkit table nesting in more detail.

Creating a Tabular Layout Window 30.3.3

1 Send **msgNewDefaults** to **clsTableLayout**.

2 Specify the constraints in **tableLayout**.

3 Send **msgNew** to **clsTableLayout**.

4 Use the normal **msgWinInsert** message (remember that all UI Toolkit classes inherit from **clsWin**) to insert your UI Toolkit components in the table layout window.

Creating a Custom Layout 30.3.4

1 Send **msgNewDefaults** and **msgNew** to **clsCustomLayout**.

2 Use the normal **msgWinInsert** message to insert your UI component in the custom layout window.

3 As you insert each component window, set up the appropriate constraints for it in the **metrics** field of a CSTM_LAYOUT_CHILD_SPEC, put its UID in the **child** field, and send the custom layout window **msgCstmLayoutSetChildSpec**.

Creating a Button 30.3.5

If you need to create a free-standing UI component (instead of one inside a toolkit table), here's how you would go about creating a button:

1 Send **msgNewDefaults** with the appropriate structure to **clsButton**.

2 Fill in the **button.msg** and **button.data** fields with the message and data you want the button to send.

3 Set the **control.client** to the UID of the application instance (assuming the application is the object handling button notifications). Set the **label.pString** to a suitable name.

Send **msgNew** to **clsButton**.

4 Insert the button into a window to make it visible.

5 The client must handle the button's message, so mention the message in the application's method table and write a message handler for it.

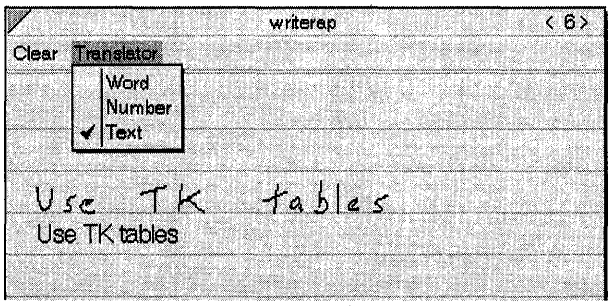
You often create a main window in response to **msgAppOpen** and destroy it at **msgAppClose**, since your application only needs a user interface while it is on screen. See "Filed Representation" in Chapter 31, Concepts and Terminology, for more information on when to create toolkit components and whether to file them.

Example 30-1
A Simple Menu with Nested Buttons and a Choice

The relatively simple toolkit table example below creates the menu bar in the WriterApp sample program (in \PENPOINT\SDK\SAMPLE\WRITERAP\WRITERAP.C).

The menu bar has two menu buttons:

- **Clear** operates immediately (it has no submenu)
- **Translator** has a pull-down submenu with a choice in it.



This is non-standard; a real application would normally have the Standard Application Menus (Document and Edit).

The code defining the menu as a set of nested toolkit tables is as follows:

```
// Data structure for the menu
static const TK_TABLE_ENTRY menuBar[] = {
    {"Clear",           msgWriterAppClear, 0},
    {"Translator",      0, 0, 0, tkMenuPullDown},
      {0, 0, 0, 0, 0, clsChoice},
        {"Word",        msgWriterAppTranslator, 0, 0, tkButtonOn},
        {"Number",      msgWriterAppTranslator, 1},
        {"Text",        msgWriterAppTranslator, 2},
        {pNull},  // This pNull ends the clsChoice table
      {pNull},  // This pNull ends the "Translator" tkMenuPullDown
    {pNull}  //This pNull ends the tkTable
};
```

Later on, in its **msgAppInit** method, WriterApp creates the menu bar:

```
// WriterApp creates its own custom window
...
// Create the menu bar
ObjectCall(msgNewDefaults, clsMenu, &mNew);
mNew.tkTable.pEntries = menuBar;
mNew.tkTable.client = self;
ObjCallRet(msgNew, clsMenu, &mNew, s);

// Set the client window and menu bar in the application frame
ObjCallRet(msgFrameGetMetrics, am.mainWin, &fm, s);
fm.clientWin = sNew.object.uid;
fm.style.menuBar = true;
fm.menuBar = mNew.object.uid;
ObjCallRet(msgFrameSetMetrics, am.mainWin, &fm, s);
...
```

Other Sources of Information 30.4

Nearly every class in the UI Toolkit is a descendant of **clsObject**, **clsWin**, **clsGWin**, and **clsEmbeddedWin**. Chapter 32, Toolkit Ancestors, explains how the toolkit classes use these classes. You don't need in-depth knowledge of these classes to use the toolkit, but you need some familiarity with them. They are described in:

- *Part 1: Class Manager* (**clsObject**).
- *Part 2: PenPoint Application Framework* (**clsApp**).
- *Part 5: Input and Handwriting Translation* (**clsGWin**).

Similarly, UI component behavior is largely determined by window input processing flags. However, if you haven't read *Part 5: Input and Handwriting Translation*, you'll still be able to understand and use the UI Toolkit.

The PenPoint Application Framework is closely involved with the UI Toolkit. It can supply applications with a default frame and a Standard Application Menu, and can file and restore an application's UI. It is described in *Part 2: PenPoint Application Framework.*

clsField and its descendants in the UI Toolkit let you create text controls for hand-written input. These are built from the complex functionality of handwriting translation, scribble collection, insertion pads, translation objects, and so on, which are explained in detail in *Part 5: Input and Handwriting Translation.*

The *Application Writing Guide* takes a tutorial approach towards some of the ideas in Part 4. The Tic-Tac-Toe program developed in the tutorial peforms the following tasks:

- Creates a menu bar of debugging commands.
- Creates a scroll window to scroll its board.
- Creates an option sheet containing numerous UI components.

In addition, sample programs that look like they create user interface components probably do create UI toolkit objects or subclass UI Toolkit classes. For example, the Calc program uses many UI Toolkit windows and nothing else for its user interface. The Clock sample program (which is also part of the standard set of tools) uses several approaches to layout classes to implement the clock display desired by the user.

The source to all these programs is in subdirectories of \PENPOINT\SDK\SAMPLE.

You can put together many different UI Toolkit component layouts. *PenPoint UI Design Reference* suggests appropriate ways to use the UI Toolkit in keeping with PenPoint's Notebook user interface.

Chapter 31 / Concepts and Terminology

Toolkit Classes 31.1

The UI Toolkit class hierarchy is large because there are so many different kinds of toolkit windows and controls. Figures 31-1 and 31-2 show the hierarchy of many of the UI Toolkit classes. Some UI Toolkit classes are not shown in these figures. For completeness, Figure 31-3 provides an outline view of the class hierarchy of all UI Toolkit classes.

The layering of the class hierarchy of UI components and their fluid design provide a framework for constructing a wide variety of user interface tools. While this makes it possible to create new and bizarre kinds of tools, deviations from the standard UI components can confuse users. For this reason, you should restrict yourself to the standard classes in the PenPoint UI Toolkit unless you can determine that none of them meet your needs.

Similarly, the UI Toolkit does not preclude other combinations of components besides those you see in PenPoint. For example, you can easily put a menu bar in the middle of an option sheet (not the right place for a menu bar). See the *PenPoint UI Design Reference* for information regarding the correct use of UI Toolkit components and suggested ways of combining them consistently.

Figure 31-1
UI Toolkit Classes Not Inheriting from clsControl

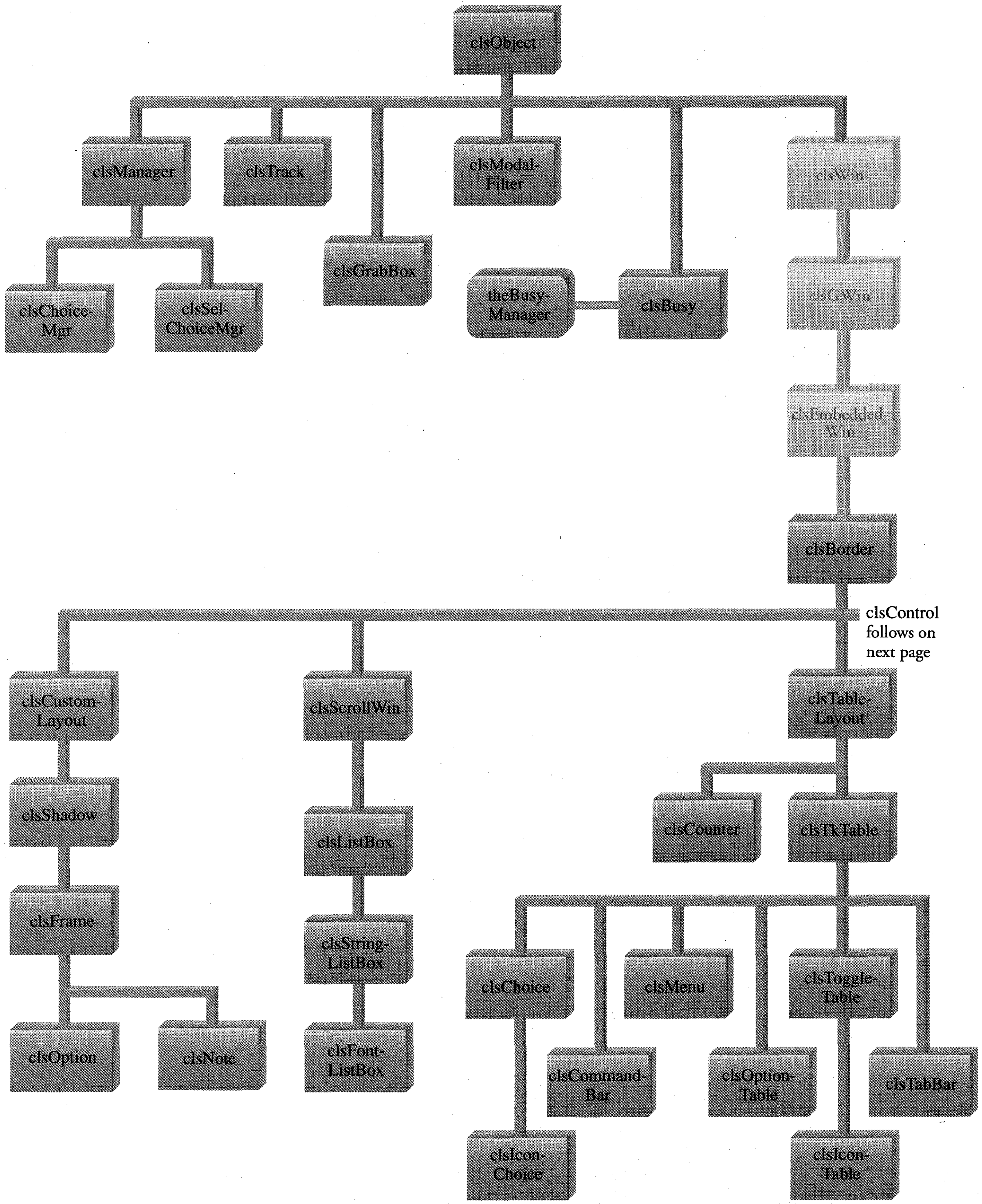


Figure 31-2
UI Toolkit Classes Inheriting from clsControl

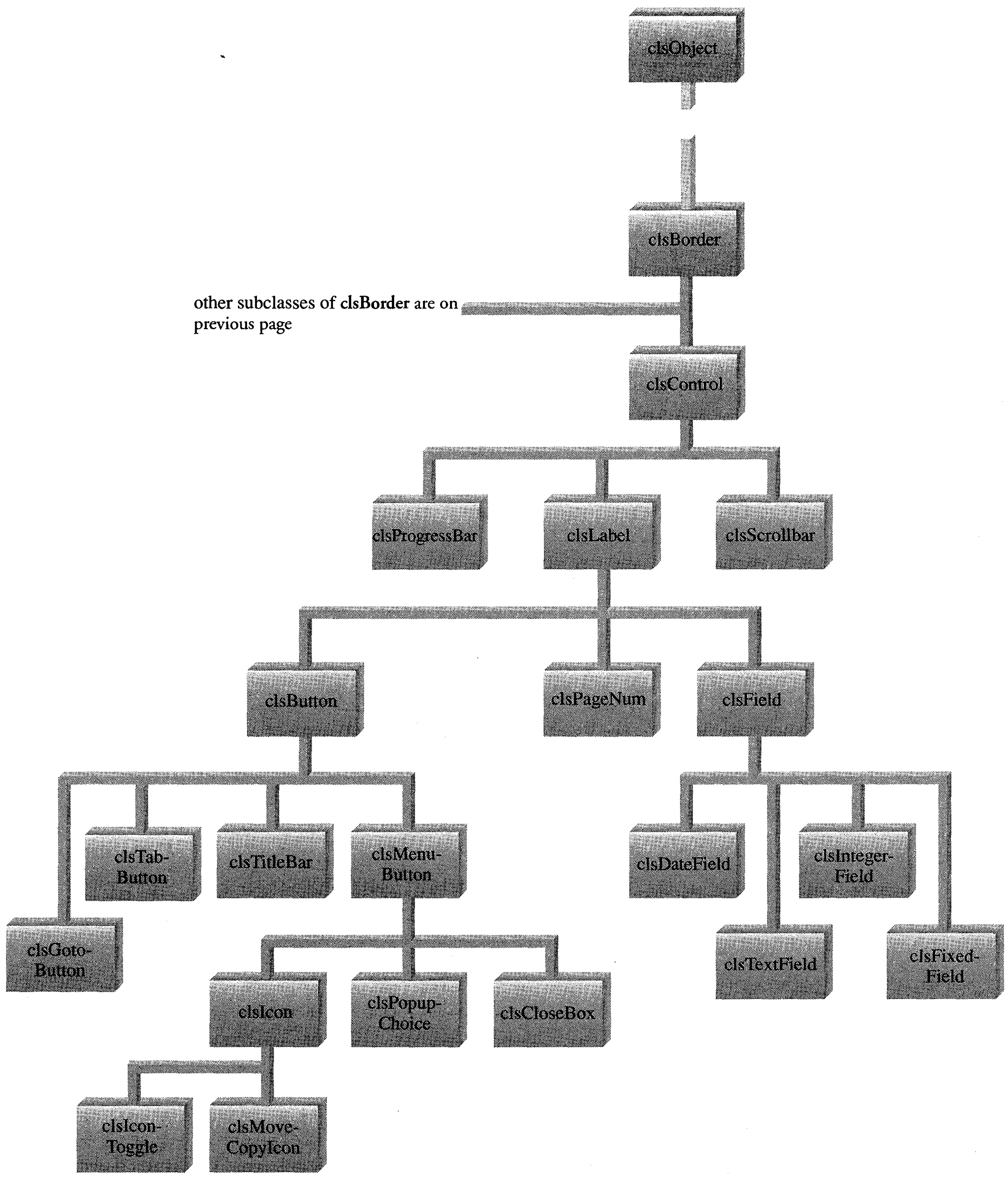


Figure 31-3
UI Toolkit Class Outline

```
clsObject
├─clsManager
│ ├─clsChoiceMgr
│ └─clsSelChoiceMgr
├─clsTrack
├─clsGrabBox
├─clsModalFilter
├─clsBusy
└─clsWin
  └─clsEmbeddedWin
    └─clsBorder
      ├─clsControl
      │ ├─clsLabel
      │ │ ├─clsButton
      │ │ │ ├─clsGotoButton
      │ │ │ ├─clsMenuButton
      │ │ │ │ ├─clsCloseBox
      │ │ │ │ ├─clsIcon
      │ │ │ │ │ └─clsMoveCopyIcon
      │ │ │ │ └─clsPopupChoice
      │ │ │ ├─clsTabButton
      │ │ │ └─clsTitleBar
      │ │ ├─clsField
      │ │ │ ├─clsDateField
      │ │ │ ├─clsFixedField
      │ │ │ ├─clsIntegerField
      │ │ │ └─clsTextField
      │ │ └─clsPageNum
      │ ├─clsProgressBar
      │ └─clsScrollbar
      ├─clsCustomLayout
      │ ├─clsAppWin
      │ ├─clsIP
      │ │ └─clsTextIP
      │ ├─clsPrintFrame
      │ ├─clsShadow
      │ │ └─clsFrame
      │ │   ├─clsNote
      │ │   └─clsOption
      │ └─clsView
      │   ├─clsNotePaper
      │   ├─clsSPaper
      │   └─clsTextView
      ├─clsScrollWin
      │ ├─clsBrowser
      │ ├─clsGestureMargin
      │ └─clsListBox
      │   └─clsStringListBox
      │     └─clsFontListBox
      └─clsTableLayout
        ├─clsCounter
        └─clsTkTable
          ├─clsChoice
          │ └─clsIconChoice
          ├─clsCommandBar
          ├─clsMenu
          ├─clsOptionTable
          ├─clsTabBar
          └─clsToggleTable
            └─clsIconTable
```

Four Kinds of Classes 31.2

There are many classes involved in UI components because the UI Toolkit separates the implementation of user interface components into different functional parts, with corresponding classes:

- Window border
- Layout
- Message dispatching
- Presentation/interaction behavior

Borders 31.2.1

clsBorder supports the border styles of windows in the PenPoint UI:

- None
- Black
- Double
- Gray
- Rounded
- Shadow
- Resizing from the shadow or drag handles
- Inner margins

The **clsBorder** shadow is not a true shadow with transparent corners; see clsShadow for a perfect shadow.

Layout 31.2.2

clsWin defines various layout messages and flags, plus related shrink-to-fit flags, but it does not itself implement layout policies for windows. **clsCustomLayout** and **clsTableLayout** implement two useful styles of layout. They do not determine how user interface components look; instead they specify how collections of user interface components are arranged. A layout window lays out its child windows according to these specifications. For example, a menu bar is a layout window that lays out its elements in a row.

Usually, you create layout windows to lay out the components of your dialog boxes and other windows. Although this use of layout windows is normally the most convenient, you can insert UI component windows in any kind of window. Conversely, you can use layout windows to lay out other kinds of windows than UI components.

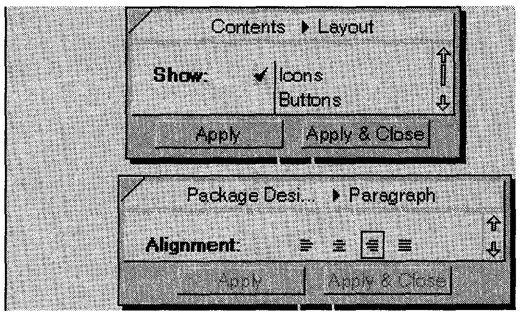
Nested Components

31.3

The UI Toolkit allows you to combine components together to create interesting new kinds of components. For example, a **scrollwin** groups two scrollbars with a client window so that the user can scroll the client window. As another example, a string list box is a kind of scrollwin whose contents are a set of string labels.

The most common form of nested components is a toolkit table. The descendants of **clsTkTable** group multiple windows (often buttons) together to form more complex toolkit components. For example, a choice component is a group of buttons, each set up to provide feedback with a check mark.

Figure 31-4
A Choice and its Component Buttons



In Figure 31-4, the Contents Layout option card includes a choice of two buttons: Icons and Buttons. The choice buttons preview in the normal way. And because only one button in the set can be on at any time, the choice must also manage the set of buttons. The buttons send preview messages (**msgButtonBeginPreview**, **msgButtonUpdatePreview**, **msgButtonRepeatPreview**, and **msgButtonCancelPreview**) to their **manager**, which in this case is their parent, the choice. The choice maintains a hidden manager object which responds to a choice button's preview message by turning off the currently selected button. When the user finally raises the pen, the button sends its client its **msgButtonNotify** or other specified message, and notifies its manager so that the manager knows which button is active.

Note that this choice is itself embedded in another window, the option card. The choice itself notifies its manager when the user raises the pen, and this sets the option.

Also note the many forms that a choice can take. By inserting different kinds of buttons in a choice and changing the choice's table alignment, you can create a choice like the Alignment choice in the MiniText Paragraph option card shown below the Layout card in Figure 31-4. It has the same manager protocol despite its different appearance.

Separating the manager object from the parent component supports other kinds of complex components, such as menus and selected choices. The details of this complex layered interaction are described in Chapter 38, Toolkit Tables.

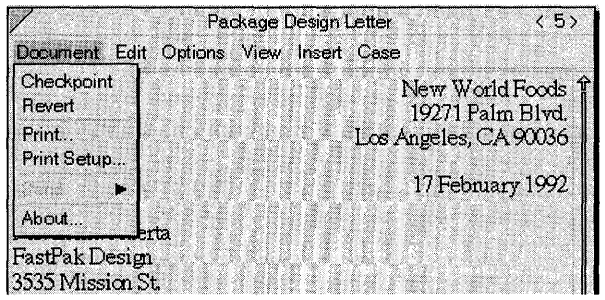
How Menus Work

31.3.1

Pull is a misnomer for the tap-based menu UI, but it survives in the API.

PenPoint's pull-right and pull-down menus may appear to be menus nested inside other menus inside other menus, but the reality is simpler. A menu bar is a toolkit table of several menu buttons (instances of **clsMenuButton**, a subclass of **clsButton**), and the latter may each be associated with another menu made up of other kinds of components. For example, Figure 31-5 shows the UI Toolkit components involved when you choose **About...** from the **Document** menu of MiniText.

Figure 31-5
Nesting of Controls in Menus



The **application menu bar** is a toolkit table of several menu buttons. In MiniText, the **Document** menu button has a menu associated with it, so it responds to previewing by displaying its menu. The Document menu is a separate toolkit table. Its manager is the **Document** menu button, but it is otherwise a separate window containing its own set of components. One of these components is the **About** menu button.

When the user taps on **About**, the button notifies its manager (the menu manager). The Document menu notifies its manager (the **Document** button), which sends a message which removes the Document menu from the screen. The **About...** button then notifies its client (the application) by sending it its message (**msgAppAbout**). Thus, there are two communication paths:

- Up the management chain.
- Directly to the client.

Note that in this example, the menu button, the menu bar, and the default application response are all handled by the PenPoint Application Framework. Even the simplest applications with the **Standard Application Menus** provided by the Application Framework display this menu and respond to it, without any special coding on your part.

Instance Creation and D‹ 31.4

As you can see from the class diagram, UI Toc ep.
Many descendant classes only work as docum ıtion
of their many ancestors. For example, buttons rtain
input flags set. However, UI Toolkit classes dc ɔle
msgNew arguments to ancestors, and they do
ancestors that might adversely affect their ope g for
performance reasons, and also because they are designed to be subclassed, and a subclass implementation might well want radically different behavior.

You must always send **msgNewDefaults** to a UI Toolkit class before sending it **msgNew** to create a new instance. This will ensure reasonable behavior from the component. The header files in \PENPOINT\SDK\INC for the various classes document the defaults initialization performed in response to **msgNewDefaults**; the same information is in the *PenPoint API Reference.*

You need to fill in some of the dozens of ancestor fields in the **msgNew** and msgNewDefaults structure, but tinkering with others may lead to unpredictable results. The header files describe the defaults for each class. You may find that to get a component to work in a way it was not intended to work, it may not be enough to change its style fields; you may need to create a new class.

Toolkit Tables 31.4.1

Toolkit tables provide a very different approach to creating UI components. You can declare the contents of a toolkit table statically in an array that specifies things like the string of a label, the number of columns in a field, and so on. However, you can also create components in the usual way by sending them **msgNew**, and then nest them in the toolkit table by sending it messages like **msgTkTableAddAsLast**. **clsTkTable** knows how to create standard instances of various components. See the example from the WriterApp sample program in Chapter 30.

This approach of static specification reduces code size and is much easier to maintain. If it's possible to create all or part of your UI as toolkit tables, you should do so. Toolkit tables foster a certain homogeneity among components, which is often what you want for standard application elements, such as menus and option sheets.

Filed Representation 31.5

Toolkit components file themselves. They also file their descendants. However, you may not want to take advantage of this.

There is a paradox at work in the UI Toolkit: toolkit components do an excellent job of filing their state, which is good, but to conserve memory, you don't want lots of static toolkit components around (either as live objects or filed) when your application is not on-screen.

Another paradox: toolkit components should reflect the state of the application, yet if you let them file, they duplicate the state of the application. For example, if your application has a choice with which the user picks either circle mode or rectangle mode, then when that choice is told to file, it will store the mode the user chose. However, your application should probably also be storing its current mode in its instance data or some other object. Keeping two copies of application state is wasteful and can lead to internal inconsistencies.

One Approach to Filing UI Toolkit Components 31.5.1

It is difficult to generalize, but here is a scheme for creating and filing UI Toolkit components that takes advantage of filing:

- Create your user interface in advance, for example in your application's INIT.DLL.
- File it as one or more well-known **resources**.
- You can then read your UI from the resource list in each document.
- Don't file UI components per document.
- File application state separately from UI.
- Set UI state from application state.

This approach avoids duplicate filed copies of UI components in each document.

Layout Speedup 31.5.2

You can also file the UI in advance to speed up layout. When windows file, they store their bounds. If, when a window restores, it is positioned with the same bounds as when it was filed (and if some other conditions are met), it need not lay out, nor lay out its children—the sizes computed for the windows are valid. This layout saving can speed up performance, especially when the parent window has many descendant windows.

Windows filed with dirty layouts (**wsLayoutDirty** set) will require layout whenever they are restored, reducing the efficiency of your application. To prevent this, send **msgWinLayout** to the topmost window before filing the windows. Another window style flag, **wsFileLayoutDirty**, ensures that the **wsLayoutDirty** flag is set whenever the window is restored from a file.

This may not work as you expect, depending on decisions made in the PenPoint Application Framework about when or whether to lay out.

Other Benefits of Using Resource Files 31.5.3

There are other benefits to using resource files:

- If the environment is the same when the UI is read from the resource file, its windows won't have to lay out again—the sizes computed for the windows that were filed with them will be correct. However, if the top-most window is a frame or client window, it may still be laid out as a result of the user floating, zooming, or resizing the window.

- The code that uses the UI can be independent of the code that creates it. The code that uses the UI just reads it from a resource file, without concern for the appearance of the UI. Someone could, in theory, replace the filed UI with a different resource, and the application would still work the same. (Note that the application often has to reach in and send specific messages to controls in the UI, so this degree of independence is hard to achieve in practice.)
- The code to create the UI can, in fact, be deleted after instance zero runs it. The document instances never create the UI, they read it from the application's resource list, so as part of installation you could deinstall the installation code. One way to do this is to have your UI creation code in a separate INIT.DLL that the Installer automatically runs at installation and then immediately deinstalls.

UI Toolkit Programming Details 31.5.4

In instance zero of your application, create the UI. You could do this in a separate INIT.DLL; when its **DLLMain** routine is called by the Installer, create the UI.

After creating the UI, send **msgWinLayout** to the highest level component (such as the frame, or the option sheet) of each subtree. Then file the components you want in the application's resource file. You can get the application resource file by sending **msgAppMgrGetMetrics** to the class of your application.

In the other instances of your application (each document), respond to **msgAppOpen** by reading in the filed instance information. Instead of reading the information from the application resource file, just get the application's resource list from its application metrics, and read the resource from that. This allows the default UI to be overridden in one document or another.

Make sure you turn off the **wsSendFile** window flag of components in your main window that came from a resource file so that they aren't filed by **clsWin** when the PenPoint Application Framework files your application's frame.

Chapter 32 / Toolkit Ancestors

As you've probably noticed, there are many classes in the UI Toolkit. Some of them provide obvious visual components. Others, such as **clsControl** and **clsTableLayout**, provide vital support for other classes. Moreover, all classes in the UI Toolkit are descendants of **clsGWin**.

All the functionality provided by these ancestor classes is available to you. The **msgNew** arguments for any visual toolkit component include OBJECT_NEW_ONLY, WIN_NEW_ONLY, GWIN_NEW_ONLY and EMBEDDED_WIN_NEW_ONLY fields. You can send object, window, gesture window, and embedded window messages to toolkit components.

However, be aware that toolkit components rely on certain behavior from their ancestor classes. Changing around ancestors may produce unexpected results. You should rely on **msgNewDefaults** to set up the ancestor fields appropriately. Only change them if a component does not operate as you want.

This chapter explains how toolkit components use features provided by ancestor classes. It's intended to illustrate rather than explain in detail.

Objects 32.1

All toolkit components are objects.

Often, toolkit windows are embedded inside other toolkit windows. The parent component may not know in advance what kind of components are inside itself. Thus, toolkit sometimes ask their nested components what their class is (**msgClass**), or whether they inherit from a particular class (**msgIsA**).

Some of the machinery of the toolkit is implemented by objects you might not know about. Many toolkit classes allow you to plug in other objects as their children, managers, or clients. Never assume that you know the class of an object passed back by the toolkit.

Windows 32.2

All visual toolkit components are windows. They use **clsWin** messages and functionality for obvious things such as painting and UI component resizing.

The UI Toolkit nests components inside other components (such as buttons in menus, labels in tables, fields in option sheets, and so on) by inserting them as child windows of the parent component. Thus, the hierarchy of toolkit components corresponds to the window tree. The UI Toolkit takes advantage of this correspondence to perform the following tasks:

- List nested components using **msgWinEnum**.

- Find nested components by tag using **msgWinFindTag**.
- Send messages from nested components to their ancestors using **msgWinSend**.
- Propagate and respond to the layout messages **msgWinLayoutSelf** and **msgWinGetDesiredSize**.

This nesting of components isn't always what you might expect. For example, the client window inside a scrollwin is not a child of the scrollwin: it is actually a child of a child of the scrollwin. The pop-up menu associated with a menu button isn't a child of it, but a child of the the root window.

Repaint 32.2.1

The UI Toolkit handles window repainting itself, so you rarely need to intercept **msgWinRepaint** yourself. The UI Toolkit carries out all its drawing operations using a private toolkit drawing context shared between all processes. You cannot access this DC. However, several of the toolkit component classes let you affect the drawing of components by setting certain metrics, such as background ink and border thickness.

Filing 32.2.2

The UI Toolkit does an excellent job of filing its state. All (well, nearly all) components are windows, so you can use the window hierarchy filing provided by **clsWin** to file your entire user interface.

Gesture Windows 32.3

Most UI Toolkit components support **gestures**, in which the user handwrites a symbol in the component. For example, the user can flick a vertical scrollbar up or down by drawing an up or down stroke. **clsGWin** supports gestures in windows; it handles the pen input, deciding when the user has completed the gesture, and the translation of the gesture. It self-sends **msgGWinGesture** announcing the translation of the gesture. The interpretation of the gesture is up to descendant classes.

To disable gesture support, set **gestureEnable** in GWIN_STYLE to **false**.

Gesture Propagation 32.3.1

In the PenPoint user interface, gestures should propagate up the window tree whenever possible. For example, a scrolling flick made on a label inside a table inside a scrollwin should be passed up to the scrollwin, which will scroll the entire table. Also, a question mark over one button of an exclusive choice should generate help on the choice, rather than Help on the particular button of the choice.

How this works in practice is **clsGWin** has a forwarding flag in GWIN_STYLE (**gestureForward**) set by default. When the user makes a gesture over a gesture window, it self-sends **msgGWinGesture**. If no descendant class handles **msgGWinGesture**, the message ends up at **clsGWin**. If the gesture is not the Help gesture, **clsGWin** returns **stsRequestForward**. If **clsGWin** gets **stsRequestForward** back from sending **msgGWinGesture**, it assumes that this object did not handle the gesture.

If **gestureForward** is set, **clsGWin** then propagates the message by self-sending **msgWinSend** with the sent message field set to **msgGWinForwardedGesture**. **msgWinSend** propagates up the window tree. If it arrives at **clsGWin**, **clsGWin** unpacks the **msgGWinForwardedGesture** message and self-sends it. If **msgGWinForwardedGesture** returns **stsRequestForward**, **msgWinSend** goes to the ancestor class.

This scheme allows components to be embedded in other windows (possibly non-toolkit windows) without regard for tying them to a client, and still let some window pick up their gestures. For example, all the frame components have their gestures passed on via **msgWinSend** of **msgGWinForwardedGesture**, and the frame would pick them up.

The GWIN_GESTURE structure for the message arguments to **msgGWinGesture** and **msgGWinForwardedGesture** includes a **uid** field. **clsGWin** sets this field to the UID of the window that received the gesture. Thus, if you have a parent window that handles the gestures in child windows, it can still figure out which child window received the gesture.

Responding to Gestures 32.3.2

If you create your own UI component class and want your class to respond to gestures, your class should intercept **msgGWinGesture**. If your class recognizes the gesture, it should respond to it and return **stsOK**. If your class doesn't recognize the gesture, it should pass the gesture to its ancestor class. If none of the ancestors handle the gesture, **clsGWin** will propagate the gesture to the instance's parent window (if **gestureForward** is set).

If you create your own UI component class and want to respond to gestures made in child windows embedded in instances of your class, your class needs to respond to **msgGWinForwardedGesture**. This message takes the same arguments as **msgGWinGesture**. If your class doesn't distinguish between gestures in its own windows and the gestures of their children, your class can handle both gesture messages in the same procedure. You can self-send **msgGWinTransformGesture** to transform the gesture bounds and hot point to the local window coordinate system from the coordinates of the original window.

If your class uses instances of **clsControl** or one of its many descendant classes, your class can get involved in gesture handling by setting up one of its objects (such as the application) to be the client of a control. As explained in Chapter 35, Controls, **clsControl** forwards gestures to its client. A control is sent gesture messages, which it sends to its ancestor class, and then passes to its client object, and then propagates to its parent window.

Help IDs 32.3.3

clsGWin does interpret one gesture: the Help ? gesture. If no other class handles **xgsQuestion** during all the propagation described above, when it reaches **clsGWin**, it will try to display Quick Help by sending self **msgGWinHelp**. You can assign a Quick Help ID to any gesture window (in **clsGWin**'s metrics), and **clsGWin** will find the Quick Help resource for that window and display it in the Quick Help window using **msgQuickHelpShow**. If the window does not have a Quick Help ID, **clsGWin** propagates **msgGWinForwardedGesture** in the manner described above.

For more information on creating Quick Help resources, see *Part 9: Utility Classes.*

Embedded Windows 32.4

In PenPoint, you can freely move and copy applications and components into and out of each other. The result that one application or component is **embedded** inside another. **clsEmbeddedWin** supports the protocol for moving and copying applications and components by moving their windows.

All UI Toolkit windows are embedded windows. However, the UI Toolkit does not use the features of **clsEmbeddedWin** much itself, since UI components cannot, in fact, be moved using the press-hold-and-drag technique.

Descendants of toolkit window classes that implement real components, such as text views and application windows, do use **clsEmbeddedWin** functionality. **clsEmbeddedWin** uses special move or copy icons during move and copy operations.

For more information on embedded windows and the move/copy protocol, see *Part 2: PenPoint Application Framework.*

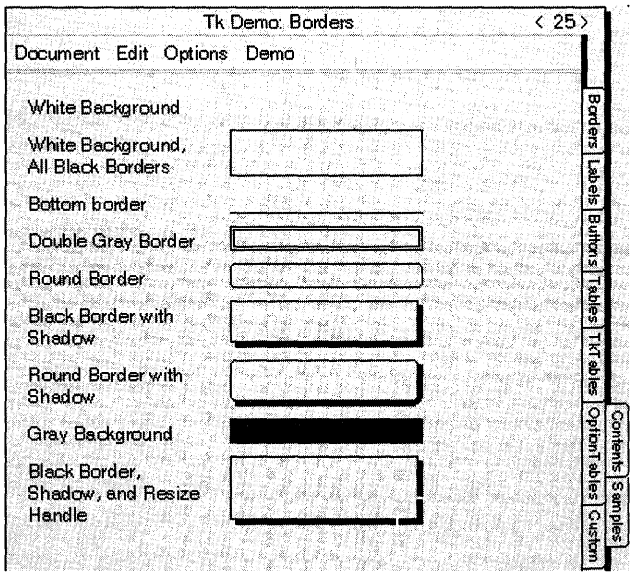
Borders 32.5

UI Toolkit components are descendants of clsBorder, which implements much of the rendering and layout ability of UI toolkit windows. See Chapter 33, Border Windows, for more information on clsBorder.

Chapter 33 / Border Windows

Many UI components have similar visual elements, such as background colors, shadows and outlines. To share code, all UI Toolkit classes are descendants of **clsBorder** (a descendant of **clsWin**), which draws these elements.

Figure 33-1
Sample Border Windows



clsBorder Messages 33.1

Table 33-1 summarizes the messages **clsBorder** defines. The sections following discuss these message in more detail.

Table 33-1
clsBorder Messages

Message	Takes	Description
Class Messages		
msgNewDefaults	P_BORDER_NEW	Initializes the BORDER_NEW structure to default values.
msgNew	P_BORDER_NEW	Creates a border window.
Attribute Messages		
msgBorderGetStyle	P_BORDER_STYLE	Passes back the current style values.
msgBorderSetStyle	P_BORDER_STYLE	Sets all of the style values.
msgBorderSetStyleNoDirty	P_BORDER_STYLE	Sets all of the style values.
msgBorderGetLook	P_U16	Passes back value of style.look.

continued

Table 33-1 (continued)

Message	Takes	Description
msgBorderSetLook	U16 (bsLook...)	Sets style.look as in msgBorderSetStyle.
msgBorderSetPreview	BOOLEAN	Sets style.preview as in msgBorderSetStyle.
msgBorderGetPreview	P_BOOLEAN	Passes back value of style.preview.
msgBorderSetSelected	BOOLEAN	Sets style.selected as in msgBorderSetStyle.
msgBorderGetSelected	P_BOOLEAN	Passes back value of style.selected.
msgBorderPropagateVisuals	pNull	Propagates visuals to children.
msgBorderSetDirty	BOOLEAN	Recursively sends msgBorderSetDirty to each child.
msgBorderGetDirty	P_BOOLEAN	Passes back true if any child responds to msgBorderGetDirty with true, otherwise passes back false.
msgBorderGetForegroundRGB	P_SYSDC_RGB	Passes back forground RGB to use given current visuals.
msgBorderGetBackgroundRGB	P_SYSDC_RGB	Passes back background RGB to use given current visuals.
msgBorderInkToRGB	P_SYSDC_RGB	Maps ink value (bsInkGray66, for example) to RGB.
msgBorderRGBToInk	P_SYSDC_RGB	Maps RGB value to ink value.
msgBorderSetVisuals	P_BORDER_STYLE	Sets only the visual fields from pArgs.
		Border Geometry Messages
msgBorderGetBorderRect	P_RECT32	Passes back the rect on the border.
msgBorderInsetToBorderRect	P_RECT32	Assumes given rect is window bounds, insets to border rect as in msgBorderGetBorderRect.
msgBorderGetInnerRect	P_RECT32	Passes back the rect after the inner margin.
msgBorderInsetToInnerRect	P_RECT32	Assumes given rect is window bounds, insets to inner rect as in msgBorderGetInnerRect.
msgBorderGetMarginRect	P_RECT32	Passes back the rect after the border.
msgBorderInsetToMarginRect	P_RECT32	Assumes given rect is window bounds, insets to margin rect as in msgBorderGetMarginRect.
msgBorderGetOuterSize	P_SIZE32	Passes back the sum of the border, margin and shadow sizes for width and height.
msgBorderGetOuterSizes	P_RECT32	Passes back the breakdown of the outer size requirements.
msgBorderGetOuterOffsets	P_RECT32	Passes back the distance from the outer edge to the border rect in each dimension.
		Rendering Messages
msgBorderXOR	U16	Sets the raster-op to XOR and paints the background.
msgBorderPaint	VOID	Paints the border, background, shadow, and so on using msgWinBeginPaint.
msgBorderFlash	VOID	Flashes self's window by drawing a thick border and erasing it.
msgBorderTop	U32	Brings the border window to the front with optional UI feedback.
msgBorderConvertUnits	P_BORDER_UNITS	Converts values from one unit to another.

continued

Table 33-1 (continued)

Message	Takes	Description
		Subclass Responsibility Messages
msgBorderProvideDeltaWin	P_WIN	Receiver must provide window to be dragged, resized or topped.
msgBorderProvideBackground	P_BORDER_BACKGROUND	Receiver must provide rect and ink for drawing background.
msgBorderPaintForeground	VOID	Receiver must paint the foreground, if any.

Creating a Border Window 33.2

To create a border window, you send **msgNew** to **clsBorder** or one of its many descendants. This takes a pointer to a BORDER_NEW structure. In BORDER_NEW you specify:

style several style flags

These style flags are (currently) the only field in BORDER_NEW_ONLY. The flags are in a BORDER_STYLE structure and are summarized in Table 33-2.

These are among the most important clsBorder flags. See the *PenPoint API Reference* and BORDER.H for more information on clsBorder flags.

You can set the style flags after sending **msgNew** with **msgBorderSetStyle**.

The border itself is not a separate window, it is just additional graphics drawn inside UI component windows by their common ancestor, **clsBorder**.

Table 33-2
BORDER_NEW Styles

Styles/Style Flags	Functional Description
edge bsEdgeLeft bsEdgeRight bsEdgeTop bsEdgeBottom	Defines which edges have borders. Can be bsEdgeAll, bsEdgeNone, or a combination OR'd together.
join bsJoinRound bsJoinSquare bsJoinEllipse	Describes how borders edges are joined.
lineStyle bsLineSingle bsLineDouble bsLineMarquee bsLineDashed bsLineDoubleMarquee bsLineDoubleDashed	Describes line border thickness.
borderInk	Describes ink to draw border.
backgroundInk	Describes ink to fill background.

continued

Table 33-2 (continued)

Styles/Style Flags	Functional Description
shadow	Describes border edge shadow style.
bsShadowNone	
bsShadowThinGray	
bsShadowThickGray	
bsShadowThinBlack	
bsShadowThickBlack	
bsShadowThinWhite	
bsShadowThickWhite	
bsShadowCustom	Use shadowThickness and shadowInk.
bottomMargin, leftMargin, rightMargin, topMargin	Describes the four inner margin sizes, in marginUnits (described below), of the component's window. Value can be anywhere from 0-15; some common values predefined.
bsMarginNone	No inner margin.
bsMarginSmall	One margin unit.
bsMarginMedium	Two margin units.
bsMarginLarge	Eight margin units.
marginUnits	Units for the four inner margins.
bsUnitsLayout	Use layout units (described below).
bsUnitsDevice	Use device units (pixels).
bsUnitsTwips	Use twips (0.05 points).
bsUnitsPoints	Use points (1/72 inch).
bsUnitsLines	Use system font line size.
bsUnitsRules	Use rules (0.05 lines).
bsUnitsMetric	Use units of 0.01 millimeters.
bsUnitsMil	Use mils (0.001 inch).
bsUnitsFitWindow	Compute units at layout time.
bsUnitsFitWindowProper	Compute units at layout time and preserve aspect ratio.
shadowGap	Determines whether the shadow contains notches.
bsGapNone	No corner gaps.
bsGapWhite	Clear gaps to white.
bsGapTransparent	Don't paint gaps.
resize	Determines if UI component window has resize handles. A set of flags.
bsResizeNone	No resize handles; the default.
bsResizeCorner	Lower right corner handle. User can resize in both dimensions.
bsResizeBottom	Bottom edge handle. User can resize vertically.
bsResizeRight	Right edge handle. User can resize horizontally.
bsResizeAll	A combination of bsResizeBottom, bsResizeCorner, and bsResizeRight.
drag	Determines if and how user can drag UI component.
bsDragNone	No dragging.
bsDragHoldDown	Drag when user press-holds down pen.
bsDragDown	Drag when user touches pen.
bsDragMoveDown	Drag when user moves pen while down beyond threshold.
top	Determines if and how user can bring border window to front of its siblings.
bsTopNone	Never top window.
bsTopUp	Top window when user lifts pen.
bsTopDrag	Top window after user drags it.

continued

Table 33-2 (continued)

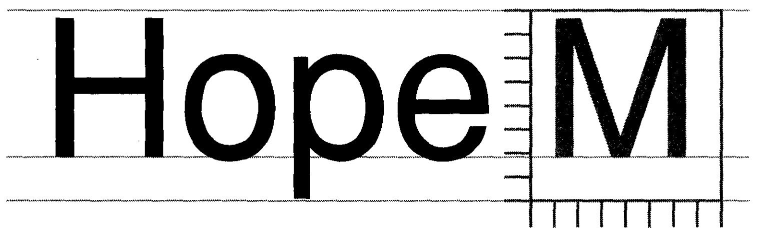
Styles/Style Flags	Functional Description
getDeltaWin	Determines if changing this window should affect it or other windows (see msgBorderProvideDeltaWin).
preview	Determines whether window is previewing.
selected	Determines whether window is selected.
previewAlter	Determines what to alter when window is previewing.
selectedAlter	Determines what to alter when window is selected.

The bsUnitsLayout Measurement 33.3

The **bsUnitsLayout** unit is scaled so that eight horizontal units are the width of a typographer's em in the system font, and eight vertical units are the height of an em.

For example, if the user sets the system font to eight points, then a **bsUnitsLayout** unit is one point; if the user sets the system font to 16 points, a **bsUnitsLayout** unit is two points. Also, an em is always square, regardless of whether any character in the font is square. Therefore, **bsUnitsLayout** units are always square. For more information on font geometry, see *Part 3: Windows and Graphics.*

Figure 33-2
Layout Units



Painting a Border Window 33.4

In repaint, first **clsBorder** draws the background and border, then descendant classes draw the contents of the window. If the window's size is fixed and the contents are too large, they may overflow the margin, border, and shadow. Descendants should send **msgBorderGetInnerRect** to figure out the area in which they should draw.

Painting the Border 33.4.1

msgDcDrawRect draws borders with square or rounded corners and the specified thickness. If you specify that only some edges should be drawn, **clsBorder** draws only those edges, maintaining the join style. If the join style is **bsJoinEllipse**, **clsBorder** uses **msgDcDrawEllipse** to draw the joint.

Painting the Background 33.4.2

clsBorder fills the background with **backgroundInk** when it calls **msgDcDrawRect.**

In a rounded-corner border window, there are gaps in the corners that the border line will not touch. If the border window shares clipping with its parent (**wsParentClip** is set to **true**) and the parent can write on its children (**wsClipChildren** is **false**), **clsBorder** relies on the parent filling in these dog-ears. Otherwise, **clsBorder** clears the entire background rectangle to the background ink. If the background ink is **bsInkTransparent**, the background is not drawn at all.

Painting Background and Foreground 33.4.3

If a **clsBorder** instance isn't selected or being previewed, it uses the **backgroundInk** you specify. If selected or previewing, then the background ink is changed to look like the window is selected or previewing. What this looks like depends on which subclass of **clsBorder** you are working with.

You can't set the foreground ink directly. Instead, you choose a **look**, which gives you either a black or gray foreground color. Rather than directly controlling the foreground color and style of painting, you set certain properties of the border window in its BORDER_STYLE field that affect painting. These properties are called the visuals of the bordered window. They are the **look, preview, selected,** and **backgroundInk** fields in the border style.

The look (**bsLookActive** or **bsLookInactive**), preview, and selected fields all affect the foreground color. The look takes precedence.

Descendants and Colors 33.4.4

It's entirely possible for you to create your own toolkit component classes. However, if these are to work well with option sheets, menus, and other existing components, they need to respond to changes in visuals. Rather than reimplement all the border messages, it's easiest to inherit from **clsBorder** and let it handle these messages.

It is much better to change visuals rather than to force windows to use a different color; using the colors suggested by **clsBorder** will ensure that your own UI gadgets have a similar interaction behavior to PenPoint's own components.

If, when you receive **msgWinRepaint**, you do inherit from **clsBorder**, you should probably use the same colors for drawing as all other buttons and labels use. **clsBorder** provides several messages that help you translate its current state into specific colors to use, without having to hard-code the relationships between different visuals, selected state, and colors. To get the correct foreground and background colors, send **msgBorderGetForegroundRGB** and **msgBorderGetBackgroundRGB. clsBorder** also provides **msgBorderInkToRGB,** which maps the ink value of the line used for the border to an RGB value, and its inverse, **msgBorderRGBToInk.**

Providing Custom Backgrounds 33.4.5

clsBorder provides another way for its descendants to adjust background painting. When **style.preview** or **style.selected** is on, **clsBorder** self-sends **msgBorderProvideBackground** during repaint. Subclasses can intercept this message and alter the background ink and the rectangle used by **clsBorder** (or both) during repaint of the background. This takes a pointer to a BORDER_BACKGROUND structure, in which you specify these parameters:

ink	the background ink to use, for example, **bsInkBlack.**
rect	the rectangle that **clsBorder** should fill with the background ink.

clsBorder fills these in with the ink and color it would use before sending **msgBorderProvideBackground** to self.

Painting the Shadow 33.4.6

The shadow is also part of the window. It is drawn on the bottom and right of the main part of the window. If the **shadowGap** style field is **bsGapNone**, the shadow extends to the left and top of the rest of the window. Otherwise, there are two gaps at the top and left of the shadow. The other values of the **shadowGap** style field control how these gaps are painted. If the **shadowGap** is **bsGapWhite**, they are cleared to white. If it is **bsGapTransparent**, they are not painted, and what is behind the border window shows through the gaps.

Resizing, Dragging, Topping 33.5

If **resize** is on, the user can grab onto a resize corner or edge of a toolkit window. If **drag** is set to a style other than **bsDragNone**, the user can hold the pen down and then drag the window, and if **top** is set to a style other than **bsTopNone**, the user can bring the window to the front of its siblings (or push it to the back if it is already at the front). Normally, these actions affect the size and location of self—the user resizes this window, and it changes size.

Delta Window 33.5.1

However, often the window with drag, resize, and/or top enabled is actually inserted in another window. For example, the part of a frame with a resize handle may actually be a child of another window that contains the shadow and tabs, and it is the latter that needs to be dragged or resized when the user adjusts the size. To support this (if **getDeltaWin** is on), **clsBorder** uses **msgWinSend** to send **msgBorderProvideDeltaWin** up the window tree to get the window dragged, resized, or topped. When **clsBorder** receives **msgBorderProvideDeltaWin**, it returns self's UID if **getDeltaWin** is set to **false**; otherwise, it lets the message continue to its parent. The result is that the first window found without **getDeltaWin** set is the one that gets dragged, resized, and topped.

Layout 33.6

If you turn on borders and shadows after creating a border, you increase the space needed by a toolkit window, so you should lay out the window again. **clsBorder** dirties the window's layout when you change its style, but it doesn't actually send it **msgWinLayout**. You need to send **msgMinLayout** to the border window or its parent window.

Avoiding Repaint and Relayout 33.6.1

Normally, when you send **msgBorderSetStyle**, the border window figures out whether the change requires laying out the window again or repainting the window. If it repaints one or the other, the border window self-sends **msgWinDirtyRect** and **msgWinSetLayoutDirty**. The former would usually cause the border window to repaint, and the latter would result in the border window being relaid out in the next layout episode. It's up to you to make sure that, at some point, you send **msgWinLayout**. However, if you send **msgBorderSetStyleNoDirty**, neither of these is sent to self, even if the new pixels would dirty the window. This is an optimization for cases where you want to avoid the computation and messages related to calculating the dirty region.

Propagating and Notifying Visuals 33.7

To support the nesting of components, you want to create high level components out of other components, and have the high level component work as though it were a single control. Thus, you want the components nested within it to share the same visual appearance. By setting **propagateVisuals**, any changes in visuals (look, preview, selected, and background ink) are propagated to child border windows using **msgBorderSetVisuals**.

If you only want this to happen on demand, you can send **msgBorderPropagateVisuals** to the border window to update child border windows only once.

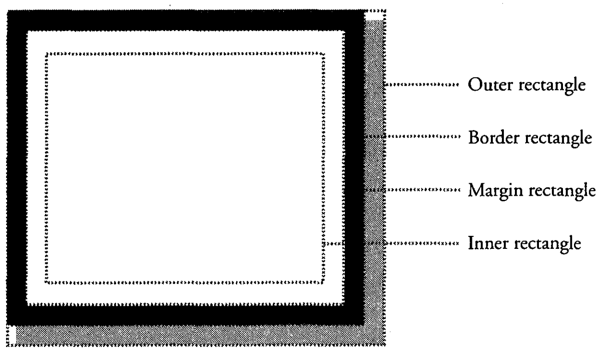
This works if the components are nested windows. However, if they are not, you can still keep changes in sync by making components observers of the border window and set **notifyVisuals**. Whenever the visuals of the border window change, the observers are sent **msgBorderSetVisuals** (via **msgNotifyObservers**).

Border Geometry

33.8

There are four regions to each border window, as illustrated in Figure 33-3:

Figure 33-3
Regions of a Border Window



- The outer size of the border window, including border and shadow.
- The size of the bordered area, excluding the shadow.
- The size of the margin area.
- The size of the inner area, excluding the border, shadow, and margin.

The size of the inner rectangle is the size of the margin rectangle less the left, right, top and bottom margins. You control the size of the margins by setting **leftMargin**, **rightMargin**, **bottomMargin**, and **topMargin** in BORDER_STYLE to some value. The contents of the window are drawn by some subclass of **clsBorder**.

The default margin units are layout units, so the margins scale with the size of the system font.

Although a border window is a single window, you can find out the size of the various parts of it using **msgBorderGetBorderRect**, **msgBorderGetInnerRect**, and **msgBorderGetOuterSize**. These all pass back the appropriate dimensions in LWC (device units relative to the lower left corner of the window) as a RECT32 or SIZE32.

Often, the current size of the border window is not the final size, so you want to compute the size of the border rectangle and inner rectangle. **msgBorderInsetToBorderRect** and **msgBorderInsetToInnerRect** compute the border and inner rectangles for the border window as if it were the size of the rectangle passed in.

Conversely, you can self-send **msgBorderGetOuterSize** to get the total size (including the border, margin, and shadow) for a particular size of border window. This is useful for subclasses of **clsBorder** that are trying to compute their size in response to **msgWinLayoutSelf**.

Outer Offsets 33.8.1

The shadow and its border take up some amount of the outside edge of a window. To zoom a window to fill another appropriately, you need to know where the inner part of the window is so you can push all this border out of the way. If you send **msgBorderGetOuterOffsets** to a border window, it passes back a RECT32. These aren't the coordinates of a rectangle; they are the lengths of the offset of this inner area from the four edges. For example, the **origin.x** is the distance from the left edge to the left-most pixel of the inner area, and the **size.h** is the distance from the top edge to the top-most pixel of the inner area .

Subclassing clsBorder 33.8.2

If you are implementing a descendant of **clsBorder**, you need to draw inside the rectangle passed back by **msgBorderGetInnerRect**. To respect visuals, you should use **msgBorderGetForegroundRGB** to figure out what color to use for foreground.

Chapter 34 / Layout Classes

The layout window classes orchestrate the recursive layout of a subtree of windows. Broadly speaking, **clsTableLayout** positions windows in a tabular format, while **clsCustomLayout** aligns windows relative to each other. You can use these to create pleasing high level user-interface constructs, such as an option sheet. The UI Toolkit itself uses table layout for menus, choices, and other toolkit tables. The built-in frame class is a particular kind of custom layout window.

clsWin defines the layout protocol, its messages, and window flags; see *Part 3: Windows and Graphics* for a full explanation. As part of a layout episode, windows are told to lay themselves out with **msgWinLayoutSelf**. Layout uses a model in which the parent gets desired sizes from child windows, then decides how to position and size the children.

You can position windows of any kind using layout windows, not just control windows. For example, if you have two or more windows in your application, you can create a layout window as the frame's client view, and use the layout window to position them.

Clients ordinarily tell a layout window to position its offspring by sending it **msgWinLayout**. The window system figures out what subtree of the window hierarchy will be affected by the change in layout, and coaxes windows into position by sending them **msgWinLayoutSelf**.

Window Layout 34.1

When a layout window receives **msgWinLayoutSelf**, it asks each child for its desired size with **msgWinGetDesiredSize** and, using algorithms from its class and data supplied when it was created, it positions and resizes its children. As a side effect of asking for the child's desired size, the window system may, in turn, ask the child to lay itself out with **msgWinLayoutSelf**.

This message is defined by **clsWin** and is fully explained in *Part 3: Windows and Graphics*, but here is a review. **msgWinLayoutSelf** tells a window to determine how best to lay itself out, then tells it to go and do so. Re-laying out usually involves moving child windows around. **msgWinLayoutSelf** takes a WIN_METRICS structure that contains a flag indicating whether the window can change its own size (**wsLayoutResize**).

The two layout window classes generally work as follows:

- You specify instructions on how a layout window should lay out its child windows. The layout window instance stores this information, not the children.
- You add child windows to the layout window using **msgWinInsert**.

When a layout window receives **msgWinLayoutSelf**, it:

- Gets the sizes of its child windows (using **msgWinEnum**).
- Computes new locations (and possibly sizes) for its child windows based on their sizes, possibly their desired sizes, and its specifications for them.
- Sends each child **msgWinDelta** to position it.
    - If positioning the child changed the child's size, the window system sets the window's wsLayoutDirty bit. Later, when the window system sends the child **msgWinLayoutSelf**, the dirty window will lay itself out to fit the new space.
- If **wsLayoutResize** is set, the layout window can change its own size. You can set up a layout window to **shrink-wrap** around its children by settings its **wsShrinkWrapWidth** and **wsShrinkWrapHeight** window style flags.

clsTableLayout and clsCustomLayout 34.1.1

Note that the layout window does not have to pay attention to the desired size of child windows. The parent can simply tell them where to go. In the UI Toolkit, most **leaf** controls (non-nesting controls such as labels, buttons, and so on) respond to **msgWinLayoutSelf** by recomputing their size based on the current system font.

clsTableLayout lays out its children in an invisible tabular grid. It takes constraints for the row and column dimensions of the grid (for example, three rows tall with each column as wide as the widest entry). By looking at the size of its child windows, it computes the grid layout and positions its children. You can tell **clsTableLayout** to resize its child windows to match the space it computes for them.

clsCustomLayout takes constraints for the size and position of each child window (for example, align on left edge, position after left of window A, extend height to top edge of parent) and figures out how to position and size them when it receives **msgWinLayoutSelf**. **clsFrame** uses **clsCustomLayout** to provide a consistently decorated top-level frame window for applications.

Because **clsCustomLayout** requires you to specify layout contraints for each dimension of every window in the layout, it is best suited for a small, relatively fixed number of child windows, such as the **decoration windows** that implement the controls on an application frame.

Coordinate System 34.2

Layout classes take lengths and positions in any of the measurement units that clsBorder supports. The lower left corner is the origin, as standard in PenPoint graphics.

Table Layout

34.3

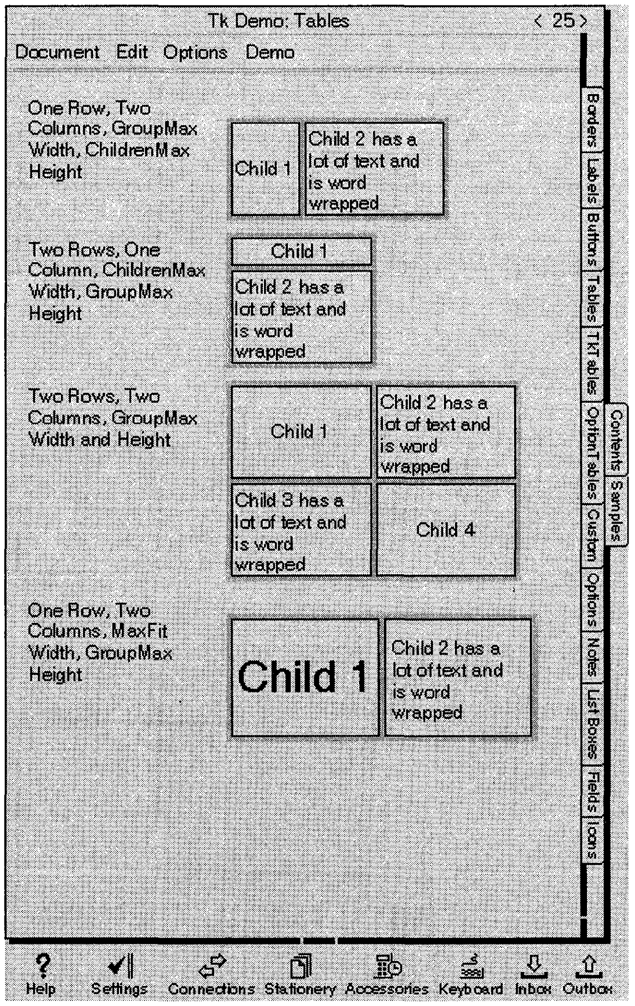
clsTableLayout lays out child windows in tabular format. You specify constraints for the number of rows and columns, the height of each row, and the width of each column. The table layout window does not store any constraints for particular items, rows, or columns. However, you can tell it to adjust the size of each column to fit its members. For example, you can specify layouts:

- Child windows in three rows and two columns.
- Each row 10 units tall as many as will fit; three columns each as wide as the widest entry.
- Two columns of menu buttons, the buttons in each column to be the same width as the widest button in that column.

All of the UI Toolkit's nested control windows—choices, menus, toggle tables, and so on—are toolkit tables, and **clsTkTable** is a descendant of **clsTableLayout**.

Figure 34-1 shows some sample table layouts.

Figure 34-1
Sample Table Layouts


Tk Demo: Tables
< 25 >
Document Edit Options Demo
One Row, Two Columns, GroupMax Width, ChildrenMax Height
Child 1
Child 2 has a lot of text and is word wrapped
Two Rows, One Column, ChildrenMax Width, GroupMax Height
Child 1
Child 2 has a lot of text and is word wrapped
Two Rows, Two Columns, GroupMax Width and Height
Child 1
Child 2 has a lot of text and is word wrapped
Child 3 has a lot of text and is word wrapped
Child 4
One Row, Two Columns, MaxFit Width, GroupMax Height
Child 1
Child 2 has a lot of text and is word wrapped
Borders
Labels
Buttons
Tables
TkTables
OptionTables
Custom
Options
Notes
List Boxes
Fields
Icons
Contents
Samples
Help
Settings
Connections
Stationery
Accessories
Keyboard
Inbox
Outbox

clsTableLayout Messages

34.4

Table 34-1 summarizes the messages **clsTableLayout** defines.

Table 34-1
clsTableLayoutMessages

Message	Takes	Description
		Class Messages
msgNewDefaults	P_TBL_LAYOUT_NEW	Initializes the TBL_LAYOUT_NEW structure to default values.
msgNew	P_TBL_LAYOUT_NEW	Creates a table layout window.
		Attribute Messages
msgTblLayoutGetMetrics	P_TBL_LAYOUT_METRICS	Passes back current metrics.
msgTblLayoutSetMetrics	P_TBL_LAYOUT_METRICS	Sets current metrics.
msgTblLayoutGetStyle	P_TBL_LAYOUT_STYLE	Passes back current style values.
msgTblLayoutSetStyle	P_TBL_LAYOUT_STYLE	Sets style values.
		Rendering Messages
msgTblLayoutXYToIndex	P_TBL_LAYOUT_INDEX	Determines a child zero-based index from an xy position.
msgTblLayoutAdjustSections	BOOLEAN	Adjusts the border edges and margins of children to correctly reflect a sectioned table.
msgTblLayoutComputeGrid	P_TBL_LAYOUT_GRID	Computes the table grid parameters given the current constraints.
msgTblLayoutComputeGridXY	P_TBL_LAYOUT_GRID	Computes the table grid start xy given the other grid parameters.
msgTblLayoutFreeGrid	P_TBL_LAYOUT_GRID	Frees any storage allocated by msgTblLayoutComputeGrid.

Table Layout Structure

34.4.1

The TBL_LAYOUT_STYLE structure lets you specify a variety of flags which control the behavior of the table layout. Table 34-2 summarizes the flags and their values.

Table 34-2
Table Layout Flags

Fields/Field Values	Functional Description
tblXAlignment, tblYAlignment	Determines the alignment of the table. You can specify the alignment of the table grid as a whole within the table layout window. Possible values are the same as for child window alignments, described below.
childXAlignment	Determines the x alignment of the child windows within their grid cells. If grid cell size is larger than child window, child will be aligned according to this value. You cannot specifiy different alignments for child windows.
tlAlignLeft	Position child window to the left in its cell.
tlAlignCenter	Center the child window in its cell.
tlAlignRight	Position child window to the right in its cell.
tlAlignBaseline	Position the baseline of the child on the baseline of the cell (described in "Layout Baseline," below).

continued

Table 34-2 (continued)

Fields/Field Values	Functional Description
childYAlignment	Determines the y alignment of the child windows within their grid cells. If grid cell size is larger than child window, child will be aligned according to this value. You cannot specify different alignments for different child windows.
tlAlignBottom	Position child window at the bottom of its cell.
tlAlignCenter	Center the child window in its cell.
tlAlignTop	Position child window at the top of its cell.
tlAlignBaseline	Position the baseline of the child on the baseline of the cell (described in "Layout Baseline," below).
growChildWidth	Determines whether the table layout should resize the width of the child windows to fill their grid cells. For example, to maintain the same highlight width for each button in a menu, menus set growChildWidth so that all menu buttons in a menu are the same width.
growChildHeight	Determines whether the table layout should resize the height of the child windows to fill their grid cells.
placement	Determines whether table layout places child windows in the grid cells. Table layout also enumerates child windows in back-to-front order to place children into the grid.
tlPlaceRowMajor	Top row fills before next row is started.
tlPlaceColMajor	Left-most column fills before column to the right is started.
tlPlaceStack	All children are stacked one on top of the other in the first (top left) grid cell.
tlPlaceOrientation	Table layout uses tlPlaceColMajor if the table's window device is in portrait mode, or tlPlaceRowMajor if it is in landscape mode.
reverseX, reverseY	Determines placement order of child windows. By default, clsTableLayout places child windows from left to right, top to bottom. Setting reverseX or reverseY reverses the order of placement. For example, tab bars use this to get tabs to overlap appropriately. Bookshelf also uses reverse to lay out icon from bottom of screen upwards.
wrap	Determines whether to wrap long row or column to next row or column.
widthExtra, heightExtra	Determines what to do with extra space.
tlExtraNone	Leave extra space as is.
tlExtraFirst	Put extra space before first row or column.
tlExtraAfterFirst	Put extra space after first row or column.
tlExtraLast	Put extra space after last row or column.
tlExtraBeforeLast	Put extra space before last row or column.
tlExtraAll	Divide extra space and add evenly to each row or column.
tlExtraBetweenAll	Divide extra space and add evenly after each row or column.

clsTableLayout positions each child in the grid cell formed by the row/column intersections. If you set **growChildWidth** or **growChildHeight**, the table layout window resizes child windows to fit their grid cells in that dimension. Otherwise, child windows are aligned within their grid cells according to the table's **childXAlignment** and **childYAlignment** styles. If a child window is too big it will overlap some edge of its cell.

Specifying the Table Layout 34.4.2

You specify the number of rows and columns in two TBL_LAYOUT_COUNT structures, one for rows (**numRows**) and one for columns (**numCols**). In this, you specify:

constraint a table **constraint**, as described above in Table 34-2.

value an optional absolute number of rows or columns.

You specify row height and column width in two TBL_LAYOUT_SIZE structures, one for all rows (**rowHeight**), another for all columns (**colWidth**). In this you specify:

constraint a table constraint, as described in Table 34-2.

value an optional absolute height or width.

gap the gap to put between rows or columns.

baseline an optional absolute baseline alignment, as described below. PenPoint 1.0 implements only limited support for baseline alignment.

valueUnits the units in which to interpret the value field. This can be any unit understood by clsBorder (bsUnitsLayout, for example). See Chapter 33, Border Windows, for more information on border units.

The gap is only between rows and columns.

Table Layout Constraints

34.4.3

Table 34-3 lists the possible values for a TBL_LAYOUT_CONSTRAINT. The same constraints, more or less, can apply to both the number of rows and columns (in a TBL_LAYOUT_COUNT structure) and the size of rows and columns (in a TBL_LAYOUT_SIZE structure). If you specify a constraint that does not apply, you will get back **stsTblLayoutBadConstraint** from **msgWinLayoutSelf**.

Table 34-3
Table Layout Constraints

Constraint	Meaning for numRows/Cols	Meaning for ColWidth/RowHeight
tlAbsolute	Fixed number of rows or columns given by value.	Fixed size given by value.
tlChildrenMax	Not applicable.	Size is max of all children in table.
tlGroupMax	Not applicable.	Size is max of children in column or row.
tlMaxFit	As many as will fit.	As wide or as high as possible.
tlInfinite	Unbounded number of rows or columns.	Not applicable.

Using **tlMaxFit** for the number of rows or columns means as many rows or columns as will fit given the height or width, row or column gap, and parent size. Using **tlMaxFit** for row height or column width means as high or wide as possible, given the number of rows or columns, row or column gap, and parent size.

If you OR **tlBaselineBox** with **tlGroupMax**, the constraints will take the maximum of the ascender and descender of each child in the group. OR-ing **tlMaxFitIfConstrained** with any of the **colWidth/rowHeight** constraints gives you the equivalent of using **tlMaxFit**, but only if the width or height is constrained during layout (for example, if one of **wsLayoutResize**, **wsShrinkWrapWidth**, or **wsShrinkWrapHeight** is *not* set).

When it receives **msgWinLayoutSelf**, **clsTableLayout** uses the grid size and row and height information to create a grid of child window locations. It enumeraters the table layout window's children using **msgWinEnum** and lays them out on this grid. It places children in the table in window-depth order (bottom-most child window to top-most child window). To later reorder the child windows, you must use **msgWinInsert**, **msgWinInsertSibling**, or **msgWinSort**.

If the **rowHeight** or **colWidth** is **tlChildrenMax** or **tlGroupMax**, **clsTableLayout** asks each child window in the table (or only in the row or column) for its desired size (by sending it **msgWinGetDesiredSize**). It computes the largest dimension in the table (or only in the row or column) and uses that as the size. Note that this is independent of **growChildHeight** or **growChildWidth**. The latter tells **clsTableLayout** to size each child window to fit its cell in the table, but this takes place after **clsTableLayout** computes the grid for the table.

If the table layout window has more children than space in the grid, **clsTableLayout** does not lay out the children past the last column of the last row, so their positions are left unchanged.

Layout Baseline

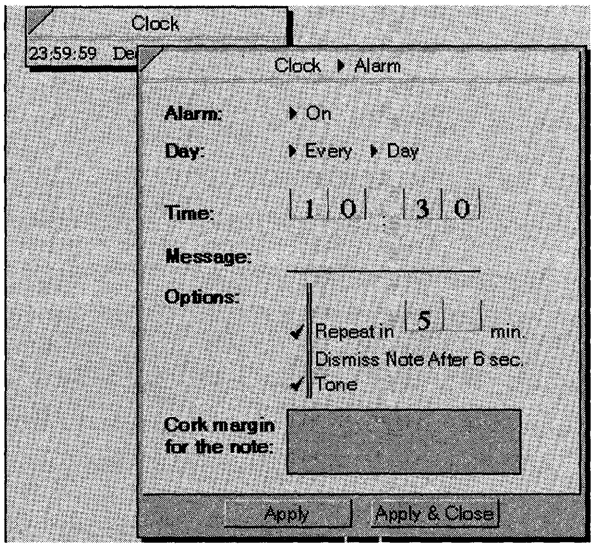
34.4.4

Windows have the notion of a **baseline**, a line that windows should be positioned on to look good, just as there is a baseline for text along which individual letters are positioned. **clsTableLayout** lets you position child windows relative to this baseline so that they align pleasingly.

PenPoint 1.0 supports baseline alignment only for child windows with the colWidth or rowHeight constraint set to tlGroupMax | tlBaselineBox. Baseline alignment is not implemented for other colWidth or rowHeight constraints.

The message to determine the baseline for a window is **msgWinGetBaseline**. This passes back the vertical offset of the baseline and a horizontal offset of the baseline; the default for **clsWin** is (0, 0). The horizontal baseline allows label decorations (such as the check mark on a toggle) to hang in the margin of a vertical set of labels, as in the Clock option sheet in Figure 34-2.

Figure 34-2
Horizontal Window Baselign Alignment in an Option Sheet



Using tlAlignBaseline for Table Layout 34.4.4.1

If **childXAlignment** or **childYAlignment** are set to **tlAlignBaseline**, the table layout positions child windows with their baselines on the baseline of the row or column. In the current PenPoint release, the only way to determine the row or column baseline is to have the table compute it when it receives msgWinGetBaseline.

In order to support this behavior, you must OR the **tlBaselineBox** flag into the TBL_LAYOUT_CONSTRAINT setting for the **rowHeight** or **colWidth** constraints. Baseline alignment makes sense only in conjunction with **tlGroupMax** or **tlChildrenMax**. Normally, if the constraint is **tlGroupMax** or **tlChildrenMax**, **clsTableLayout** gets the size of each child window and computes the largest size. If **tlBaselineBox** is OR'd in, **clsTableLayout** gets the baseline of each child window as well as its size, and computes the row height or column width as the sum of the largest ascender offset and largest descender offset of all the child windows. It doesn't really make sense not to set the child alignment to **tlAlignBaseline** if you do this.

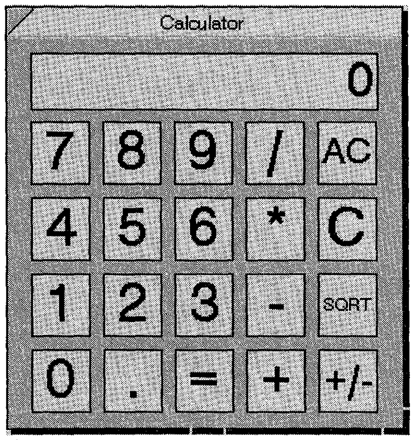
Layout Example: a Calculator 34.4.5

Menus are simple table layout windows, which arrange their child windows (menu buttons) in a row (for example, your application's menu bar) or in columns. A more complex example is the Calc sample program in the SDK directory \PENPOINT\SDK\SAMPLE\CALC. The Calc program's main window positions its calculator buttons in a matrix with gaps between them.

Locations 34.4.6

To convert an x-y location in a table layout window to an index in the table, send the table **msgTblLayoutXYToIndex**. This takes a pointer to a TBL_LAYOUT_INDEX structure. In this message, you specify the location in the local window coordinates of the table (**xy**, an XY32 structure). **clsTableLayout** passes back an **index**, such that if a child window were inserted there and the table laid out, the new child would be at the specified x-y location. **index** is the zero-based count of the new window in the child hierarchy of the table.

Figure 34-3
Calc's Positioning of Child Window Using clsTableLayout



Note that neither **clsWin** nor **clsTableLayout** defines a message to insert a new window as the Nth child of another. It is up to you to figure out the UID of the window at **index** and specify this in **msgWinInsertSibling**. However, **clsTkTable**, a descendant of **clsTableLayout** used in the UI Toolkit, provides a **msgTkTableAddAt** message.

The message is useful if you want to respond to gestures in a table layout window by creating a new window in the table.

Custom Layout

34.5

clsCustomLayout is the opposite of **clsTableLayout**. It does not take any overall specifications, except shrink-to-fit (see below). Instead, you specify constraints for each child window. You can achieve consistent effects, such as placing one window adjacent to another or making one window the same width as another. Or, you can be strict, and specify the absolute size and position of a window.

Custom Layout Example: the Frame

34.5.1

The most common example of a custom layout in PenPoint is a **frame**. Most applications appear in a page-sized frame, a container that surrounds (or decorates) the application's own views with a title bar, a resize corner, a frame header, scrollbars, and so on. **clsFrame** is a descendant of **clsCustomLayout** and uses custom layout to position its child windows. There are no hard-coded locations for any of the child windows in **clsFrame**, so frames can be resized while preserving their appearance. This is important because the user can resize a floating frame at will, and the frame must accomodate whatever size the user sets.

Figure 34-4
Sample Custom Layouts

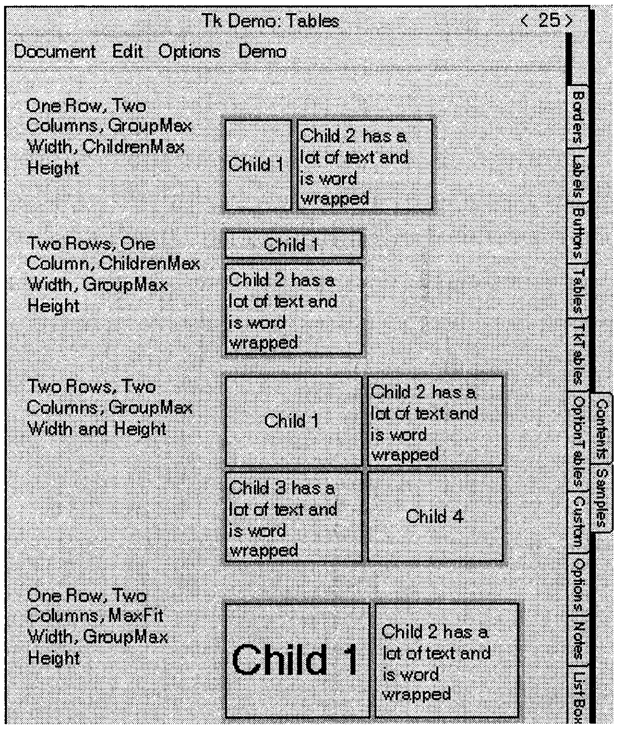

Tk Demo: Tables
< 25 >
Document Edit Options Demo
One Row, Two Columns, GroupMax Width, ChildrenMax Height
Child 1
Child 2 has a lot of text and is word wrapped
Two Rows, One Column, ChildrenMax Width, GroupMax Height
Child 1
Child 2 has a lot of text and is word wrapped
Two Rows, Two Columns, GroupMax Width and Height
Child 1
Child 2 has a lot of text and is word wrapped
Child 3 has a lot of text and is word wrapped
Child 4
One Row, Two Columns, MaxFit Width, GroupMax Height
Child 1
Child 2 has a lot of text and is word wrapped
Borders
Labels
Buttons
Tables
TkTables
OptionTables
Custom
Options
Notes
List Box
Contents
Samples

Table 34-4 summarizes the messages **clsCustomLayout** defines.

Table 34-4
clsCustomLayout Messages

Message	Takes	Description
		Class Messages
msgNew	P_CSTM_LAYOUT_NEW	Creates a custom layout window.
msgNewDefaults	P_CSTM_LAYOUT_NEW	Initializes the CSTM_LAYOUT_NEW structure to default values.
		Instance Messages
msgCstmLayoutGetMetrics	P_CSTM_LAYOUT_METRICS	Passes back current metrics.
msgCstmLayoutSetMetrics	P_CSTM_LAYOUT_METRICS	Sets current metrics.
msgCstmLayoutGetStyle	P_CSTM_LAYOUT_STYLE	Passes back current style values.
msgCstmLayoutSetStyle	P_CSTM_LAYOUT_STYLE	Sets style values.
msgCstmLayoutSetChildSpec	P_CSTM_LAYOUT_CHILD_SPEC	Sets layout spec for given child.
msgCstmLayoutGetChildSpec	P_CSTM_LAYOUT_CHILD_SPEC	Passes back the current spec for the specified child.
msgCstmLayoutRemoveChildSpec	WIN	Removes the spec for the specified child window.
CstmLayoutSpecInit()	P_CSTM_LAYOUT_SPEC	Initializes the P_CSTM_LAYOUT_SPEC to zero.

Creating a Custom Layout Window 34.6

You send **msgNewDefaults** and then **msgNew** to **clsCustomLayout**. In the CSTM_LAYOUT_NEW_ONLY structure, the only field (currently) is CSTM_LAYOUT_STYLE, and in this the only field (currently) is **limitToRootWin**, which limits the size of a custom layout window so that it fits on-screen.

Specifying Constraints 34.6.1

When you insert a child window into a custom layout window, at some point you will need to specify how the custom layout window positions the child window. The next sections explain the form of this specification. There are two ways to specify child window positioning:

- Specify a static constraint for the child window using **msgCstmLayoutSetChildSpec**. The custom layout window stores the constraint for the child window.
- Subclass **clsCustomLayout** and respond to **msgCstmLayoutGetChildSpec** by supplying a constraint for the child window.

The first method lets you create instances of **clsCustomLayout** directly. However, the constraint information for each child window takes up memory (in addition to the code filling in the constraint), so if you have a lot of windows in a custom layout, the information uses up a lot of memory. The second method requires you to create a descendant of **clsCustomLayout** that responds to **msgCstmLayoutGetChildSpec**. The advantage is that you save memory.

Both messages take the same CSTM_LAYOUT_CHILD_SPEC structure. In both cases, someone gives **clsCustomLayout** the information it needs to position the child window; the difference is that in one a client (your application) is sending a message telling **clsCustomLayout** what the child constraint specification is, while in the other, your descendant of **clsCustomLayout** must respond to a message.

Four Child Window Constraints 34.6.2

CSTM_LAYOUT_CHILD_SPEC specifies the child window and its CSTM_LAYOUT_SPEC. The latter is the structure in which you specify four separate constraints for the child window's origin (x and y of its lower left corner) and for its width and height. The possible constraints for these four **dimensions** (they are really two dimensions and an origin) are the same, and each is stored in a CSTM_LAYOUT_DIMENSION structure, described later.

The hierarchy of the nested structures is as follows:

A CTSM_LAYOUT_CHILD_SPEC specifies a child window and its CSTM_LAYOUT_SPEC.

The CSTM_LAYOUT_SPEC specifies four CSTM_LAYOUT_DIMENSIONs.

Each CSTM_LAYOUT_DIMENSION specifies the constraints for a particular dimension.

CSTM_LAYOUT_CHILD_SPEC also includes **parentShrinkWrapWidth** and **parentShrinkWrapHeight**. When **clsCustomLayout** self-sends **msgCstmLayoutGetChildSpec**, it sets these two booleans to indicate whether the custom layout window (the parent) is shrink-to-fit in either dimension. In some situations, you want the child to have different constraints if the parent is going to adjust its size.

Custom Layout Dimensions 34.6.3

Each of the four CSTM_LAYOUT_DIMENSION structures (for the x-y, width, and height of a child window) specifies the following values:

constraint a particular constraint enumerated in CSTM_LAYOUT_CONSTRAINT (with additional optional specifications OR'd in).

value an optional offset (or absolute value). **valueUnits**, below, specifies the unit of measurement.

valueUnits the unit of measurement for value. valueUnits can be any unit that **clsBorder** recognizes, such as **bsUnitsLayout**.

relWin the window relative to which **clsCustomLayout** applies the constraint (if applicable). If **objNull**, then constraint is relative to the parent window (the custom layout window itself).

relWinTag the tag of the window relative to which **clsCustomLayout** applies the constraint (if applicable).

Constraints

34.6.4

The **constraint** field indicates the kind of constraint you want to apply to the child window's x-y, width, or height. **clsCustomLayout** supports many different layout techniques within the limitations of C structure syntax, so the specification of **constraints** can be difficult to explain, but if you understand how to set them up, you can specify almost any window layout. One way to learn is by looking at other programs that use custom layout.

The six basic types of constraints are listed in Table 34-5.

Table 34-5
Layout Constraints for clsCustomLayout

Constraint	Meaning for x/y	Meaning for width/height
clAsIs	Leave unchanged.	Use desired size.
clAbsolute	Value gives absolute offset.	Value gives absolute size.
clPctOf	Value * relWin edge / 100.	Value * relWin size/100.
clBefore	Position one pixel less than relWin's.	Size one pixel less than relWin's.
clSameAs	Position same as relWin's.	Size same as relWin's.
clAfter	Position one pixel greater than relWin's.	Size one pixel greater than relWin's

If the constraint for a dimension is **clAsIs**, do not change the dimension's value. For width and height, the custom layout window sends **msgWinGetDesiredSize** to the child, and uses the values the child passes back. **value** and **relWin** are ignored.

If the constraint **clAbsolute** is set for x or y, the **value** specifies an absolute position relative to the parent window in border units. If **clAbsolute** is set for width or height, the **value** specifies a width or height.

If the constraint is **clPctOf**, value specifies a percentage (for example 50% if value is 50) relative to relWin.

The three remaining constraints all align this window with **relWin**. Sometimes you want the windows to touch, other times you want one window to be exactly adjacent (one pixel before or after) to the border of the other window. Hence, the three flavors, **clBefore**, **clSameAs**, and **clAfter**. The alignment isn't strictly with the edge of the other window; **clsCustomLayout** sends **msgBorderGetOuterOffsets** to the child window to find out the inset (if any) from the child window's outer edge to its border rectangle.

Picking an Edge for Alignment Constraints 34.6.5

When you align windows, you are saying "I want this edge of this window to touch (or be next to) this edge of the other." Rather than **#define** dozens of possible alignments, **clsCustomLayout** provides a macro, **ClAlign**(), which generates the appropriate constraint information with three parameters:

- The child edge to align.
- The type of alignment.
- The edge of **relWin** to align with.

For both the child window and the **relWin**, **clsCustomLayout** lets you pick from several different edges to align:

clMinEdge the left or bottom edge.

clCenterEdge the middle of the side.

clMaxEdge the right or top edge.

clBaselineEdge the baseline of the window as reported by **msgWinGetBaseline**.

The alignment type can be **clBefore**, **clSameAs**, **clAfter**, or **clPctOf** (with some restrictions). The two edges in the macro can be independently set to **clMinEdge**, **clCenterEdge**, or **clMaxEdge**. **ClAlign**() returns a bit pattern, which you set as the x or y constraint in CSTM_LAYOUT_DIMENSION. For example:

```
metrics.x.constraint = ClAlign(clMaxEdge, clBefore, clMaxEdge);
```

will place this window's right edge on the pixel to the left of **relWin**'s right edge as defined by **msgBorderGetOuterOffsets**. You might use this to place a component right-adjusted inside a window without obscuring the window's border.

Aligning Width and Height Dimensions 34.6.6

Aligning width or height is similar. You can tell **clsCustomLayout** to extend the width or height of a window so that it aligns with the edge of another window. The **ClExtend**() macro generates the constraint for you. For example:

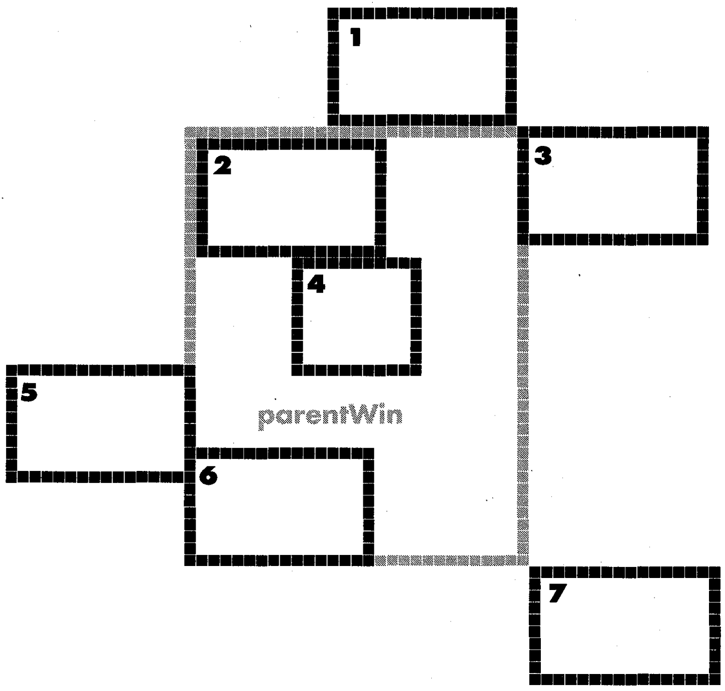
```
metrics.w.constraint = ClExtend(clAfter, clMinEdge);
```

will extend the width of a window so that it ends one pixel to the right of relWin's left edge as defined by **msgBorderGetOuterOffsets**.

It is possible for constraints to conflict or be unresolvable. For example, the above two constraints fail to determine an x position for this window if **relWin**'s x position is the same as **relWin's** width.

Figure 34-5 shows some examples of interesting layout constraints.

Figure 34-5
Layout of Adjacent Windows by clsCustomLayout



relWin is **parentWin** and **value** is 0 unless otherwise indicated. The width constraint is **clAsIs**, in most cases.

1 x = clAlign(clMaxEdge, clBefore, clMaxEdge).
y = clAlign(clMinEdge, clAfter, clMaxEdge).

2 x = clAlign(clMinEdge, clAfter, clMinEdge).
y = clAlign(clMaxEdge, clBefore, clMaxEdge).

3 x = clAlign(clMinEdge, clSameAs, clMaxEdge).
y = clAlign(clMaxEdge, clSameAs, clMaxEdge).

4 x = clAlign(clCenterEdge, clSameAs, clCenterEdge).
y = clAlign(clMaxEdge, clBefore, clMinEdge), with relWin set to the window marked 2 in the illustration, and width set to clPctOf, value 32.

5 x = clAlign(clMaxEdge, clSameAs, clMinEdge).
y = clAlign(clMaxEdge, clSameAs, clMinEdge), with relWin set to the window marked 4 in the illustration.

6 x = clAlign(clMinEdge, clSameAs, clMinEdge).
y = clAlign(clMinEdge, clSameAs, clMinEdge).

7 x = clAlign(clMinEdge, clAfter, clMaxEdge).
y = clAlign(clMaxEdge, clBefore, clMinEdge).

Additional Constraint Flags

34.6.7

There are several additional flags that you can OR in to any CSTM_LAYOUT_CONSTRAINT to produce additional effects. Some combinations of constraints, edge specifications, and flags are meaningless or nonsensical.

You can OR the **clOpposite** flag with **clBefore**, **clSameAs**, or **clAfter** to refer to the opposite dimension. Usually, you align the x position with the x position of another window, but it is possible to align with the y position instead. You can use this to ensure square windows, for example, to set the height of a window to be the same as its width:

```
metrics.w.constraint    = clSameAs | clOpposite;
metrics.w.relWin        = self;
```

Constraints and Shrink-Wrap

34.7

If the custom layout window is set to shrink-wrap, it will shrink to the minimum size necessary to show all of its children, then lay itself out. If all of the children are sized relative to the layout window, this process will shrink them all out of existence.

If you OR in **clAsIsIfShrinkWrap**, **clsCustomLayout** will check to see if the parent is set to shrink to fit in the relevant dimension, and if so, it will use the child's size. **clsFrame** uses the **clAsIsIfShrinkWrap** bit in specifying the width and height of the **clientWin**, so that if the frame is shrink-to-fit it will leave the client window its desired size, but if the frame is forced to a particular size (for example, when it's a page in a Notebook), then the child window will fill it.

Another variant is that if the custom layout is shrink-to-fit, it should leave a child window no smaller than its desired size. You can do this by OR'ing in **clAtLeastAsIs**. An example is the command bar at the bottom of an option sheet. If the frame is shrink-to-fit, it should not clip off the end of the command bar, but if other components in the option sheet lead to a wider frame, then the command bar should be expanded to the width of the frame.

Finally, if you wish to exclude a width or height constraint from the shrink-wrap computation, OR **clShrinkWrapExclude** with the dimension you wish to exclude. This is useful if you have overlapping children.

Other points to watch out for with shrink-wrap:

- If the parent is shrink-wrap, any margins around child windows (specified with **value**) will be shrink-wrapped out of existence.
- If the parent is shrink-wrapped, and one or more children have width or height constraint of **clAsIs** and have very large desired sizes, the parent window may be too large to fit on-screen. You can set the custom layout window's style flag **limitToRootWin** to ensure that it will never be sized larger than the display root window.

Relative Window 34.7.1

Every constraint but **clAsIs** and **clAbsolute** takes a window to which it is relative. If it is more convenient, you can specify the relative window by its tag instead of its UID by filling in **relWinTag** instead of **relWin**. **clsCustomLayout** looks up the tag if **relWin** is **objNull**. **relWin** and **relWinTag** must refer to a sibling window. This means that, for example, you can't align a window with the bookshelf. You have to write your own layout class, which queries the window metrics of the bookshelf, then converts them to your parent's window coordinates.

If **relWin** and **relWinTag** are both **objNull**, the constraint is relative to the parent window. This is the default. If you want **relWin** to see the parent window, don't use the parent's UID, use **objNull**.

Value 34.7.2

For all constraints other than **clAbsolute**, **clAsIs**, and **clPctOf**, **clsCustomLayout** adds the **value** you specify in CSTM_LAYOUT_DIMENSION to the computed value of the dimension as an offset. For example, if you want to position a child five units to the right of another child, use **clAfter** with **value** set to 5.

For **clPctOf**, value is the percentage of the relative dimension. For all other constraints, value is an offset or value in some units. Value can be negative.

Custom Layout Initialization 34.7.3

You should always use **CstmLayoutSpecInit** to initialize a CSTM_LAYOUT_SPEC. This initializes all the constraints to **clAsIs**, value to zero, and **valueUnits** to **bsUnitsLayout**.

More on msgCstmLayoutGetChildSpec 34.7.4

When **clsCustomLayout** requires the constraint specifications for a child, it always self-sends **msgCstmLayoutGetChildSpec**. If you subclass **clsCustomLayout** and respond to this message, you can save on memory, especially if you use a lot of windows. When you receive this, **child** is the UID of the window that needs a layout spec. **metrics** has been initialized by **CstmLayoutSpecInit**.

If you specified a static custom layout constraint, the custom layout window still receives **msgCstmLayoutGetChildSpec**. If you call your ancestor first, you'll get the static constraint, which you can modify. Your **msgCstmLayoutGetChildSpec** method should never **ObjectCallAncestor** after you modify the CSTM_LAYOUT_CHILD_SPEC, since it will ignore and overwrite your changes.

Shrink-Wrap

34.8

The window style flags of **clsWin** include two **shrink-to-fit** or **shrink-wrap** flags: **wsShrinkWrapWidth** and **wsShrinkWrapHeight**. If a window with either of these flags set receives **msgWinLayoutSelf**, it can compute a size to fit its contents (it can expand as well as contract).

If a table layout or custom layout window has shrink-wrap turned on when it lays out. it will will lay out its children as usual, then it will shrink or expand horizontally or vertically to fit around the **bounding box** of its child windows. The bounding box is the smallest rectangle that encloses all the child windows. The layout window leaves enough room to support its border (inner margin, border itself, and shadow).

Lazy Layout

34.9

In general, the UI Toolkit does not try to guess when windows need laying out. If you change the size of a child window, add a new child window, or add a margin around a child window, the layout window set its wsLayoutDirty bit, but will not automatically reposition its children. It is up to the application, or possibly the task that has altered the window layout, to decide when to send **msgWinLayout**. They rely on someone telling them to lay out. After altering a window, send it **msgWinLayout** to cause a layout episode.

If you want to change several windows at once before laying out, send each **msgWinSetLayoutDirty** before finally sending **msgWinLayout** (many changes to the style of UI Toolkit windows do, in fact, mark a window's layout as dirty for you, but they don't directly cause layout).

The exceptions to this lazy layout are scrollwins and option sheets, which self-send **msgWinLayout** at appropriate times (for example, when changing to a new card on an option sheet).

Layout Loops

34.10

You should not specify self-referential layout constraints, that is, constraints that loop. If **msgWinLayout** determines that it is in a layout loop, it will return **stsWinInfiniteLayout**, **stsTblLayoutLoop** or **stsCstmLayoutLoop**.

In **clsTableLayout**, if you set the number of rows to **tlMaxFit** (fit in as many rows as possible) and set the height of each row to **tlMaxFit** (make the row height as high as possible), then **clsTableLayout** cannot determine either.

In **clsCustomLayout**, because you can use **clsSameAs** to set the dimension of one window to be the same as another, you can have circular dependencies between windows.

Shrink-Wrap and Parent-Relative Sizing 34.10.1

You can have the extent of the child windows depend on the parent's size in both table layout windows and custom layout windows. If the parent is set to shrink-wrap around its children, you might think that this creates a layout loop—the child is as wide as the parent, but the parent contracts to fit around the child.

Instead, the order of processing is as follows (size here refers to either width or height).

1. The parent lays out its children using a size of (0,0).
2. The parent sizes itself (shrink-wraps) around its children.
3. The parent lays out its children a second time. At this point, it should have shrink-wrapped around all its children of a fixed size, and its children whose size depends on it should have adjusted to that size. The layout episode will continue until the parent window size becomes stable. If the size does not become stable within a fixed number of iterations, the parent returns **stsCstmLayoutLoop**.

The net effect is that the UI Toolkit can satisfy some requests for both a child that fills its parent and a parent that wraps around its children, so long as there is a window around with a definite size. A simple example of a example of an erroneous situation is a shrink-to-fit custom layout window with a child window whose width or height constraint is 150% of its parent's size.

Capturing vs. Layout 34.11

Part 3: Windows and Graphics describes how you can set up a window (using **msgWinDeltaOk**) so that it can modify or even veto its children's sizes and insert requests. This approach is best when you need to guard against unfriendly child windows, such as embedded applications, which may mess up your window.

On the other hand, the layout semantics described here allows a parent window to position and direct its child windows. Capture is better for incremental layout, in which the parent window handles the insertion and size changes of different child windows. Layout is better for static window organizations that are periodically re-laid out.

Chapter 35 / Controls

clsControl is an important ancestor class for many kinds of UI components. Although its descendant classes have very different visual appearances, **clsControl** provides them with a similar programmatic interface. **clsControl** mainly acts to translate user inputs into **notification messages** which it sends to its client.

Here's a quick sketch of how you use controls in your programs. **clsControl** is ancestor to a wide variety of toolkit elements: buttons, menu buttons, handwriting fields, page numbers, scrollbars, and so on.

- You create the control you want.
- You specify a client for the control. The control **notifies** the client when the user **activates** the control with a gesture (such as a tap). The form of the notification is determined the particular subclass of **clsControl** that you use.
- Some controls have the notion of a current value which you can set and retrieve.
- You can ask for more detailed notification of the user's interaction with a control before he or she finally activates it (if at all). As a result, the control self-sends additional **preview** messages.
- Each notification message (if any) sent by a control is triggered by an intermediate message which **clsControl** self-sends in response to user input.

Filing Controls 35.1

clsControl responds to **msgSave**. It does not file its client object. However, if the control's client is the application object (it uses **OSThisApp**() to check), then during restore, **clsControl** will set the control's client to the new application object passed back by **OSThisApp**(). Otherwise, the control's client will be **objNull** after **msgRestore**, and you will have to go in and reset the client using **msgControlSetClient**.

Message Dispatching 35.2

clsControl defines a set of messages and the circumstances under which controls send them to their clients. **clsControl** converts pen input event messages in a control window into intermediate control messages which clsControl sends to self. Descendants of **clsControl** are free to respond to these intermediate messages as they wish.

If the user activates a control, the final message that the control sends itself is **msgControlAcceptPreview**. Before the control sends this message, the user has been interacting with the control. For example, the user might move the pen tip in and out of an item in a menu without choosing it. The menu items flicker on and off during this interaction, even though the user hasn't really initiated any action. This stage is called **previewing**, during which controls can self-send more detailed messages, such as **msgControlBeginPreview**, **msgControlCancelPreview**, and so on.

The main descendant of **clsControl** is **clsButton**. This responds to **msgControlAcceptPreview** by notifying the control's client. A control's client can be any object; typically it is the one that created the control. The button's message to the client can be either **msgButtonNotify**, indicating that the user wants something to happen, or an arbitrary message of your choice, such as **msgMyAppQuit**.

Some components act like controls even though they do not inherit from **clsControl**. This state of affairs arises because PenPoint classes inherit from only one line of descent. For example, an exclusive choice responds to the **msgControlGetValue** and **msgControlSetValue**, but it is not truly a subclass of **clsControl**.

Presentation and Interaction Behavior 35.3

clsLabel is the workhorse class that depicts controls on-screen. It draws the text, the highlight, and label decoration.

The descendants of **clsLabel** tell it what presentation style to use for their particular style of label, such as button, toggle, or menu button. They also determine the interaction behavior of the control and tell **clsLabel** how to draw the various states of previewing.

The descendants of **clsControl** provide the interaction behavior of particular kinds of controls. Buttons support various kinds of previewing (checking or unchecking, highlighting, and so on).

clsControl Messages

35.4

Table 35-1 summarizes the messages defined by **clsControl**:

Table 35-1
clsControl Messages

Message	Takes	Description
		Class Messages
msgNewDefaults	P_CONTROL_NEW	Initializes the CONTROL_NEW structure to default values.
msgNew	P_CONTROL_NEW	Creates a control window.
		Attribute Messages
msgControlGetMetrics	P_CONTROL_METRICS	Passes back the current metrics.
msgControlSetMetrics	P_CONTROL_METRICS	Sets the metrics.
msgControlGetStyle	P_CONTROL_STYLE	Passes back the current style values.
msgControlSetStyle	P_CONTROL_STYLE	Sets the style values.
msgControlGetClient	P_UID	Passes back metrics.client.
msgControlSetClient	UID	Sets metrics.client.
msgControlGetDirty	P_BOOLEAN	Passes back true if the control has been altered since dirty was set false.
msgControlSetDirty	BOOLEAN	Sets style.dirty.
msgControlGetEnable	P_BOOLEAN	Passes back style.enable.
msgControlSetEnable	BOOLEAN	Sets style.enable.
msgControlEnable	P_CONTROL_ENABLE	The control re-evaluates whether it is enabled.
msgControlGetValue	P_S32	Passes back the current value of the control.
msgControlSetValue	S32	Sets the current value of the control.
		Intermediate Preview Messages
msgControlBeginPreview	P_INPUT_EVENT	Self-sent when msgPenDown is received.
msgControlUpdatePreview	P_INPUT_EVENT	Self-sent when msgPenMoveDown is received.
msgControlRepeatPreview	P_INPUT_EVENT	Self-sent if style.repeatPreview is true. Initial delay is 600ms, then immediate repeat until msgPenUp.
msgControlCancelPreview	P_INPUT_EVENT	Self-sent when style.previewGrab is false and msgPenExitDown is received. Clients or subclasses can send this to a control to cancel existing preview.
msgControlAcceptPreview	P_INPUT_EVENT	Self-sent when msgPenUp is received when gestureEnable is false, or when xgs1Tap is received when gestureEnable is true.
		Notification Messages
msgControlProvideEnable	P_CONTROL_PROVIDE_ENABLE	Sent out to client or specified object during processing of msgControlEnable.
msgInputEvent	P_INPUT_EVENT	Notification of an input event.

The following sections go through this interface in a top-down order. You usually do not need to use the lower level API for controls described towards the end. Moreover, much of the machinery provided by **clsControl** is used by descendant classes, such as **clsButton**, which take care of it for you.

Creating a Control 35.5

Controls are an **abstract class**; there's no reason why you would create an instance of **clsControl** itself. However, **clsControl** handles much of control interaction and housekeeping, and there are important control initializations you specify at **msgNew** time. This information is in the CONTROL_NEW_ONLY structure (currently the same as the CONTROL_METRICS structure). The CONTROL_METRICS structure contains two fields:

style various style fields for the control, described below.

client the client object that will receive all notifications from the control. A control has only one client and generally does not notify observers—adding observers to a control won't make the control send messages to other objects.

You can get and set these with **msgControlGetMetrics** and **msgControlSetMetrics**. **clsControl** also defines **msgControlGetClient** and **msgControlSetClient** to get and set the client alone, and similar **msgControlGetStyle** and **msgControlSetStyle** messages.

Control Style 35.5.1

The control **style** is a CONTROL_STYLE structure. Table 35-2 summarizes the possible fields:

Table 35-2
CONTROL_STYLE Fields

Fields/Field Values	Functional Description
enable	Describes how the control responds to input.
dynamicEnable	Describes how the enable value is determined.
csDynamicNone	
csDynamicClient	
csDynamicObject	
csDynamicPArgs	
previewEnable	Determines whether the control should self-send previewing messages.
previewGrab	Determines whether previewing starts an input grab. The default is it does not grab input.
previewRepeat	Determines whether the control sends out additional messages (msgControlRepeatPreview after a certain period of time. The default is no repeat.
previewing	Determines whether the control is previewing at this moment. The default is no previewing.
dirty	Determines whether the control is dirty (has been altered). Up to subclasses to maintain this information. The default is not dirty.
showDirty	Determines whether the control should indicate that it is dirty. Up to subclasses to make use of this. Default is it does indicate dirty.

Control Defaults

35.5.2

By default (in the CONTROL_NEW_ONLY structure passed back by **msgNewDefaults**), a control is enabled, does not grab input, does not repeat, and is not previewing or dirty, and shows dirty (although the last is up to subclasses to implement).

Values

35.6

For many descendants of **clsControl**, it makes sense for the control to have an arbitrary value. For example, buttons are on or off, and scrollbars have a numeric offset. **clsControl** defines **msgControlGetValue** and **msgControlSetValue**, but it is up to descendant classes to respond to these. The value is a signed 32-bit value (S32). Table 35-3 shows examples of values for a number of standard subclasses of **clsControl**.

The interpretation of the value is up to the descendant class. Some classes may return **stsBadParam** if you set a value that the descendant doesn't like; other control classes have no notion of a value and will send self **msgNotUnderstood** if you try to get or set it.

Table 35-3
Values for Different Subclasses of clsControl

Descendant Class	Value
Button	0 for off, 1 for on.
Label	None.
Scrollbar	Scrollbar offset.
Field	Not applicable—the client must get the value Using msgLabelGetString.
Integer field	Integer value of field (can also use msgLabelGetString).
Fixed field	Integer value of the field in hundredths.
Date field	Date value of field as a YYYYMMDD numeric string.

Dirty Controls

35.6.1

The **dirty** bit field in CONTROL_STYLE indicates if a control's value has changed. **clsControl** doesn't check this; it is up to subclasses to interpret. You can set and get it separate from the other style fields using **msgControlSetDirty** and **msgControlGetDirty**. Note that this is different from a dirty window (which needs repainting) or a dirty window layout (which needs to be relaid out).

The related style field **showDirty** indicates to subclasses whether they should change the way they paint an instance to indicate that it is dirty. For example, **clsLabel** draws its decoration in black if it is dirty, and in gray if it is not dirty. By default, **showDirty** is set.

Descendants of **clsControl** use the dirty bit to indicate those controls in option sheets that the user has fiddled with.

Control Enable 35.7

A control responds to user input only if its enable bit is set. If the enable bit is clear, the control is read-only. You can disable or enable a control by sending it **msgControlSetEnable** with a message argument of **true** or **false** (or, to modify **enable** along with other **style** values, you can send **msgControlGetStyle**, assigning the values, and sending **msgControlSetStyle**). One way for subclasses to disable or enable input is to set the **inputDisable** window input flag to **true** or **false**.

To indicate that a control is inactive, **clsControl** sends **msgBorderSetLook**, with an argument of either **bsLookInactive** or **bsLookActive**. Most controls change from black to gray ink if they are not enabled.

Whether a control is enabled or not is often dynamic. For example, the **Move** command in the Edit menu should be disabled if there is no selection. The UI Toolkit provides a protocol for the client to ask whether each control should be enabled. This protocol allows items to have their **enable** state either static, or dynamically based on criteria such as:

- A decision from the item's client.
- A decision from the current selection owner.
- Whether the current selection owner's process matches the application's process.

The protocol works between several classes. **clsControl** defines the messages and provides some default responses. Toolkit tables, described in Chapter 38, Toolkit Tables, provide some semantics to check whether controls are enabled when creating a tree of controls. Menu buttons, described in Chapter 39, Menus and Menu Buttons, provide additional semantics for changing the enabled status of the controls in their associated menus.

Evaluating Control Enable 35.7.1

When a control receives **msgControlEnable**, it should reevaluate whether it is enabled. **clsControl** does different things based upon the value of its **dynamicEnable** style field. **msgControlEnable** takes a pointer to a CONTROL_ENABLE structure as its message arguments. In this the client should specify the following values:

root the window originating the enable check.

object an object to query if the control's style is **csDynamicObject**.

enable a new **enable** value to use if the control's **dynamicEnable** style is **csDynamicPargs**.

If the control's **dynamicEnable** style is:

csDynamicNone then the control returns **stsOK**.

csDynamicClient then the control sends **msgControlProvideEnable** to its client, and then changes its **enable** value to what the client passed back (if the client changed it).

csDynamicObject then the control sends the same **msgControlProvideEnable** message, but it sends it to the **object** specified in the message arguments of **msgControlEnable**.

csDynamicPargs then the control sets its **enable** value to match the **enable** value specified in the message arguments of **msgControlEnable**.

Dynamic Control Enable 35.7.2

The **msgControlProvideEnable** message that **clsControl** sends out if **dynamicStyle** is **csDynamicClient** or **csDynamicObject** takes a CONTROL_PROVIDE_ENABLE as its message arguments. In this, the control specifies between one to four arguments:

root the window originating the check. This is the same window as specified in **msgControlEnable**.

control the message's UID.

tag the message's window tag.

enable its current **enable** value.

The receiver of **msgControlProvideEnable** should pass back the new **enable** value of the control. Since the control itself is passed to the receiver of **msgControlProvideEnable**, the receiver could choose to alter other attributes of the control at that time.

The Toolkit Demo sample program creates a menu of buttons with different enable styles. See \PENPOINT\SDK\SAMPLE\TKDEMO\TKDEMO.C.

Internal Notification 35.8

You need only read this subsection if you intend to create your own subclasses of **clsControl**.

Many descendants of **clsControl** end up sending the client (the object stored in the control's metrics) an activation message of some sort when the user activates them. For example, a vertical scrollbar sends **msgScrollbarVertScroll** to **client**.

If you set **previewEnable** in CONTROL_STYLE, then underneath this interaction, **clsControl** self-sends a stream of various notification messages. These are called **previewing** messages because a control generates them while the user is working with the controls but before the user activates the control (or decides not to activate it). These messages are important for descendant classes because many controls need to change as the user toys with them, mainly to provide visual feedback.

For example, an individual button must highlight itself or show some kind of decoration when preview begins, and de-highlight when previewing ends. The messages that **clsControl** self-sends all have names of the form **msgControl...Preview**. Descendant classes respond to these messages as they see fit. For example, **clsButton** highlights in response to **msgControlBeginPreview**.

Remember that a control sends these messages to itself. If you create an instance of a control descendant, and make your application its **client**, your application will not receive any of these messages. It is up to the control to notify its client in some way.

The messages are:

msgControlBeginPreview The user has begun previewing.

msgControlUpdatePreview The user continues to preview in a manner which requires the client to update. For example, if a slider and a text field both indicate a value, then it might be appropriate for the client to change the text field as the user moves the slider.

msgControlRepeatPreview The previewing has repeated. If a control's **previewRepeat** style bit is set, then it will send msgControlRepeatPreview after a timer notification. This is true for scrollbars and the page turn buttons.

msgControlCancelPreview The user has finished previewing this control but hasn't activated it.

msgControlAcceptPreview The user has activated this control.

The term **activated** is slightly misleading in this context. A button only sends a message to its client when self receives **msgControlAcceptPreview**, but scrollbars do something on **msgControlUpdatePreview** and **msgControlRepeatPreview**. **clsControl**'s definition of activation may not be the same as a given descendant's.

Every control should respond to **msgControlBeginPreview** by highlighting in some way to indicate that the user has chosen it. Most controls invert, but others do something else. For example, **clsScrollbar** moves the thumb up and down when it receives **msgControlBeginPreview** over the thumb. Table 35-5 summarizes previewing behavior in some subclasses of **clsControl**.

Table 35-4
Previewing in Different Subclasses of clsControl

Subclass	Previewing Behavior
Normal button	Inverts foreground and background colors.
Toggle button	Displays decoration.
Menu button	Inverts foreground and background colors.
Label	Ignores preview messages (previewEnable is false).
Scrollbar	Thumb bar inverts, arrow buttons use msgControlRepeatPreview, thumb creates a tracker that moves the thumbing bar.
Field	Depends on style fields; may display input focus indicator.

When Are Preview Messages Generated? 35.8.1

clsControl self-sends these **msgControl...Preview** messages when it receives certain user input. The user input is delivered to **clsControl** in two forms: as pen input events and as gestures. Pen input events are sent to the control from the input system. The control calls its ancestor with all input events. Because one of its ancestors is **clsGWin**, **clsGWin** receives pen events in the control. If the control has gestures enabled, then **clsGWin** recognizes pen motions as gestures, and as a result, self-sends **msgGWinGesture**. Also, if resizing or dragging are permitted in **clsBorder**, **clsBorder** will grab certain input events.

The mapping from input events to these messages is as shown in Table 35-6.

Table 35-5
Control Messages Sent in Response to Events

Event	Message Sent to Self
msgPenDown	msgControlBeginPreview
msgPenMoveDown	msgControlUpdatePreview
msgPenExitDown	msgControlCancelPreview (if gestures disabled and control is not grabbing input)
msgPenUp	msgControlAcceptPreview (if gestures disabled)
xgs1Tap	msgControlAcceptPreview (if gestures enabled)
msgTimerNotify	msgControlRepeatPreview (if previewRepeat set)

If the control has gestures enabled (**gestureEnable** in GWIN_STYLE), then **clsControl** looks for gestures, and accepts preview on receipt of **xgs1Tap**. If not, then it accepts preview on **msgPenUp** and cancels preview on **msgPenExitDown** (if **previewGrab** isn't enabled).

The mapping from window input flags to **msgPen...** input events is explained in *Part 5: Input and Handwriting Translation.* **clsControl** doesn't set window input flags. If you want different input flags than **clsGWin**, you need to set them.

The message argument for every **msgControl...Preview** message is either **pNull**, or a pointer to the INPUT_EVENT message arguments structure for the event that caused the message. Control subclasses can use the information in the event to determine where the pen was.

Previewing 35.8.2

When **msgPenDown** input arrives at **clsControl**, it triggers previewing. **clsControl** sets the previewing bit in CONTROL_STYLE to **true**. It then self-sends the corresponding **msgControlBeginPreview** message.

Stopping Preview 35.8.2.1

msgControlCancelPreview sets previewing to **false** when it arrives at **clsControl**. **msgControlAcceptPreview** also sets previewing to **false**. The user can usually cancel previewing by dragging the pen out of the control.

Descendants can terminate previewing at any time by not returning **stsOK** in response to **msgControl...Preview** messages. **stsControlCancelPreview** is a status value defined for this purpose; it cancels preview but it is not negative, so **clsControl** does not interpret it as an error.

Preview Grab 35.8.2.2

If **previewGrab** is set in the control's style bits, previewing starts an input grab. The control will continue previewing even if the user drags the pen out of it; normally, the control would send itself **msgControlCancelPreviewing**. The user can still cancel previewing by drawing some unrecognizable gesture then lifting the pen, or the descendant class can return some status other than **stsOK**.

Scrollbars set **previewGrab** so that the user doesn't have to keep the pen in them while adjusting.

Preview Repeat 35.8.2.3

If **previewRepeat** is set in the control's style bits, **msgControlBeginPreview** starts a timer by sending **msgTimerRegister** to **theTimer**. 600 milliseconds later, **theTimer** sends a **msgTimerNotify** to the control. If previewing is still on (the control is still previewing) and **previewRepeat** hasn't been reset, the control generates **msgControlRepeatPreview**. Its message arguments are the event that started the preview.

After self-sending **msgControlRepeatPreview**, the control registers a new timer with **theTimer**. This has a zero timeout. The result is that controls that repeat start repeating after 600 milliseconds, then repeat as fast as events can be delivered.

Gesture Notification 35.9

When **clsControl** receives **msgGWinGesture** or **msgGWinForwardedGesture**, **clsControl** sends **msgGWinForwardedGesture** to the control's client. **clsControl** returns whatever status is returned by its client. If the client does not return **stsOK**, the gesture reaches **clsGWin**, which returns **stsRequestForward** to propagate the message up the window tree. See "Gesture Windows" in Chapter 32, Toolkit Ancestors, for more information on how gestures are forwarded and propagated in general.

Special Gesture Handling 35.9.1

Single Taps 35.9.1.1

Note that **clsControl** unconditionally steals away the **xgs1Tap** gesture and maps it into **msgControlAcceptPreview**. This allows the user's tap on a button to execute the button rather than send **msgGWinForwardedGesture** to the button's client.

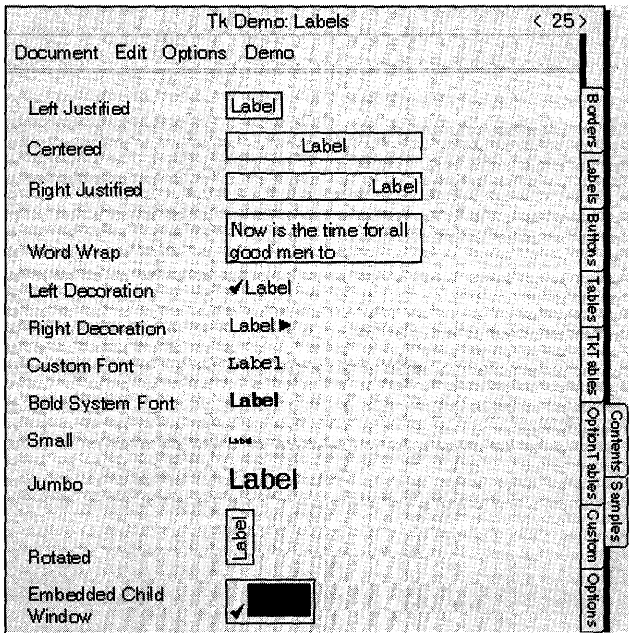
Quick Help 35.9.1.2

xgsQuestion is one gesture that **clsGWin** handles itself. If the user makes the Quick Help ? gesture, no one responds to it, and the control has a Quick Help ID specified in its gesture metrics, **clsGWin** will display the Quick Help text directly.

Chapter 36 / Labels

clsLabel handles the presentation of most controls (exceptions include **clsScrollbar** and **clsProgressBar**). Buttons, menu buttons, individual toggles, and frame title bars are all descendants of **clsLabel**. A label displays either a string you specify or a window you provide. You can specify that it display other decorative elements, such as check marks and arrows, next to the string or window. **clsLabel** does not provide any notification or preview behavior at all.

Figure 36-1
Sample Labels



clsLabel Messages

36.1

Table 36-1 summarizes the messages defined by clsLabel.

Table 36-1
clsLabel Messages

Message	Description
	Class Messages
msgNew	Creates a label window.
msgNewDefaults	Initializes the LABEL_NEW structure to default values.
	Instance Messages
msgLabelGetStyle	Passes back the current style values.
msgLabelSetStyle	Sets the style fields.
msgLabelGetString	Passes back current string.
msgLabelSetString	Sets the label string.
msgLabelGetWin	Passes back the child window.
msgLabelSetWin	Sets the child window.
msgLabelGetFontSpec	Passes back the font spec.
msgLabelSetFontSpec	Sets the font spec.
msgLabelGetScale	Passes back the font scale.
msgLabelSetScale	Sets the font scale.
msgLabelGetRows	Passes back the number of rows the label will size itself to.
msgLabelSetRows	Sets the number of rows the label will size itself to.
msgLabelGetCols	Passes back the number of columns the label will size itself to.
msgLabelSetCols	Sets the number of columns the label will size itself to.
msgLabelGetBoxMetrics	Passes back the current box metrics.
msgLabelResolveXY	Resolves a point to a character in the string.
msgLabelGetRects	Computes the rectangle for each given character index.
	Self-Sent Messages
msgLabelAlign	Self-sent if style.xAlignment or style.yAlignment is lsAlignCustom. Subclass must set pArgs->offset.
msgLabelProvideInsPt	Self-sent message to obtain where to render insertion point.
msgLabelProvideBoxSize	Self-sent message to obtain the character box size.

In its default usage, **clsLabel** paints the label string that you set with **msgNew** or **msgLabelSetString** aligned at the bottom left corner of its window. You can set the label style so that the label displays one of a fixed set of glyphs to the left or right of the label string, and to control other aspects of the label's appearance.

Since the behavior of a label is quite different when its contents are a window instead of a string, the details of labels with child windows are presented separately, in Section 7.6.

Creating a Label

36.2

You send **msgNew** to **clsLabel** to create a label. This takes a LABEL_NEW structure as its message arguments; part of this is a LABEL_NEW_ONLY structure, as usual. In this you specify:

style various style fields, described below.

pString the string for the label, or its child window, or its resource ID.

font the SYSDC_FONT_SPEC to open to draw the label string. Ignored if **style.fontType** is set to **lsFontSystem** or **lsFontUser**.

fontName the name of the font to draw the label string. Ignored if **style.fontType** is set to **lsFontSystem** or **lsFontUser**.

scale the scale of the label in **scaleUnits**.

rows the number of rows in the label. Each row has the height of one typographer's em in the label's font. Ignored if **style.numRows** is **lsNumAsNeeded.**

cols the number of columns in the label (zero indicates no limit). Each column is one em (eight layout units) wide. Because PenPoint typically uses a proportionally spaced font, it is impossible to predict what will fit in a label with **cols** specified. Ignored if **style.numCols** is **lsNumAsNeeded.**

Label Styles

36.2.1

The various styles are used by label subclasses to form the familiar UI Toolkit components. LABEL_STYLE incorporates several categories of label appearance, shown in Table 36-2:

Table 36-2
LABEL_STYLE Fields

Fields/Field Values	Functional Description
infoType	Label information type.
lsInfoString	Label information is a string.
lsInfoStringID	Label information is a resource ID.
lsInfoWindow	Label information is a window UID.
xAlignment	Horizontal alignment of label.
lsAlignLeft	Align with left edge.
lsAlignRight	Align with right edge.
lsAlignCenter	Center horizontally.
lsAlignCustom	Self-send msgLabelAlign to get offset.
yAlignment	Vertical alignment of label.
lsAlignBottom	Align with bottom edge.
lsAlignTop	Align with top edge.
lsAlignCenter	Center vertically.
lsAlignCustom	Self-send msgLabelAlign to get offset.

continued

Table 36-2 (continued)

Fields/Field Values	Functional Description
rotation	Degree of rotation of the text.
lsRotateNone	Do not rotate label text.
lsRotate90	Rotate text 90 degrees.
lsRotate180	Rotate text 180 degrees.
lsRotate270	Rotate text 270 degrees.
underline	Underline style of text.
lsUnderlineNone	Do not underline label text.
lsUnderlineSingle	Single underline.
lsUnderlineDouble	Double underline.
strikeOut	Determines whether text has a strikeout line through it.
decoration	Type of label decoration.
lsDecorationNone	
lsDecorationBlank	
lsDecorationExclusiveOn	
lsDecorationExclusiveOff	
lsDecorationNonExclusiveOff	
lsDecorationNonExclusiveOn	
lsDecorationCheck	
lsDecorationCircle	
lsDecorationBox	
lsDecorationCheckedBox	
lsDecorationCheckedCircle	
lsDecorationHollowLeft	
lsDecorationHollowRight	
lsDecorationSolidLeft	
lsDecorationSolidRight	
lsDecorationButtonOn	
lsDecorationButtonOff	
lsDecorationPopup	
lsDecorationCustomLeft	
lsDecorationCustomRight	
numCols, numRows	Style for the number of rows and columns.
lsNumAbsolute	Fixed number of rows or columns specified in rows or columns.
lsNumAsNeeded	As many rows or columns as needed.
box	Style of box around characters in a label.
lsBoxNone	No box around characters.
lsBoxSquare	Square box, for fields.
lsBoxTicks	Ticks or combs, for fields.
lsBoxInvisible	Don't draw specified boxes.
wordWrap	Determines whether label text should wrap to the next row at the end of a word.
fontType	Style of label font.
lsFontSystem	Use the system font.
lsFontUser	Use the user font.
lsFontCustom	Use custom font specified by font or name.
scaleUnits	Specifies scale of units.
bsUnitsLayout	Use the UI Toolkit layout units.
bsUnitsPoints	Use points (1/72 inch).
bsUnits...	Use any other border unit (see BORDER.H).
stringSelected	Determines whether the string should show the selected visual.

In general, each of the settings within a category is exclusive. A label can only have one decoration; it can't have a pull-right arrow as well as a check box.

The UI Toolkit's label descendent classes set the LABEL_STYLE flags to achieve different effects. They also make use of the drawing styles provided by **clsBorder** to control their outline (none, rectangular, or round-cornered rectangle, with different shades) and background; border windows are described in Chapter 33, Border Windows.

The fact that labels do not respond to input might lead you to think that **clsLabel** is an abstract class. However, this lack of behavior is perfect for annotations in dialog boxes or option sheets.

Example 36-1
Creating an Annotation Label

The following code from the Hello World (Toolkit) sample program (in \PENPOINT\SDK\SAMPLE\HELLOTK\HELLOTK1.C) puts the words *Hello, World* in the center of the window. It uses label styles to make the label scale to the window. Hello World (Toolkit) creates this label in its **msgAppInit** handler.

```
LABEL_NEW             ln;
STATUS                s;
...
    // Create the Hello label window.
    ObjCallRet(msgNewDefaults, clsLabel, &ln, s);
    ln.label.style.scaleUnits    = bsUnitsFitWindowProper;
    ln.label.style.xAlignment    = lsAlignCenter;
    ln.label.style.yAlignment    = lsAlignCenter;
    ln.label.pString                = "Hello World!";
    ObjCallRet(msgNew, clsLabel, &ln, s);
    // Insert ln.object.uid in some window.
    ...
```

Label Strings and Special Characters

36.3

clsLabel copies the label string you give it. You must send **msgLabelSetString** to change the label string; changing your own copy of the string won't work.

By default, label strings appear in the current system font. This font is used in the notebook tabs, message box, and frame headers, as well as the UI Toolkit. The encoding for the system font is **sysDcEncodeGoSystem**, which has several special GO symbols in its low ASCII area, including symbols for label decorations. To draw decorations, **clsLabel** merely draws a string of characters. If **SysDC** does not find a special GO glyph in the font cache, it looks for the glyph in the current system font. If the character is missing from the system font, **SysDc** looks for it in a special GO glyph font. No matter what font you use, the UI Toolkit will display decorations matching its size.

You can use some other font either by setting the **fontName** in LABEL_NEW_ONLY to the system name of a font (such as HE55), or by supplying a SYSDC_FONT_SPEC in the **font** field of LABEL_NEW_ONLY. The **fontName** takes priority unless it is **pNull** (the default).

Layout

36.4

String labels are leaf windows—they don't have any child windows. Thus, a string label has nothing in it to lay out in response to **msgWinLayoutSelf**. But it does contain a string, which may change in size when you send **msgLabelSetString**. Sometimes you want the label to change its size to fit around the string, other times you want the label to remain a fixed size.

Normally, a window recomputes its size and changes its size if necessary when it receives **msgWinLayoutSelf** with **wsLayoutResize** set. You can control whether a label changes size by setting its **wsShrinkWrapWidth** and **wsShrinkWrapHeight** window style flags. If these are **false**, the label will not change size.

If either is **true**, the label will recompute its width or height and size itself so that it is just big enough to display its current label string and decorations in the style you've specified inside the border you've specified. The exception to this is if you've specified a fixed number of rows or columns (**lsNumAbsolute**), in which case the label changes its size to fit the number of rows or columns in the label font. The default is that both **wsShrinkWrapWidth** and **wsShrinkWrapHeight** are **true**, so that labels change size to fit their contents.

If you have a label with a changing string, you have several choices:

- Keep the label's size constant and run the risk that all of its string may not be visible.
- Set the **scaleUnits** style to either **lsScaleFitWindow** or **lsScaleFitWindowProper** so that the scale of the label's contents changes to fit inside the label.
- Make the label grow and shrink.

In the latter case, you need to send **msgWinLayout** to the label with **wsLayoutResize** set whenever you change its string.

No Notification

36.5

clsLabel does not turn on **previewEnable** in **clsControl**, or set any window input flags. Thus, an instance of **clsLabel** does not respond to input, and **clsControl** never generates any messages. By default, input in a label won't even be passed to its parent window. It is the descendents of **clsLabel** that turn on different combinations of window input flags and thereby receive **msgControl...** messages.

Painting

36.6

A label paints itself as best as it can within the rectangle of its window. It paints its:

- Border (by **clsBorder**).
- Label string.
- Label decoration.
- Insertion point.

When you change the label style, **clsLabel** tries to be smart about painting, and paints only what has changed.

clsLabel responds to **msgBorderPaintForeground** by painting its decoration and string.

Child Windows 36.7

This section describes how labels use child windows. You need read it only if you want to put a window in a label.

If you set a label's **style.infoType** to **lsInfoWindow**, it assumes **pString** is the UID of a window. Or, if you send **msgLabelSetWin** to a label, this changes the **infoType** to **lsInfoWindow**. You need to be careful not to set the **infoType** to **lsInfoString** when displaying a child window, and vice-versa. Set **pString** to **pNull** first, then change **infoType**, then set **pString** to the new value.

Instead of painting a string of text, **clsLabel** inserts the window as a child of the label. It never paints the child window; it relies on the child window repainting itself in response to **msgWinRepaint**. Everything else about label window behavior is unchanged.

If the child window's parent is not the label, **clsLabel** makes the label the child's parent. If the label doesn't clip its children, then **clsLabel** sets the child window to share the parent's clipping and not clip its own child windows.

If you know your child window will draw within its boundary, then you can turn on **wsParentClip** in its window style flags, and set **backgroundInk** to **bsInkTransparent | bsInkExclusive**. This will let the child window share the update region of its parent (the label), which saves space and speeds repaint.

Layout 36.7.1

As explained in Section 7.3, labels will resize themselves when they receive **msgWinLayoutSelf** if both the following hold:

- **wsLayoutResize** is set in the message arguments.
- One or both of **wsShrinkWrapWidth** and **wsShrinkWrapHeight** are set in the label's window style flags.

In the last case, the label will fit around the child window's current size.

If a window label does change size, it will ordinarily fit around the size of its child window or string. However, if **bsUnitsFitWindow** or **bsUnitsFitWindowProper** is set in LABEL_STYLE, the label will resize its child window so that it fits within the current size of the label. If your child window can repaint to fit its size, this is fine. However, if your child window needs to be a particular size, you should not set **bsUnitsFitWindow** or **bsUnitsFitWindowProper**. You might also want to reset the label's **wsShrinkWrapWidth** and **wsShrinkWrapHeight** window style flags so that the label will not change its size. If you specify a fixed-size child window, note that it won't handle the system font changing very well—all other labels will change size except the one with a child window. It's best to let the label size the child window.

If you want to change the size of your child window, you should send **msgWinLayout** to the label it's in to make the label change size also.

Painting 36.7.2

Your child window will receive **msgWinRepaint** when the label needs to repaint. The label takes care of drawing the border and decorations, and if the child window has **wsParentClip** set, then the label will clear the child window's area.

Field Support 36.8

Fields allow handwritten and keyboard input. They inherit from **clsLabel** (see Chapter 42, Fields, for more information). **clsLabel** does the drawing for fields, so it has some internal messages that **clsField** uses.

Insertion Point 36.8.1

clsLabel draws the boxes for the insertion point that indicates where the next character from the keyboard will appear. To find out where it should draw the insertion point, **clsLabel** self-sends **msgLabelProvideInsPt**. Descendants can respond by passing back the zero-based character offset of the insertion point.

If the label style is non-boxed, **clsLabel** draws the insertion point as a vertical before this character; if the label style is boxed, **clsLabel** highlights the baseline of the box around this character. If the message gets to **clsLabel**, it passes back the value –1, which tells itself not to draw the insertion point.

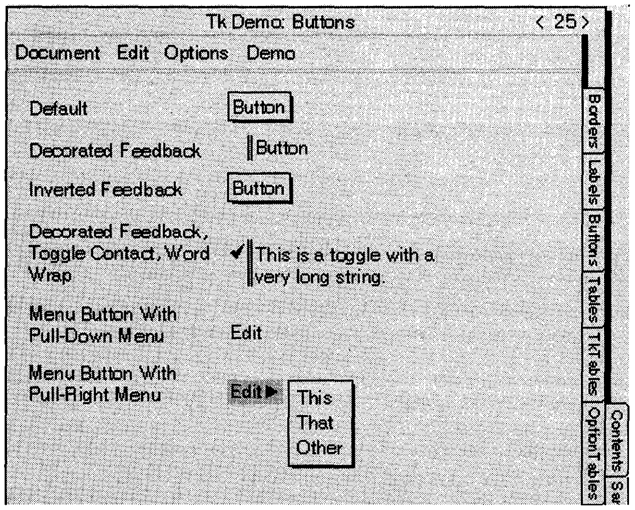
Character Positions 36.8.2

clsField handles gestures over fields. To figure out which character is closest to the hot point of a gesture, it self-sends **msgLabelGetRects**. This computes the bounding rectangles for a set of characters. It takes a pointer to an array of LABEL_RECT structures. In each structure, the sender specifies the location in the string (**index**). As in **msgLabelProvideInsPt**, characters are specified by a zero-based index in the string. **clsLabel** computes the bounding rectangle for the character in its string at **index**, and passes it back as a RECT32 in device units (**rect**). **clsLabel** knows it has reached the end of the array of LABEL_RECTs when the **index** specified is the value –1.

Chapter 37 / Buttons

Buttons are labels with input behavior—the user can tap a button. When the user activates a button, the button sends its client (maintained by **clsControl**) information that you specify.

Figure 37-1
Sample Buttons



clsButton Messages

37.1

Table 37-1 summarizes the messages defined by **clsButton**.

Table 37-1
clsButton Messages

Message	Description
	Class Messages
msgNew	Creates a button window.
msgNewDefaults	Initializes the BUTTON_NEW structure to default values.
	Instance Messages
msgButtonGetMetrics	Passes back the current metrics.
msgButtonSetMetrics	Sets the metrics.
msgButtonGetStyle	Passes back the current style values.
msgButtonSetStyle	Sets the style values.
msgButtonGetMsg	Passes back metrics.msg.
msgButtonSetMsg	Sets metrics.msg.

continued

Table 37-1 (continued)

Message	Description
msgButtonGetData	Passes back metrics.data.
msgButtonSetData	Sets metrics.data.
msgButtonSetNoNotify	Sets the value of the button without notifying.
	Messages Sent to Button's Manager
msgButtonDone	Sent via msgWinSend to the manager when button receives msgControlAcceptPreview.
msgButtonBeginPreview	Sent via msgWinSend to the manager when button receives msgControlBeginPreview.
msgButtonUpdatePreview	Sent via msgWinSend to the manager when button receives msgControlUpdatePreview.
msgButtonRepeatPreview	Sent via msgWinSend to the manager when button receives msgControlRepeatPreview.
msgButtonCancelPreview	Sent via msgWinSend to the manager when button receives msgControlCancelPreview.
msgButtonAcceptPreview	Sent via msgWinSend to the manager when button receives msgControlAcceptPreview.
	Self-Sent Messages
msgButtonNotifyManager	Sent to self when button wants to notify its manager.
msgButtonNotify	Sent to self when button wants to notify its client.

To create a button:

- Specify a client for the button in the **control** part of its BUTTON_NEW structure.
- Specify the visual appearance of the button in the BUTTON_STYLE part of its BUTTON_NEW_ONLY structure.
- Specify a message and data that the button will send to its client when the user **activates** it.

There are several different styles of button. The default button responds to input, sets its border style to a rectangle with a shadow, centers its label. Buttons respond to **msgControlBeginPreview** and **msgControlAcceptPreview** by providing some kind of visual feedback. For example, the default button previews by becoming gray.

Other Kinds of Buttons 37.2

Menu buttons Menu buttons are a special kind of button. They display an associated menu when the user taps on them. Menu buttons and menus are explained in Chapter 39, Menus and Menu Buttons.

Pop-up choices Pop-up choices are buttons which display a current value of chosen from a selection of values. The user can flick to move to other values, or tap to display a pop-up menu showing all the choice values. Pop-up choices are also documented in Chapter 39, Menus and Menu Buttons.

Icons Icons are buttons which can display a bitmap as well as a string. Icon toggles are icons which maintain an on or off state, displaying a different picture for each of the two states.

Creating a Button 37.3

clsButton's class-specific **msgNew** arguments (BUTTON_NEW_ONLY) are the same as its metrics (BUTTON_METRICS). The structure contains three fields:

style various style bits for the button, described below.

msg the message to send when the button is activated. This may just be raw data, see Table 37-2.

data 32 bits of data. If **style.pArgs** is **bsPargsData**, then this data will be part of the message arguments sent to the client when the button is activated.

You can get and set all of these with **msgButtonGet/SetMetrics**. In addition, **clsButton** defines other messages to get and set individual elements of the metrics: **msgButtonGet/SetStyle**, **msgButtonGet/SetMsg**, and **msgButtonGet/SetData**.

Button Defaults 37.3.1

By default (that is, in the BUTTON_NEW structure passed back by **msgNewDefaults**), a button notifies its client by sending the **msg** you define for it. In **clsControl**, a button is enabled, does not grab input, does not repeat, does not send detailed previewing messages to its client, and is not previewing or dirty.

clsButton supports different kinds of controls: pushbuttons, toggles, and lock-on buttons. It also supports different styles of notification that control how the **msg** and **data** in the button's metrics are sent to the button's client. The look and behavior are controlled by style flags in BUTTON_STYLE, shown in Table 37-2.

Table 37-2
BUTTON_STYLE Styles

Styles/Style Flags	Functional Description
contact	Describes how the button behaves when pushed.
bsContactMomentary	Button is changed momentarily to on, then off when the button is released.
bsContactToggle	Button is toggled on and off between each push.
bsContactLockOn	Button is set to on, but stays on after the user lets go. Used in choices where user can't turn off a button by tapping on it.
feedback	Describes how the current value (on or off) should display.
bsFeedbackNone	No visual feedback.
bsFeedbackInvert	Invert the button.
bsFeedbackDecorate	Use onDecoration or offDecoration to draw button.
bsFeedbackNone	No feedback.
bsFeedback3D	Use three-dimensional shadow effect.
bsFeedbackBox	Outline the button with a box.
on	Determines whether button is on or off; the button's value.
onDecoration	Use when button is on if feedback is set to bsFeedbackDecorate.
offDecoration	Use when button is is off if feedback is set to bsFeedbackDecorate.
pArgs	Determines the kind of button notification message arguments.
bsPargsData	Message argument is the data in the button's metrics.
bsPargsValue	Message argument is the button's current value.
bsPargsUID	Message argument is the button's UID.
notifyDetail	Determines whether the button sends messages to its manager for its detailed previewing messages.

continued

Table 37-2 (continued)

Styles/Style Flags	Functional Description
notifyWithMsg	Determines whether button's notification message is specified in msg or the generic message msgButtonNotify.
halfHeight	Determines if button has partial border when not previewing or executing and a full-round; fill when previewing.
manager	Determines the kind of manager the button has.
bsManagerNone	Button has no manager.
bsManagerParent	Button's parent window is the manager.
bsManagerClient	Button's control client is the manager.

Notification 37.4

Simple Activation 37.4.1

The model for the simplest use of buttons is:

1 User interacts with button.

2 Button sends message to manager.

3 Button sends message to client at end of interaction if the user actually activated the button.

Note that the button will send a message to its client even if the value of the button (**on** in BUTTON_STYLE) is the same as it was before. It sends the message whether the user or the API sets its value.

At this level, **clsControl** self-sends **msgControlAcceptPreview. clsButton** responds to this by sending self **msgButtonNotify** (the next sections describe how a button comes to send itself this message). The arguments to this are in a BUTTON_NOTIFY structure. **clsButton** responds to **msgButtonNotify** as follows:

Buttons rely on ***ObjectCall***.

- The **notifyWithMsg** button style field determines what **clsButton** sends to the client when it receives **msgButtonNotify**. If set, the message that the button sends to its client is the message you specified in the button's metrics (**msg**). If **msg** is **null, clsButton** won't send any message.
- However, if **notifyWithMsg** is **false**, then the message that the button sends to its client is the same generic **msgButtonNotify**. The message arguments are a BUTTON_NOTIFY structure containing the **msg** and **data** you specified in the button's metrics, and the UID of the button sending the notification message. In this case, the button does not interpret the **msg** field of BUTTON_METRICS, so it, like **data**, could be any 32-bit data.

Example 37-1
Creating a Button

As an example of the first style, if your application has a button labeled **Recalc**, you could set **notifyWithMsg** and specify **msgMyAppRecalc** as its message and the application UID as the client. When the user taps this button, the application would receive **msgMyAppRecalc**. The nice thing here is that the application is isolated from its user interface. You could change the button or add another way to recalculate, or the application could receive the message from an agent process without requiring any changes to the application.

```
BUTTON_NEW bn;
APP        myApp;
STATUS     s;

myApp   = OSThisApp();

ObjCallRet(msgNewDefaults, clsButton, &bn, s);
bn.win.parent    = parentWin;
bn.win.options   = wsPosTop;

bn.label.pString    = "Recalc";
bn.control.client   = myApp;
bn.button.msg       = msgMyAppUserRecalc;
ObjCallRet(msgNew, clsButton, &bn, s);
ObjCallRet(msgWinInsert, bn.object.uid, &bn.win, s);
```

The application object **myApp** will receive **msgMyAppUserRecalc** with P_ARGS of null when the user activates the button. This example doesn't use the data field because all the information the client needs is the **msgMyAppRecalc** itself. You could associate a different message with every button in your application. However, the cost of defining separate messages for every button is that the client must respond to dozens of messages. The **data** field is useful when you want several buttons to share the same message, but want to distinguish between them. For example, you might have several buttons to zoom in and out of a diagram. Each could have the same **msg** field (**msgMyAppZoom**), and a different **data** corresponding to the different zoom factors or styles associated with each button.

With **notifyWithMsg** set (as in this example), the client doesn't automatically get the UID of the button sending the message. You can get around this by specifying in the BUTTON_STYLE that its data be the UID of the button (set **pArgs** to **bsPargsUID**).

Unwelcome Notification 37.4.2

A button normally notifies its client whenever someone sets its value. This is true even if the new value is the same as the old value. This may cause problems. For example, you have a toggle in your application that indicates the zoomed state of the application. When you restore the application, you want to set the toggle to show whether the view is zoomed or not. But if you send **msgControlSetValue** to the toggle, it will notify its client that it has a new value.

If you want to temporarily avoid receiving these kinds of notifications, you can either use **msgButtonSetNoNotify** to set the value of the button without notifying its manager and client, or don't set the button's client until after you have set it up.

Painting 37.5

If **halfHeight** is set in BUTTON_STYLE, then buttons draw a half-height border when not previewing or executing, and a full-round fill when previewing.

The **bsFeedback3D** style sets up many border metrics to provide the three-dimensional effect.

clsButton responds to **msgBorderGetForegroundRGB** with the appropriate RGB color to use for the foreground, given the current visuals. Usually, it calls its ancestor, but if the button's **style.look** is **bsFeedback3D**, it computes the appropriate color to use.

Value 37.6

The value of a button is either 1 (on) or 0 (off). You can set a button's value with **msgControlSetValue** and test it with **msgControlGetValue.** You can also manipulate the value by setting and getting the BUTTON_STYLE fields, which include **on.**

Control Dirty 37.6.1

When a button's value changes (either programmatically or by the user changing it), the button self-sends **msgControlSetDirty**, so that if its **showDirty** control style bit is set, it will indicate that its value is different. Someone else (probably the button's client) is responsible for resetting the button's control dirty. For example, the client might reset control dirty after it completes the action requested by the button.

If a button's contact style is not **bsContactMomentary**, then as soon as the user taps it (and it thereby receives **msgControlBeginPreview**), it sends itself **msgControlSetDirty** with value **true.** Thus, a button is dirty as soon as the user touches it. The intent of control dirty is to allow **option tables** and other collections of controls to determine which of their nested controls has been altered. If a control is dirty, then the change will be applied. The assumption is that if a user has touched a button, then the user wants its value applied, even if the user never changed its state.

Creating Many Buttons 37.7

If you need to create many buttons, then you can create them in a toolkit table. **clsTkTable** lets you create all the nested buttons at once. **clsToggleTable** and **clsChoice** are collections of buttons with additional semantics. See Chapter 38, Toolkit Tables, for more information on creating a set of buttons at once.

Advanced Button Notification Techniques 37.8

Unless you need to create a completely new class of button, don't read this section!

Most developers need not be concerned with the internals of button notification. A single button works as expected, as do the many classes that combine groups of buttons. However, in the rare case that you must create a completely new class of button, you will have to write code to handle low level button notifcation and management protocols.

If you set the **notifyDetail** button style field, the button's manager will receive a host of additional messages. You set the **manager** at creation time or in the BUTTON_METRICS structure. The manager is an object that receives notification messages from the button. These messages are called **previewing** messages because a button generates them while the user is interacting with the button, but before the user activates the button.

The manager can alter the behavior of the button or of other buttons in a group, as for example, a choice does to coordinate its toggles. This is useful if you want to change things around as the user toys with buttons. For example, you might want to change the style of some sample text as the user touches the pen on a choice, not just after the user makes his final choice.

The messages are all of the form **msgButton...Preview** and an extra message, **msgButtonManagerNotify**. These messages to the button manager correspond to the **msgControl...Preview** messages that **clsControl** sends to the button. The button sends them using **msgWinSend**, so that if its manager doesn't respond, the message propagates to the manager's ancestor window, and on up the window tree.

Table 37-3
clsButton Previewing Messages

Message	Description
msgButtonBeginPreview	The user has begun previewing.
msgButtonUpdatePreview	The user continues to preview in a manner that requires the client to update. For example, if a slider and a text field both indicate a value, then it might be appropriate for the client to change the text field as the user moves the slider.
msgButtonRepeatPreview	The previewing has repeated. If a button's previewRepeat control style bit is set, then it will start repeating the last action after a while. This is true for scrollbars and the page turn buttons.
msgButtonCancelPreview	The user has finished previewing this button but hasn't activated it.
msgButtonAcceptPreview	The user has activated this button.

Manager Objects 37.8.1

There are some common styles of button management, such as the exclusive-on buttons in choices and multiple selectable buttons in a list box. The UI Toolkit includes manager classes that do the housekeeping for the preview messages from these sets of buttons: **clsManager**, **clsChoiceMgr**, and **clsSelChoiceMgr**. They are described in more detail in Chapter 38, Toolkit Tables.

How clsButton and clsTkTable Respond to Button Previewing Message 37.8.2

If the manager receiving these messages is itself a button or toolkit table, and it calls **ObjectCallAncestor**, **clsButton** and **clsTkTable** respond to them by notifying the manager's own manager if the manager's **notifyDetail** flag is set. In other words, the previewing messages continue to flow up the chain of managers if they all set **notifyDetail**.

The object sending **notifyDetail** messages ignores the status returned by the recipient.

Examples of Previewing 37.8.3

clsChoice is one built-in class that responds to **msgButton...Preview** messages. Choices are made up of several ordinary buttons (**clsChoice** is a toolkit table; this type of class is described below), but the choice must ensure that only one of the buttons is on at once. When the user previews another button by holding the pen tip over it, the choice must turn off the current button. To implement this, a choice sets the button **style.manager** of its buttons to **bsManagerParent** (the parent of the buttons, that is, the choice itself), and uses a hidden object to handle the button previewing messages. See Section 9.6 for more information.

As another example, if you were going to be a client of a joystick-like control, and you wanted to update a view as the user moves the joystick or keeps it sideways, you would set **notifyDetail** and update your view on receiving **msgButtonUpdatePreview** and **msgButtonRepeatPreview**. The pseudo-joystick control would need to be a subclass **clsButton** to generate these messages.

Unwanted Manager Notification 37.8.4

Since the button's value is the **on** field in its BUTTON_STYLE, one side effect of sending **msgButtonSetStyle** or **msgButtonSetMetrics** is that the button sends itself a **msgButtonNotifyManager** message and also notifies its client.

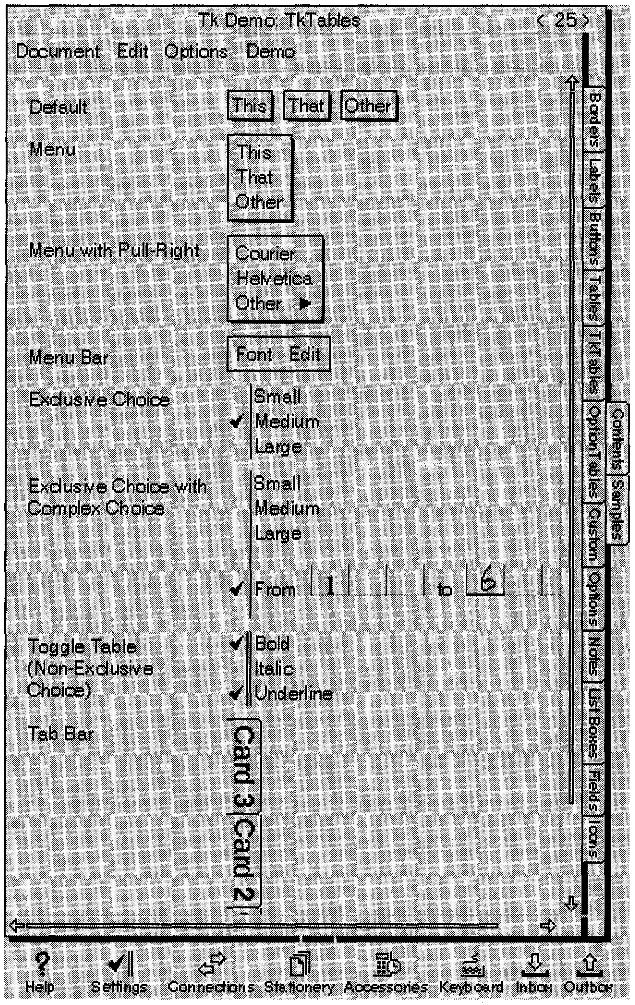
Chapter 38 / Toolkit Tables

clsTkTable groups a collection of UI Toolkit components, typically buttons or descendants of **clsButton**, into a table. It creates all the items at once. The items can be from different classes, and you can specify particular initialization for each one. The items can even be toolkit tables themselves. Thus, not only can you create homogeneous tables of buttons, such as a bank of switches, you can also put choices, arrays of buttons, fields, submenus, and any other kind of UI Toolkit component in the same toolkit table. For example, many of the option cards in PenPoint option sheets are created from a single toolkit table specification.

Menus, choices, option tables, tab bars, and command bars are all toolkit tables that are composed of collections of labels and buttons. Each item in the menu, or possible choice in the choice, or toggle in the toggle table, is a toolkit component nested inside the toolkit table as a child window. These descendants of **clsTkTable** are described in later sections.

The menu, choice or toggle table manages its component buttons, arranging them and managing their previewing and notification. The arrangement aspect is best handled by **clsTableLayout**, so **clsTkTable** inherits from **clsTableLayout**. To alter the layout of buttons in toolkit tables, you can use the messages and structures provided by **clsTableLayout**.

Figure 38-1
Sample Toolkit Tables



clsTkTable Messages 38.1

Table 38-1 summarizes the messages defined by **clsTkTable**.

Table 38-1
clsTkTable Messages

Message	Description
	Class Messages
msgNew	Creates a toolkit table window.
msgNewDefaults	Initializes the TK_TABLE_NEW structure to default values.
	Instance Messages
msgTkTableGetStyle	Passes back the current style values.
msgTkTableSetStyle	Sets the style values.
msgTkTableGetClient	Passes back the client of the first child in the table.
msgTkTableSetClient	Sets the client of each child in the table to pArgs.
msgTkTableGetManager	Passes back the manager.
msgTkTableSetManager	Sets the manager.
msgTkTableGetMetrics	Passes back the metrics.
msgTkTableSetMetrics	Sets the metrics.
msgTkTableChildDefaults	Sets the defaults in pArgs for a common child.
msgTkTableAddAsFirst	Inserts pArgs as the first child in the table.
msgTkTableAddAsLast	Inserts pArgs as the last child in the table.
msgTkTableAddAsSibling	Inserts pArgs->newChild in front of or behind pArgs->sibling.
msgTkTableAddAt	Inserts pArgs->newChild table at zero-based index pArgs->index.
msgTkTableRemove	Extracts specified window from the table.
	Third-Party Notification Messages
msgTkTableInit	Sent to TK_TABLE_ENTRY.class after default mappings from entries to pChildNew.

Other Kinds of Toolkit Tables 38.2

Toggle Tables

A toggle table (**clsToggleTable**) is a table of independent toggle buttons. **clsToggleTable** maintains a 32-bit bitmask encoding the values (on or off) of the first 32 buttons in the table. This chapter describes toggle tables in more detail after describing **clsTkTable**.

Choices

A choice (**clsChoice**) is a table of buttons of which only one button may be on. When the user activates a button in a choice table, whatever button had been previously activated is deactivated. This chapter describes choices in more detail after describing **clsTkTable**.

Menus

A menu is a toolkit table that organizes its nested components in a column. Menus are documented in Chapter 39, Menus and Menu Buttons.

Tab Bars

A tab bar (**clsTabBar**) arranges a set of tab buttons vertically, and let the user slide tabs around to hide and expose tabs. Frames and option sheets can have attached tab bars.

Command Bars

A command bar (clsCommandBar) presents a centered set of buttons. Option sheets have a standard command bar containing **Apply** and **Apply & Close** buttons.

Option Tables

An option table (**clsOptionTable**) presents the standard two-column layout of pairs of bold labels and settings inside option sheets.

Creating a Toolkit Table 38.3

When you create a toolkit table, you indirectly specify the **msgNew** arguments for the components in it as part of **clsTkTable**'s own **msgNew** arguments. TK_TABLE_NEW_ONLY permits a mass initialization of the nested components. You can either specify **msgNew** arguments for each individual component, or a global **msgNew**, or neither, and just set some flags for the common classes of components. **clsTkTable** uses this information to create the child components itself—it sends **msgNew** over and over to create each child, so you don't have to.

This means that there are two distinct ways to create most UI Toolkit components: by sending **msgNew**, or by specifying it as a table entry when creating a toolkit table.

Common Creation Information 38.3.1

Rather than requiring you to separately create each component in the table by sending **msgNew** over and over, you supply some information common to all the components, and a pointer to an array of information for each child (P_TK_TABLE_ENTRY). The common information in TK_TABLE_NEW_ONLY is:

style the table style (currently empty).

client the client for controls in the table.

pEntries a pointer to the array of per-child information.

pButtonNew a default **msgNew** structure for all of the nested items (if needed).

manager a **manager** to notify..

Class-Dependent Creation Information

38.3.2

The array of information that you specify for each button individually consists of a null-terminated array of TK_TABLE_ENTRY structures. The fields in a TK_TABLE_ENTRY are as follows:

arg1, arg2, arg3 **clsTkTable**'s interpretation of the fields depends on the class of the item. These are a P_UNKNOWN and two U32s, respectively.

tag a window tag. Because **clsTkTable** creates the items for you, the easiest way to retrieve an object is to give it a tag (using **MakeTag**) and find it with **msgWinFindTag**.

flags a set of flags that encode common variants of items in a toolkit table, such as toggle-style button, wide border margins, and a menu button with a pull-right menu. Many of the flags only apply to certain classes of items.

class the class of the item. This is only needed to override the default **class** defined in **pButtonNew**.

helpId a Help ID for the item, used by **clsGWin** to support Quick Help.

The three unknown fields and the flags field allow a single structure to define most varieties of many different kinds of nested components, without having to supply a custom **msgNew** structure for each component. For buttons, you usually only set the string, message, and data. For a label, you only set the string.

Now for a menu button with a sub-menu, you want to specify the menu button's string, and then information for each of the items in the sub-menu. This is possible: the second argument for a menu button with a sub-menu is the address of another TK_TABLE_ENTRY array. The values of the fields for different classes are as shown in Table 38-2.

Table 38-2
Interpretation of TK_TABLE_ENTRY Fields

Class	arg1	arg2	arg3
clsLabel	pString	N/A	N/A
clsButton	pString	msg	data
clsMenuButton (no submenu)	pString	msg	data
clsMenuButton (with submenu)	pString	pEntries	N/A
clsChoice	pEntries	num of rows or cols	N/A
clsToggleTable	pEntries	num of rows or cols	N/A
clsPopupChoice	pEntries	num of rows or cols	N/A
clsPopupChoice (displaying fonts)	prune (see below)	num of rows or cols	N/A
clsField	pString	num of cols	N/A
clsListBox	num of entries	num of entries visible	N/A
clsFontListBox	num of entries	num of entries visible	look

Wherever this table calls for a **pEntries** in a TK_TABLE_ENTRY field, you supply the address of another TK_TABLE_ENTRY array (or **pNull**, and **clsTkTable** will read the embedded table's entries in-line).

Wherever this table calls for number of rows or columns in a TK_TABLE_ENTRY field, the interpretation of what you are setting depends on whether the flag **tkTableVertical** or **tkTableHorizontal** is OR'd into **flags**. For example, for a choice in a toolkit table, the default orientation is vertical and the default number of columns is one. However, if you set the **tkTableHorizontal** flag and set **arg2** to 3, you make the choice wrap onto three columns. If neither flag is set, **arg2** is ignored (flags are described below). Note that these flags apply to the nested table item, not to the parent toolkit table; you would change the orientation of the parent toolkit table by changing its TABLE_LAYOUT_NEW_ONLY fields.

prune is a FIM_PRUNE_CONTROL flags word, described in more detail in "Displaying Installed Fonts in a Table," later in this chapter.

Defining Table Entries Statically 38.3.2.1

You usually declare the TK_TABLE_ENTRY array statically:

```
static TK_TABLE_ENTRY   myMenuBar = {
    {item1arg1, item1arg2, item1arg3, item1tag, item1flags, item1class, item1helpId},
    {item2arg1, 0,       , item2arg3, item2tag, item2flags, 0, 0},
    ...
    ...
    {pNull}
};
```

This saves the code required to initialize each of the entries. You can leave trailing fields out and the C compiler will fill them with zeros.

Furthermore, wherever a particular component class calls for a pointer to another TK_TABLE_ENTRY (a **pEntries** in the above table), instead of declaring a separate array, you can embed a new array in the static definition. To do this enter **pNull** where the **pEntries** pointer would go, and follow that entry with the entries for the embedded TK_TABLE_ENTRY. **clsTkTable** will create the second toolkit table from these entries.

If you do embed TK_TABLE_ENTRYs inside others, make sure that each array ends with a null entry ({**pNull**}). **clsTkTable** has to find the empty entry to know where the embedded table ends.

Toolkit Table Flags 38.3.2.2

The possible **flags** values in TK_TABLE_ENTRY allow you to set common styles for the existing label and button classes without having to resort to subclassing or supplying a **msgNew** structure. The flags also work for classes descending from the existing label and button classes. The flag values are listed in Table 38-3.

Table 38-3
TK_TABLE_ENTRY Flag Values

Flag Values	Functional Description
tkLabelEntry	arg1 is a P_TK_TABLE_ENTRY.
tkLabelStringId	arg1 is a string resident.
tkLabelBold	Use bold system font in label.
tkLabelWordWrap	Word wrap the label string.
tkButtonPargsValue	Send value instead of data.
tkButtonPargsUID	Send UID instead of data.
tkButtonOn	Turn on the button.
tkButtonHalfHeight	Use half-height button border.
tkButtonManagerNone	Set button manager to bsManagerNone.
tkButtonToggle	Make button a toggle.
tkButtonBox	Use bsFeedbackBox.
tkMenuPullRight	arg2 is pEntries for a pull-right menu.
tkMenuPullDown	arg2 is a pEntries for a pull-down menu.
tkContentsSection	arg2 is a pEntries for section contents.
tkInputDisable	Disable input.
tkBorderEdgeTop	Turn on top border.
tkBorderEdgeBottom	Turn on bottom border.
tkBorderMarginNone	Turn off all margins.
tkBorderLookInactive	Make entry inactive.
tkTableHorizontal	Table is horizontal.
tkTableVertical	Table is vertical.
tkNoProto	Do not use prototypical pButtonNew.
tkNoClient	Do not copy client fields.
tkPopupChoiceFont	Use current font name.
tkControlDynamicClient	Set dynamicEnable equal to csDynamicClient.
tkControlDynamicObject	Set dynamicEnable equal to csDynamicObject.
tkControlDynamicPargs	Set dynamicEnable equal to csDynamicPargs.
tkControlCallSel	tkControlDynamicObject.
tkControlSelLocal	tkControlDynamicPargs.
tkMenuButtonGetMenu	Send msgMenuButtonProvideMenu.
tkMenuButtonEnableMenu	Send msgMenuControlEnable.

As an example of a complex nested toolkit table, the following example shows the code from TkDemo for its sample option table (in \PENPOINT\SDK\SAMPLE\TKDEMO\OPTABLES.C).

Example 38-1
TK_TABLE_ENTRY Array for an Option Card

Option cards, the client windows in option sheets, are usually instances of **clsOptionTable**, a descendant of **clsTkTable**. The only differences between **clsOptionTable** and **clsTkTable** is that the defaults for the former are a two-column table of bold labels. You can often specify every component in the option card in a deeply nested static TK_TABLE_ENTRY array.

To show off the flexibility of toolkit tables, two of the items nested in the table are identical custom-aligned **On/Off/Show** groupings. The Header & Footer and the Background Doc options use this same item, so it is specified as a separate TK_TABLE_ENTRY (**onOffChoice**) to avoid duplicating a static array. (If it weren't for this, the entire option table could be specified in one TK_TABLE_ENTRY array.)

```
static const TK_TABLE_ENTRY onOffChoice[] = {
    {0, 0, 0, 0, tkLabelEntry},
        {0, 0, 0, tagNestedTbl, tkTableWideGap | tkTableHorizontal | tkInputDisable, clsTkTable},
            {"On", 0, 0, 0, tkInputDisable | tkBorderMarginNone, clsLabel},
            {"Show", msgButtonNotify, 0, 0, tkButtonManagerNone, clsButton},
            {pNull},
    {"Off", 0, 0, 0, tkButtonOn},
    {pNull}
};
```

Here's the main TK_TABLE_ENTRY for the card.

```
static const TK_TABLE_ENTRY sampleCard[] = {
    {"Pages:"},             {0, 0, 0, tagPagesChoice, tkNoClient, clsChoice},
        {"All"},
        {0, 0, 0, 1, tkLabelEntry | tkButtonOn},
            {0, 0, 0, tagNestedTbl, tkTableHorizontal, clsTkTable},
                {"From", 0, 0, 0, tkBorderMarginNone, clsLabel},
                {"1", 2, 0, 0, 0, clsIntegerField},
                {"to", 0, 0, 0, tkBorderMarginNone, clsLabel},
                {"1", 2, 0, 0, 0, clsIntegerField},
                {pNull},
        {pNull},
    {"No. of Copies:"},     {"1", 0, 0, 0, 0, clsIntegerField},
    {"Name:"},              {0, 10, 0, 0, 0, clsTextField},
    {"Paper Size:"},        {0, 0, 0, 0, tkNoClient, clsChoice},
        {"8 1/2 X 11"},
        {"8 1/2 X 14", 0, 0, 1, tkButtonOn},
        {pNull},
    {"Printer:"},           {0, 0, 0, 0, tkNoClient, clsChoice},
        {"HP"},
        {"Diconix", 0, 0, 1},
        {"Apple", 0, 0, 2, tkButtonOn},
        {pNull},
    {"Header & Footer:"},   {onOffChoice, 0, 0, tagHFChoice, tkNoClient, clsChoice},
    {"Background Doc:"},    {onOffChoice, 0, 0, tagBDChoice, tkNoClient, clsChoice},
    {pNull}
};
```

continued

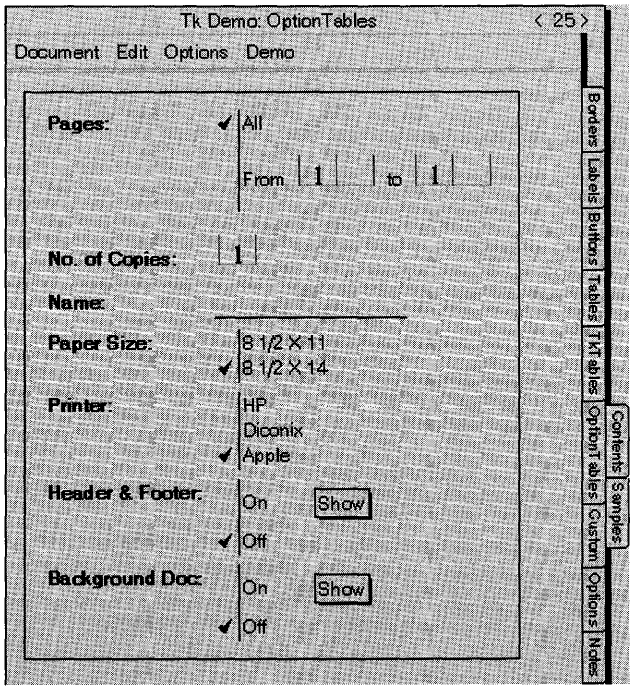
Example 38-1 (continued)

The example entry above is a static definition outside of any function. When the time comes to create the toolkit table, you specify the top level TK_TABLE_ENTRY array as an argument to **clsTkTable** (or one of its descendants). **clsTkTable** creates all the nested components, including other toolkit tables. In the case of TkDemo, the application calls an internal routine (**AddOptionTableExamples**) to create the option sheet as part of another window (**parent**).

```
STATUS LOCAL AddOptionTableExamples (WIN    parent)
{
    STATUS             s;
    OPTION_TABLE_NEW   otn;
    AddLabel(parent, "Standard Option Table, with Nested Tables");
    ObjCallRet(msgNewDefaults, clsOptionTable, &otn, s);
    otn.border.style.edge = bsEdgeAll;
    otn.tableLayout.style.childYAlignment = tlAlignBaseline;
    otn.tableLayout.rowHeight.constraint = tlGroupMax | tlBaselineBox;
    otn.tkTable.pEntries = sampleCard;
    ObjCallRet(msgNew, clsOptionTable, &otn, s);
    StsRet(AdjustTblAlignment((WIN) \
        ObjectCall(msgWinFindTag, otn.object.uid, (P_ARGS) tagPagesChoice)), s);
    StsRet(AdjustTblAlignment((WIN) \
        ObjectCall(msgWinFindTag, otn.object.uid, (P_ARGS) tagHFChoice)), s);
    StsRet(AdjustTblAlignment((WIN) \
        ObjectCall(msgWinFindTag, otn.object.uid, (P_ARGS) tagBDChoice)), s);
    otn.win.parent = parent;
    ObjCallRet(msgWinInsert, otn.object.uid, &otn.win, s);
    return stsOK;
} /* AddOptionTablesExample */
```

Figure 38-2 shows what the complete table looks like.

Figure 38-2
Toolkit Table from TkDemo Application



Pages: [✓ All] From 1 to 1
No. of Copies: 1
Name:
Paper Size: 8 1/2 X 11 [✓ 8 1/2 X 14]
Printer: HP Diconix [✓ Apple]
Header & Footer: On [✓ Off]
Background Doc: On [✓ Off]

Creating the Child Windows

38.3.3

When you send **msgNew**, **clsTkTable** creates the child windows specified in P_TK_TABLE_ENTRY. It has to create a **msgNew** structure for each one. In this structure, it sets the **win.parent** to self, sets the **win.options** to **wsPosTop**, and sets the **button.style.manager** to **bsManagerParent** (if the child window is a button). It sets the other defaults using appropriate values from the prototypical **msgNew** structure in TK_TABLE_NEW_ONLY (**pButtonNew**), the **class** specified, and the values and flags in the TK_TABLE_ENTRY. The process of establishing these defaults is quite complex, but often you can ignore it and just specify as few parameters as possible.

clsTkTable then sends **msgNew** with the resulting structure to the class of the nested component to create that child, and inserts it as a child window.

Changing Defaults in a Toolkit Table

38.3.4

When you create a toolkit table with a separate static **TK_TABLE_ENTRY** array, you eliminate all the code from your program, which declares the **msgNew** structures, fills them in, and sets their values. Instead, **clsTkTable** creates the entries in the toolkit table for you. If you want the default items in your toolkit table, you can often get by with setting no more than the label strings and button messages, leaving everything else to zero.

*If you're not sure what value to give to one of the fields in a TK_TABLE_ENTRY, leave it as zero, and **clsTkTable** and its descendants will probably behave appropriately.*

If you do want the entries to be different, there are several ways to change them. **clsTkTable** uses several levels of defaulting to establish the appropriate **msgNew** arguments when it creates the entries. On top of this are the changes made by the common descendants of **clsTkTable**, such as menus and choices.

Using the Default Item Class

38.3.4.1

If you don't specify a class for an item in its TK_TABLE_ENTRY, **clsTkTable** uses the default class for the nested items. The default class for the nested items comes from the **pButtonNew** field in TK_TABLE_NEW_ONLY as follows:

- **pButtonNew** should point to a default **msgNew** structure for the default child item in the table.
- When **msgNewDefaults** gets to **clsClass**, it sets **pButtonNew->object.class** to the UID of the class that received **msgNewDefaults**.
- **clsTkTable** looks at **pButtonNew->object.class** to see what class to create.
- Since **clsTkTable** sets up **pButtonNew** by sending **msgNewDefaults** to **clsButton**, its default child item is a button. However, you can tell **clsTkTable** to use another class by declaring **a** _NEW structure for another class, sending **msgNewDefaults** to that class, and passing the address of your structure as **pButtonNew**.

If the **class** in an item's TK_TABLE_ENTRY is not set, then **clsTkTable** sends **msgNew** to the default class for the child items, passing it the **pButtonNew** structure. Thus, you can give different defaults for all items in the table by modifying **pButtonNew**. For example, if your class wanted to have a large margin around every child window in the table, you could send **msgNewDefaults** yourself to the class of the child windows, change **border.style.margin** to **bsMarginLarge**, and set **pButtonNew** to the address of your custom **msgNew** arguments structure.

Specifying the Item Class 38.3.4.2

If **class** in an item's TK_TABLE_ENTRY is set, then **clsTkTable** does not use the **pButtonNew** structure in TK_TABLE_NEW. Instead, it sends **msgNewDefaults** to the entry's **class** to initialize it to default values. Thus, you can give different defaults for a particular child in the table by specifying a class for it.

After getting a filled-in **msgNewDefaults** structure for the entry's class, **clsTkTable** then self-sends **msgTkTableChildDefaults** so that it can modify this **msgNew** structure. This allows **clsTkTable** and its subclasses to tinker with any component placed inside them. For example, toolkit tables tinker with the border windows and parent clip. For another example, **clsMenu** changes button items so that the button's manager is its parent (**bsManagerParent**) so that it can take down the menu.

clsTkTable and its subclasses determine how much memory to allocate the **msgNew** and **msgNewDefaults** structures by sending **msgNewArgsSize** to the class of the entry.

Using Flags to Modify Items 38.3.4.3

Another way to change the defaults for a particular child item is to set appropriate flags in the item's TK_TABLE_ENTRY structure to get the desired behavior. TKTABLE.H defines flags for many common adjustments to items, including such things as making labels bold (**tkLabelBold**), making buttons send their UIDs (**tkButtonPargsUID**), giving a menu button a pull-right menu (**tkMenuPullRight**), giving a child a bottom edge (**tkBorderEdgeBottom**), and so on. **clsTkTable** checks to make sure that the class matches the flag set, so that if you set, say, **tkButtonPargsValue** in an entry's flags and the entry isn't a button, it won't try to change the entry.

Using Low-Level Customization 38.3.4.4

If all these adjustments fail, you can supply the address of a custom **msgNew** arguments structure in the first field of a particular child item's TK_TABLE_ENTRY. If you do this, you must set **tkPNew** in the entry's **flags** so that **clsTkTable** knows about this change. This is similar to supplying a **tkTable.pButtonNew**, but the former supplies custom **msgNew** arguments for every entry that doesn't specify a **class**, whereas the latter is for a single entry only.

Finally, you can always let **clsTkTable** create a standard item, and then you can locate it using **msgWinFindTag** and modify it as you desire.

Modifying a Toolkit Table 38.4

Creating and Adding Your Own Items 38.4.1

You can add new child items to a toolkit table using **msgTkTableAddAsFirst**, **msgTkTableAddAsLast**, **msgTkTableAddAsSibling** (relative to a window UID in the table), and **msgTkTableAddAt** (at a zero-based index).

If you do this, you probably want the items to have the same appearance and behavior as other items in the toolkit table. To ensure this, after sending **msgNewDefaults** to the class of the item, send **msgTkTableChildDefaults** to the table, passing it the child's initialized _NEW structure. **clsTkTable** responds by setting some window flags in the child window to improve performance; descendants of **clsTkTable** make other changes. Send **msgNew** to the child's class, passing the modified _NEW structure, then insert the child window.

Modifying Items in a Toolkit Table 38.4.2

As with all classes, you should let the defaults give you the correct behavior and modify fields only when the defaults really don't work.

After creation, you can get the UID of a nested child within a toolkit table using **msgWinFindTag** to find a particular tagged window. Having retrieved the window, you can modify its metrics. It's a bad idea to change those metrics, which a toolkit table requires its nested items to have in order to work properly—know what you're doing. For example, if you found a button in a menu and changed its manager style, the user tapping on the button might no longer take down the menu.

Toolkit Tables and Window Tags 38.4.3

You can use the window tag facility to locate items in toolkit tables without having to remember the UIDs of every window.

Since **msgWinFindTag** propagates down into child windows, it's important that you define unique tags for your components so as not to clash with other components in the UI Toolkit. You can either use low numbers, or define your tags using **MakeTag()** and one of your classes, hence guaranteeing unique tags. GO publishes the tags of many items in system/option sheets and menus so that adventurous developers can find and modify them. The tags definitions are in header files in \PENPOINT\SDK\INC, such as APPTAG.H and TV_TAGS.H.

Painting 38.5

A toolkit table may contain many child windows, which may contain their own child windows. Using dozens of windows this way is very flexible, but can lead to slow repainting. **clsTkTable** tinkers with window style flags and border styles in order to improve repainting. You need only be concerned about these changes if you are putting special windows in a toolkit table, trying to draw in it yourself, or otherwise making unusual use of **clsTkTable**.

Ordinarily, a child window is prevented from painting pixels outside its rectangle on its parent, and if it is covered by sibling windows it can't paint pixels on them.

Similarly, a parent is prevented from painting pixels within its child windows. The result is that windows don't paint over each other. The cost is that the window system has to re-compute the area to draw on for each window.

For windows in a toolkit table, all this protection is usually unnecessary. Labels do not draw outside their boundaries. **clsTkTable** places child windows so they do not overlap. **clsTkTable** paints the background for its children but does not otherwise paint over them.

Consequently, when **clsTkTable** creates its child windows, it changes their window style flags. It turns on **wsParentClip** in each child window, and turns off **wsClipSiblings** and **wsClipChildren**. In its own window style flags, it turns off **wsClipChildren.** For more information on the effects of these window flags, see *Part 3: Windows and Graphics.*

If a child window is a border window, **clsTkTable** sets its background ink to transparent (**border.style.backgroundInk** set to **bsInkExclusive**). When the toolkit table paints its background, it will fill its child windows, so the border windows don't need to fill their own backgrounds.

Layout 38.6

clsTkTable inherits from **clsTableLayout**, and toolkit tables use table layout functionality to position their nested components. By default (in response to **msgNewDefaults**), **clsTkTable** sets its table layout to a single row and multiple columns by setting:

- **tableLayout.numRows.constraint** to **tlAbsolute.**
- **tableLayout.numRows.value** to 1.
- **tableLayout.colWidth.constraint** to **tlGroupMax.**
- **tableLayout.style.growChildWidth** to **false.**
- **tableLayout.rowHeight.constraint** to **tlChildrenMax.**
- **tableLayout.style.growChildHeight** to **true.**

As a result, the nested components are all the same height but they are of different widths. Descendant classes can override this when handling either **msgNew** or **msgNewDefaults.** For example, a menu choice has one and many rows.

clsTkTable does not place any limitation on the size of its nested components, which can cause problems if your application creates menus or choices out of lists of strings that are not predefined. If one of the strings is very long, the toolkit table will be very large and ill-proportioned. You can solve this problem by putting the toolkit table in a scrollwin, described in Chapter 40, Scrollbars.

Notification 38.7

You set a client for the toolkit table in its **msgNew** arguments. By default, **clsTkTable** copies this client into each control within it, and within nested toolkit tables within it. You can turn off this behavior if you set the flag **tkNoClient** in an entry's TK_TABLE_ENTRY. **clsTkTable** also intercepts **msgControlSetClient** and does the same copying into each of its controls.

A toolkit table simply relays notification messages from its nested controls to its manager using **msgWinSend**.

clsTkTable does not set **notifyDetail** or respond to any **msgButtonControl... Preview** messages.

Control Enable 38.7.1

When a toolkit table receives **msgControlEnable**, it recursively enumerate itself and forwards the **msgControlEnable** to every instance that is a control within itself, passing the original message arguments. Since a menu is a toolkit table, if the menu receives **msgControlEnable**, the controls in the menu will also receive the message.

There are two TK_TABLE_ENTRY flags that set the **dynamicEnable** control style field to common values:

- **tkControlDynamicClient** sets it to **csDynamicClient**.
- **tkControlDynamicPargs** sets it to **csDynamicPargs**.

By setting these flags, you get dynamic control over whether a control in the toolkit table is enabled, as explained in Chapter 35, Controls.

The **tkMenuButtonGetMenu** TK_TABLE_ENTRY flag sets a menu button's **getMenu** style flag. The **tkMenuButtonEnableMenu** TK_TABLE_ENTRY flag sets a menu button's **enableMenu** style flag. By setting these flags, you get dynamic control over a menu button's sub-menu, as explained in Chapter 39, Menus and Menu Buttons.

Managers 38.8

When you have a set of objects whose interactions need to be coordinated, you can have a manager for them. **clsTkTable** maintains a **manager** field. The manager gets certain notifications from buttons in the toolkit table whose **button.style.manager** is **bsManagerParent**.

Button Manager Notification Details 38.8.1

If a button is in a toolkit table, it uses **msgWinSend** to send protocol messages (in this case **msgButtonDone**, **msgButtonAcceptPreview**, and so on) to its manager so long as **button.style.manager** is not **bsManagerNone**. **clsWin** responds to **msgWinSend** by propagating the message to the instance's parent window.

When someone sets the value of a button, it sends **msgButtonDone** to its manager using **msgWinSend**.

For example, a toolkit table sets up the buttons that are its children so that their **button.style.manager** is **bsManagerParent**. In other words, the buttons pass manager notifications to the tooklkit table (their parent) via **msgWinSend**. However, the toolkit table intercepts **msgWinSend**, and if the toolkit table has a **manager** defined in its metrics, it jumps out of the window tree send and just **ObjectCalls** its manager. If the manager returns **stsManagerContinue**, then the button will continue propagation via **msgWinSend**.

The point of all this is that you can arbitrarily nest button components and have them be managed by some object. You can have a button in a custom layout inside another button send protocols up the tree and get to the appropriate manager.

Menu Management 38.8.2

For menus, the manager is the menu button that puts up the menu. The menu button takes down the menu when the user activates one of the buttons in the menu, as follows:

- Button sends **msgButtonDone** using **msgWinSend**.
- Menu gets this and sends **msgMenuDone** to its manager, the menu button.
- Manager always receives **msgButtonDone**, even if it doesn't get all the detail messages such as **msgButton...Preview**.

The menu is doing a grab; it looks at the destination of input event, and if it's not in a descendant, it sends manager **msgMenuDone**.

Manager Classes 38.8.3

Other classes require more sophisticated managers, so there are a few classes of specialized manager objects, including **clsChoiceMgr** and **clsSelChoiceMgr**. The former manages the settings in a choice so that only one button in it is ever on; the latter manages objects that are selectable. Both these classes inherit from **clsManager. clsManager** is an **abstract class**, which means that it is not useful to create instances of **clsManager. clsManager** exists simply to define details that are common to all its subclasses.

Choice Management 38.8.3.1

clsChoice creates an instance of **clsChoiceMgr** and sets that as the **manager** of the toolkit table. The choice manager ensures that, at most, only one button is on.

Table 38-4 summarizes the messages defined by **clsChoiceMgr**:

Table 38-4
clsChoiceMgr Messages

Message	Description
	Class Messages
msgNew	Creates a choice manager.
msgNewDefaults	Initializes the CHOICE_MGR_NEW structure to default values.
	Instance Messages
msgChoiceMgrGetOnButton	Gets the current on button. Passes back objNull if no button is on.
msgChoiceMgrSetOnButton	Sets the current on button.
msgChoiceMgrSetNoNotify	Like msgChoiceMgrSetOnButton, but no notifications are generated.

Selection Choice Management 38.8.3.2

clsSelChoiceMgr goes further, and helps its client acquire the selection when one of its objects is activated.

No classes in the UI Toolkit use selection choice managers, but other PenPoint components that have to track selection choices do.

Table 38-5 summarizes the messages defined by **clsSelChoiceMgr**:

Table 38-5
clsSelChoiceMgr Messages

Message	Description
	Class Messages
msgNew	Creates a selChoiceMgr object.
msgNewDefaults	Initializes the SEL_CHOICE_MGR_NEW structure to default values.
	Instance Messages
msgSelChoiceMgrGetClient	Passes back the client UID held by the receiver.
msgSelChoiceMgrSetClient	Sets the client UID held by the receiver.
msgSelChoiceMgrGetId	Passes back the ID held by the receiver.
msgSelChoiceMgrSetId	Sets the ID held by the receiver.
msgSelChoiceMgrNullCurrent	Tells the receiver to clear the visuals and state of the choice.
	Choice Manager Messages to which Selection Choice Managers Also Respond
msgChoiceMgrGetOnButton	Gets the current on button. Passes back objNull if no button is on.
msgChoiceMgrSetOnButton	Sets the current on button.
	Client Responsibility Messages
msgSelChoiceMgrAcquireSel	Sent to the client whenever a different button is selected.
msgSelChoiceMgrNullSel	Sent to the client whenever a different button is selected.

Another example of the use of managers is if you have two toolkit tables, but want them to behave as one exclusive choice, you can specify the same manager for both of them.

Other Management Techniques

Displaying Installed Fonts in Tables 38.9

Often, you want to create a toolkit table displaying the fonts available on the system. **TkTableFillArrayWithFonts** is a utility function in TKCOMP.DLL that allocates a TK_TABLE_ENTRY array filled in with the set of currently installed fonts. It fills in **arg1** of each entry with the name of the font and sets the **tag** field to the FIM_SHORT_ID of the corresponding font . You can use this array to create a choice, menu, set of labels, or whatever, of fonts.

To use **TkTableFillArrayWithFonts**, you pass in a heap from which the toolkit allocates the TK_TABLE_ENTRY array and strings, and a U16 controlling whether the toolkit should prune the font list. Pruning refers to the removal of system and other hidden fonts from the font list. **TkTableFillArrayWithFonts** passes back a pointer to the allocated array.

After creating the toolkit table, you must call **TkTableFreeArray** to free the array created by **TkTableFillArrayWithFonts.**

Pruning and FIM_SHORT_IDs are explained in *Part 12: Installation.* Briefly, prune is a set of flags. It is defined to be a U16 in TKTABLE.H so as not to require including lots of extraneous header files, but is actually a FIM_PRUNE_CONTROL structure defined by the installed font manager in <FONTMGR.H>. This lets you reduce the number of fonts displayed. You can set **prune** to **fimNoPruning** to get a full list, or OR in the following flags to reduce the font list:

fimPruneDupFamilies remove fonts in the same family, such as Swiss Bold, Swiss Italic.

fimPruneSymbolFonts remove symbol fonts.

If you want to provide a pop-up choice showing the installed fonts, there's an even more direct way to get the installed fonts. OR the flag **tkPopupChoiceFont** into the **flags** field of a **clsPopupChoice** entry. The pop-up choice created will reflect the list of installed fonts. In this case, you specify the pruning parameter in place of **pEntries** in the first field of the entry.

FIM_SHORT_IDs are compact identifiers for fonts. **clsFontInstallMgr** provides a message, **msgFIMGetNameFromId**, which provides the font name of an ID.

There's yet another way to create a list of installed fonts: using **clsFontListBox.** This is described in Chapter 41, List Boxes.

Removing Items from a Toolkit Table 38.10

To remove a nested item from a toolkit table, send the table **msgTkTableRemove**, specifying the UID of the child window to remove. This extracts the window, and subclasses can clean up any references to it. Then you can destroy the removed window.

Subclasses of clsTkTable

38.11

There are several subclasses of **clsTkTable**. Some of these add a lot of functionality; all change the toolkit table defaults and the defaults for nested components to produce a different visual effect. Using a descendant of **clsTkTable** further reduces the amount of defaults overriding you need to do. For example, to create a vertical column of buttons with their text rotated 90 degrees using **clsTkTable**, you would have to override the default child structure. But, if you use **clsTabBar**, these settings are the default, and you are back to specifying only the string, message, and data of each entry.

The rest of the sections in this chapter document the various descendants of **clsTkTable**. Menus are covered in the next chapter.

Toggle Tables

38.12

Toggle tables are a group of independent toggle buttons. **clsToggleTable** sets the button style during **msgNew** to toggle style (**bsContactToggle**).

Its value is a 32-bit bitmask giving the values (on or off) of the first 32 toggles nested in itself. **msgControlSetValue** and **msgControlGetValue** can be used to set or get the mask value. If you place more than 32 toggles in a toggle table, you have to enumerate or find the other toggles to get their UIDs in order to set and get their values.

Modifying Toggle Tables

38.12.1

Toggle tables also respond to **msgControlSetEnable**, **msgControlGetEnable**, **msgControlSetDirty**, and **msgControlGetDirty** in a similar fashion. For the **Get** messages, **clsToggleTable** passes back a bitmask indicating which of the first 32 toggles have that style set. For the **Set** messages, you specify to **clsToggleTable** which of the first 32 buttons should be on and off by turning bits on and off in the bitmask.

The only reason to use a toggle table is so that you can set and get the values and styles of several buttons at once. You don't have to use **clsToggleTable** to create a group of buttons. You can always create a vanilla toolkit table by sending **msgNew** to **clsTkTable**, specifying **tkButtonToggle** in the flags of each entry's TK_TABLE_ENTRY.

Choices

38.13

clsChoice is a descendant of **clsTkTable**. It sets child windows in the toolkit table to be buttons with the **bsContactLockOn** style. However, **clsChoice** defines additional semantics such that only one button can be on at any given time.

Table 38-6 summarizes the messages defined by **clsChoice**:

Table 38-6
clsChoice Messages

Message	Description
	Class Messages
msgNew	Creates a choice (and its nested button windows).
msgNewDefaults	Initializes the CHOICE_NEW structure to default values.
	Instance Messages
msgChoiceGetStyle	Gets the style of the receiver.
msgChoiceSetStyle	Sets the style of the receiver.
msgChoiceSetNoNotify	Like msgControlSetValue, but without button notifications.

Creating a Choice 38.13.1

You send **msgNew** to **clsChoice** to create a choice. This takes a CHOICE_NEW structure. The most important field in this is **tkTable.pEntries**, a pointer to an array of TK_TABLE_ENTRYs that specify the buttons in the choice.

You specify the contents of the choice in the TK_TABLE_ENTRY array. The child windows can be any kind of window. By default they are buttons. The TK_TABLE_ENTRY fields for a button are **pString**, **message**, and **data** (and the standard **tag**, **flags**, **class**, and **helpId**).

There are no fields currently used in the CHOICE_NEW_ONLY part of the CHOICE_NEW structure.

Notification 38.13.2

The buttons within a choice notify their client(s) in the usual way. The buttons also send previewing messages to their manager.

clsChoice is the only descendant of **clsTkTable** that turns on **notifyDetail** in its nested buttons. It responds to their **msgButtonChild...Preview** messages by ensuring that the current choice is de-highlighted while the user previews other items.

Choice Manager 38.13.3

clsChoice internally uses a **clsChoiceMgr** to ensure that, at most, only one button is on. You can access the choice manager by sending the choice **msgTkTableGetManager**.

Choice Value 38.13.4

By default, a choice sets up its child buttons to have the button style **bsContactLockOn** set. This results in the behavior that the choice always has one button on. You set the on button at creation by setting the flag **tkButtonOn** in that buttons TK_TABLE_ENTRY array.

To allow no button to be on, you need to change the choice so that its buttons have the style **bsContactToggle**, by changing **pButtonNew->button.style.contact** to **bsContactToggle** in the CHOICE_NEW structure.

clsChoiceMgr defines messages to get and set the current on button (**msgChoiceMgrGet/SetOnButton**), but you can also get the choice's value by sending the choice **msgControlGetValue** directly. Note that a choice is not a control, but it responds to this message anyway. The value of a choice is the window tag of the on button, not the index of the button in the choice or the button's UID. If no button is on, **clsChoice** returns **stsChoiceNoValue**. Conversely, you can set the value of a choice using **msgControlSetValue**.

To set the value of the choice to be no value, send its manager **msgChoiceMgrSetOnButton** with a message argument of **objNull**.

When you set the value of the choice, the button turned on sends its notification message. Your code may be unprepared to deal with messages from buttons before its user interface is fully realized. One way to avoid this is not to set up a client until your code is ready to receive messages. You can also use **msgChoiceSetNoNotify** (or **msgChoiceMgrSetNoNotify** to the choice's manager) to change a choice's value without notification.

If you don't intend to set or get the value of the choice, you need not specify tags for its buttons.

Chapter 39 / Menus and Menu Buttons

A **menu button** may have an associated **pop-up menu**. If it does not, it acts like other buttons. If the menu button does have a menu, the menu button displays its menu when the user taps on the menu button. The menu can, in turn, have menu buttons nested in it that pop up submenus.

clsMenuButton inherits from **clsButton**. **clsMenu** inherits from **clsTkTable**.

Menu Buttons 39.1

clsMenuButton implements a menu button. Menu buttons behave similarly to regular buttons, but they can have a submenu that they pop up and take down.

Table 39-1 summarizes the messages defined by **clsMenuButton**:

Table 39-1
clsMenuButton Messages

Message	Description
	Class Messages
msgNew	Creates a menu button window.
msgNewDefaults	Initializes the MENU_BUTTON_NEW structure to default values.
	Instance Messages
msgMenuButtonGetStyle	Passes back the current style values.
msgMenuButtonSetStyle	Sets the style values.
msgMenuButtonGetMenu	Passes back the pull-right or pull-down menu, objNull if none.
msgMenuButtonSetMenu	Sets the pull-right or pull-down menu.
	Self-Sent Messages
msgMenuButtonProvideWidth	Self-sent when style.getWidth is true.
msgMenuButtonShowMenu	Puts up or takes down the menu.
msgMenuButtonInsertMenu	Self-sent when menu is down and the action specified by style.menuAction is detected. Puts up the submenu by inserting it as sibling window of the menu button or by sending msgMenuShow(true).
msgMenuButtonExtractMenu	Self-sent when menu is au and the action specified by style.menuAction is detected. Takes down the submenu by extracting its window or by sending msgMenuShow(false).
msgMenuButtonPlaceMenu	Self-sent whenever a menu button needs to position its associated menu.
	Client Responsibility Messages
msgMenuButtonProvideMenu	Sent to the client if style.getMenu is true.
msgMenuButtonMenuDone	Sent to the client if style.getMenu is true.

Creating a Menu Button 39.2

Using Toolkit Tables Instead 39.2.0.1

You can create a free-standing menu button, but usually you use menu buttons as nested controls in menus. Menus are toolkit tables, and permit you to create all their menu buttons at once from a set of TK_TABLE_ENTRYs. **clsMenu** is explained in the next section.

Send **msgNew** to **clsMenuButton** to create a menu button. This takes a MENU_BUTTON_NEW structure, which includes a MENU_BUTTON_NEW_ONLY structure. In this, you specify:

style several menu button style fields, described below.

menu the submenu of the menu button, if it has one.

Menu Button Style 39.2.1

The menu button **style** is a MENU_BUTTON_STYLE structure. Table 39-2 summarizes the structures field elements:

Table 39-2
MENU_BUTTON_STYLE Fields

Fields/Field Values	Functional Description
subMenuType	Determines type of button submenu.
mbMenuNone	No button submenu type defined.
mbMenuPullDown	Brings up submenu as a pull-down menu.
mbMenuPullRight	Brings up submenu as a pull-right menu.
mbMenuPopup	Brings up submenu as a pop-up menu.
mbMenuSibling	Inserts submenu as a sibling window of the menu button.
getWidth	Specifies whether the menu button should dynamically compute the width of the submenu.
getMenu	Specifies whether the menu button's client should dynamically provide the submenu.
enableMenu	Specifies whether the submenu should dynamically determine if its nested controls should be enabled.
menuAction	Determines if the submenu is brought up on a single tap or a double tap.
menuIsUp	Determines whether submenu is visible (read-only).

If **getWidth**, **getMenu**, or **enableMenu** is set, the menu button self-sends additional messages to determine these values; the messages are explained in more detail in "Menus," later in this chapter. You can also set and get the style separately from **msgNew** using **msgMenuButtonSetStyle** and **msgMenuButtonGetStyle**.

Notification 39.2.2

A menu button will invert itself when it receives **msgControlBeginPreview**. Even if the button has a submenu (**submenuType** is **mbMenuNone**), it does normal control notification by sending its client its **msg** and **data** on **msgControlAcceptPreview** (just as an instance of **clsButton** does). A menu button's client is usually the application.

Painting 39.2.3

If **subMenuType** is **mbPullRight**, the menu button sets its decoration style to **lsDecorationPullRight** and **clsLabel** draws it with a pull-right arrow decoration to the right of the string.

Menus 39.3

clsMenu defines the class for child windows in the toolkit table to be **clsMenuButton.** You can set the menu style to be a horizontal menu bar (**msMenuBar**), or a vertical menu (**msMenu**). Submenus off a menu bar and pull-right menus are both vertical menus. It sets selfs table layout constraints to be either one row, many columns (if self's style is **msMenuBar**) or one column, many rows (style **msMenu**).

Table 39-3 summarizes messages defined by **clsMenu.**

Table 39-3
clsMenuMessages

Message	Description
	Class Message
msgNew	Creates a menu window, together with the child windows specified in pEntries.
msgNewDefaults	Initializes the MENU_NEW structure to default values.
	Instance Message
msgMenuGetStyle	Passes back the current style values.
msgMenuSetStyle	Sets the style values.
msgMenuShow	Puts up or takes down the menu by inserting or extracting it as a child of theRootWindow.
	Manager Notification Messages
msgMenuDone	Sent via msgWinSend to the manager when the menu is "done."

msgTblLayoutAdjustSections now does what **msgMenuAdjustSections** did in earlier versions of PenPoint, but is available to all descendants of **clsTableLayout. msgMenuAdjustSections** is provided for backward compatibility; you should use **msgTblLayoutAdjustSections** in your new clients.

Creating a Menu 39.3.1

You send **msgNew** to **clsMenu** to create a menu. This takes a MENU_NEW structure. The most important field in this is **tkTable.pEntries**, a pointer to an array of TK_TABLE_ENTRYs that specify the contents of the menu.

The fields in MENU_NEW_ONLY include:

style style fields including shadow and margin style, as well as row and column constraints.

menuButtonNew in-line storage for a MENU_BUTTON_NEW structure.

In **msgNewDefaults, clsMenu** sets up **menu.menuButtonNew** to be the **msgNew** arguments for a default menu button. It does this based on the **menu.style.type** of the menu. It changes **tkTable.pButtonNew** to point to this structure. If you want to change the defaults for the menu buttons, cast **tkTable.pButtonNew** to a P_MENU_BUTTON_NEW; don't modify **menu.menuButtonNew**. **menuButtonNew** only allocates storage for the **msgNew** structure so that **clsMenu** doesn't have to.

You specify the contents of the menu in the TK_TABLE_ENTRY array. The child windows can be any kind of window. By default, they are menu buttons. The TK_TABLE_ENTRY fields for a menu button with no submenu are the same as a button's:

- **pString**, **message**, **data** (and the standard **tag**, **flags**, **class**, and **helpId**).

Creating Submenus 39.3.2

The menu buttons in the menu may have submenus of their own. You indicate this by setting either **tkMenuPullRight**, **tkMenuPullDown**, or **tkMenuPopup** in the **flags** field of a TK_TABLE_ENTRY. This tells **clsMenu** that the menu button has a submenu. It then interprets the second field as a pointer to the array of TK_TABLE_ENTRYs for the contents of the submenu, and the third field is ignored:

pString, **pEntries**, ... (and the standard **tag**, **flags**, **class**, and **helpId**)

As usual, if **pEntries** is **pNull**, then **clsTkTable** assumes it will find the TK_TABLE_ENTRYs for the nested child windows in-line. You can define an entire menu hierarchy using TK_TABLE_ENTRYs, and only need explicitly to create the topmost menu.

Displaying a Menu 39.3.3

If you want to display a pop-up menu yourself, you can send it **msgMenuShow**. This takes a Boolean: **true** to display the menu, **false** to take it down. Before sending this to display a menu, you should set it to the desired location by changing its **bounds.origin** using **msgWinDelta**. **clsMenu** ensures that the menu is entirely on-screen, repositioning it as necessary, before inserting the menu in the root window.

How a Menu Button Displays its Submenu 39.4

You are free to use a menu as you would any other toolkit component. You could have a static menu in the middle of a window (**TkDemo** actually does this). Typically, however, a menu is displayed by a menu button.

When the user taps (or double taps, depending on the value of **style.menuAction**) on a menu button, it sends its button message to its client in the usual manner. In addition, if its **subMenuType** is **mbPullDown**, **mbPullRight**, or **mbPopup**, on **msgControlAcceptPreview** the menu button puts up its submenu, and on the next **msgControlAcceptPreview**, it takes down its submenu.

In more detail, the menu button:

1. Sets itself as the manager of the menu (using**msgTkTableSetManager**).
2. Uses **msgWinDelta** to set the menu to the appropriate location relative to itself.
3. Puts up the menu by sending it **msgMenuShow** or, if **style.subMenuType** is **mbMenuSibling**, by inserting the menu as a window tree sibling of the menu button.
4. Takes down the menu when it next receives **msgControlAcceptPreview**.

clsMenu ensures that the menu will never be off-screen. While it is up, the menu grabs input so that it can see pen taps outside its window; a pen tap outside the window dismisses the menu. **clsMenu** looks at the destination of the pen tap, and if it is one of its nested buttons, it allows the tap to go to that button.

The menu button sets itself as the manager each time it puts up the submenu, in case it is sharing the menu with another menu button. Menu buttons in the menu typically set their manager to be **bsManagerParent** so that their notification messages get forwarded to the toolkit table's parent, in this case, the menu.

Usually a menu button with a submenu does not notify its own to its client; its own control **msg** and **data** are unused and the client only gets activation messages from the submenu's menu buttons.

If you set the **subMenuType** to **mbPullDown**, **mbPullRight**, or **mbPopup**, but the menu button doesn't have a submenu, the menu button will preview but not do anything.

Dynamic Submenu

39.4.1

If the **getMenu** menu button style is set, then when the menu button needs to put up its submenu, it sends **msgMenuButtonProvideMenu** to its client. This takes a MENU_BUTTON_PROVIDE_MENU structure as its message arguments, in which the menu button sets **menuButton** as its UID, and **menu** as the UID of its current submenu. The client can either modify the passed **menu** (for example to add, disable, or delete some items) or replace it with the UID of a new menu.

Control Enable

39.4.2

The control enable protocol is implemented by **clsControl**, **clsMenuButton**, and **clsTableLayout**. For a full understanding of the protocol, you need to read about enable in all three chapters.

clsMenuButton checks the value of the instance's **enableMenu** style field. If this is **false** (the default), then the menu button just puts up its submenu without further ado (by sending the menu **msgMenuShow**). Otherwise, the menu button sends **msgControlEnable** to its submenu. This takes a CONTROL_ENABLE structure, as described in Chapter 35, Controls. **clsMenuButton** fills this out as follows:

1. Sets **root** to self.
2. Sets **object** to the current selection owner.
3. Sets **enable to true** or **false**, depending on whether the selection owner's process is this application's task. If a menu button doesn't have some other

way of determining whether it is enabled, this disables it if the selection isn't in this application.

The menu relies on its ancestor **clsTableLayout** to propagate **msgControlEnable** to each control in the menu. The controls in the submenu respond to **msgControlEnable** by figuring out whether they should be enabled or not. See Chapter 35, Controls, and Chapter 38, Toolkit Tables, for more information.

Notification 39.4.3

Notification is the same as **clsTkTable**. When the user activates a menu button, it notifies its client, then its manager. The menu button's manager is its menu. If that menu is itself a submenu, then its manager is the menu button that popped it up. The menu button responds to **msgButtonAcceptPreview** by taking down the menu.

Pop-Up Choices 39.5

The UI Toolkit includes **choices**, which display several alternatives and allow the user to pick one (**clsChoice** is explained in more detail in Chapter 38). However, if there are several alternatives, the choice ends up taking up a lot of space on the screen. You can put a choice in a pop-up menu, but then the user has to pop up the menu to see the current value of the choice. **clsPopupChoice** is an alternative.

clsPopupChoice is a descendant of **clsMenuButton**. It displays a choice in a menu when you tap it, much like a menu button with a choice. The difference is that the pop-up choice's label string is a copy of the string of the current choice button. Whenever the choice changes value, the pop-up choice copies the new value's string to its label.

The user does not have to pop up the choice. The user can instead move to other values by making scrolling gestures directly on the pop-up choice button. Up and down flicks move to the next and previous value in the choice, and double-flicks move to the top or bottom value in the choice.

Table 39-4 summarizes the messages defined by **clsPopupChoice**.

Table 39-4
clsPopupChoice Messages

Message	Description
	Class Messages
msgNew	Creates a pop-up choice button.
msgNewDefaults	Initializes the POPUP_CHOICE_NEW structure to default values.
	Instance Messages
msgPopupChoiceGetStyle	Passes back the receiver's style. (Currently there are no style fields defined in POPUP_CHOICE_STYLE.)
msgPopupChoiceSetStyle	Sets the receiver's style.
msgPopupChoiceGetChoice	Passes back the choice associated with this pop-up.

Creating a Pop-Up Choice 39.5.1

If you create a pop-up choice using the C API, you create it as you would a menu, but set the **menuButton.menu** field to the UID of an instance of **clsMenu**.

The suggested way to create a pop-up choice is to specify it as a static TK_TABLE_ENTRY. This approach is described in Chapter 38, Toolkit Tables.

Miscellaneous Pop-Up Choice Messages 39.5.2

You can retrieve the UID of the toolkit table (usually a choice) associated with a pop-up choice by sending it **msgPopupChoiceGetChoice**. Remember, the pop-up choice itself is the button displaying the current value of the choice.

clsPopupChoice responds to **msgControlGetValue** by retrieving the tag of the button that is on in the choice, just as **clsChoice** does.

Chapter 40 / Scrollbars

Scrollbars let the user display more of a document than can fit in a window. The user interface of a scrollbar provides information about the size of the document and the offset of the visible part of the document relative to the whole. The scrollbar UI also allows the user to move around in this document. In addition to tapping in the scrollbar, the user can also flick to scroll up and down.

Scrollbars give the user the illusion of moving the window around relative to the document it's displaying. The classic example is a long text document: using the scrollbar, the user can move up and down to see different parts of the text file. Note that the thing displayed in the window does not itself have to be a window, or even an object.

Layout 40.1

Scrollbars can either be vertical (the default) or horizontal. It is up to you to position them next to the window that displays the scrolling using, for example, a custom layout window. Usually, you use a scroll window (described later in this chapter in "Scroll Windows"), which positions the scrollbars and can often perform scrolling as well.

Painting 40.2

A scrollbar indicates what relative location in the document is visible in the document's window by drawing a **drag handle** (sometimes called a **thumb**) in itself, representing the part of the document that is visible. The scrollbar draws this bubble based on the length (or width, for a horizontal scrollbar) of the document and the current offset in the document. However, the scrollbar does not keep track of this information stuff itself.

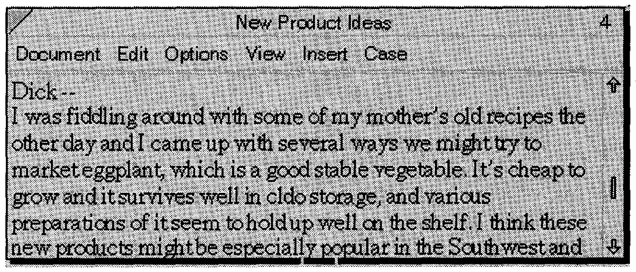
The bubble indicates the relative position of the offset in the range. For example, if the scrollbar offset is 350 and the range is –100 to 400, then the portion of the thing shown in the window is near the end, and the scrollbar paints its bubble near the bottom. When the user moves the pen into proximity near the bubble, it grabs input and tracks the pen.

Notification 40.3

Although scrollbars are intended to manipulate a document in a window, they have no explicit connection with a window. Instead, they communicate with a client, asking it for information so they can display, and sending the client scrolling messages. **clsScrollbar** inherits from **clsControl**, which maintains a client. The client can be the document being scrolled, but it need not be.

Figure 40-1 shows a vertical scrollbar along the right hand edge of a window. The components are the same for a horizontal scrollbar.

Figure 40-1
A Scrollbar



Dick --
I was fiddling around with some of my mother's old recipes the other day and I came up with several ways we might try to market eggplant, which is a good stable vegetable. It's cheap to grow and it survives well in cldo storage, and various preparations of it seem to hold up well on the shelf. I think these new products might be especially popular in the Southwest and

Thumbing

40.3.1

The scrollbar handles thumbing by creating a **track** object. This grabs input and moves the scrollbar up and down. The scrollbar does not notify its client until the user finishes with the tracker by going out of proximity. Thus, the document does not scroll while the user drags the thumb.

Providing Information

40.4

The scrollbar client must tell the scrollbar the size of the document, the size of the view with which the scrollbar is associated, and the current offset into it, so that the scrollbar can draw the bubble at the correct location.

Whenever a scrollbar needs to update its display, it sends its client either **msgScrollbarProvideVertInfo** or **msgScrollbarProvideHorizInfo.** These both take a pointer to a SCROLLBAR_PROVIDE structure. The scrollbar supplies its UID in **sb**; it is up to the client to provide the **viewLength**, **docLength**, and **offset**. These are all S32; the client can supply these in any consistent units that make sense. The offset should be the offset of the top (left) of the form.

Offset

40.4.1

Note that the offset in a vertical scrollbar increases as it reaches the bottom of the document. This document model is different from the window system's lower left origin coordinate system.

Client Notification

40.5

The scrollbar handles previewing internally. Pressing on the up and down arrow generates **msgButtonRepeatPreview** messages.

A scrollbar sends its client **msgScrollbarVertScroll** or **msgScrollbarHorizScroll,** depending on the scrollbar's orientation. These take a SCROLLBAR_SCROLL structure as their message arguments. This structure includes:

sb the UID of the scrollbar that generated the message.

action the current action.

offset the current offset, or a proposed new offset if the user thumbed.

lineCoord the coordinate of the line where the user made the gesture in root window space.

Table 40-1 lists the possible scrollbar actions and the user actions that cause them:

Table 40-1
Scrollbar Actions

Vertical Action	Horizontal Action	Generated By
sbLineUp, sbLineDown	sbLineLeft, sbLineRight	Tap on arrow.
sbPageUp, sbPageDown	sbPageLeft, sbPageRight	Tap above or below bubble.
sbThumbUpDown	sbThumbLeftRight	Double tap.
sbLineToTop	sbColumnToLeft	Flick up/flick left.
sbTopToLine	sbLeftToColumn	Flick down/flick right.
sbToTop, sbToBottom	sbToLeft, sbToRight	Double-flick or drag bubble to end.
sbEndScroll	sbEndScroll	(Same)pen up.

What Goes On

40.5.1

In the next sections, we'll only use the vertical scroll action names, but the same ideas apply to horizontal scrolling.

In **sbLineUp** and **sbLineDown**, offset is not supplied (zero). The scrollbar client should pass back in offset the new desired offset. **sbPageUp** and **sbPageDown** are similar.

In **sbThumbUpDown**, **clsScrollbar** does supply a suggested new offset. It does this by converting the location of the tap in the scrollbar to an offset in the document.

If your window is slow to repaint, it won't be able to keep up with repeating scrolls. If this is the case, you cannot scroll in response to repeating messages (**sbLineUp/sbLineDown**). At the end of the user's scroll, you receive **sbEndScroll** as the action, at which point you can perform the entire scroll at once. You can either keep track of the number of repeating messages received, or normalize the offset each time and then perform the final scroll using the offset passed in along with **sbEndScroll**.

Line, Page Scrolling versus Thumbing

40.5.2

For all scroll actions, the client must interpret the scroll action and redraw the window to comply with the request (although often you can simplify the task using **clsScrollWin**).

There are three main kinds of scrolling: line scroll, page scroll, and thumbing scroll.

With a line or page scroll, the scrollbar has no idea how big a line or page is, so it can't compute the new offset. The **offset** in the SCROLLBAR_SCROLL structure is the current offset (the one returned by **msgScrollbarProvideVertInfo** or **msgScrollbarProvideHorizInfo**). You (the scrollbar client) must interpret how a line or a page scroll should change the offset of the scrollbar, and pass back the new offset as an out parameter. If you don't respond to these messages, the position of the bubble doesn't change.

Typically, in a line scroll, you display a new part of the scrolling offset by a small amount (a "line"), while in a page scroll, you offset the display by the same amount or slightly less than the size of the window.

With a thumbing scroll (scrollbar action is **sbThumbUpDown** or **sbThumbLeftRight**), the user taps at a new location to indicate the offset. Hence, the scrollbar can supply the new offset in the offset field in the SCROLLBAR_SCROLL structure (based on the sizes of the view and document).

Offset Range 40.5.3

When you set the value of the scrollbar, you should set the offset of the top or left edge of the scrolled object from the top or left edge of the window. This is the calculation used by the scrollbar display code in figuring out where to draw the thumb pointer.

Note that the offset range is not 0 – **docLength**. The offset represents the location of the top of the visible area relative to the document length, so an offset of **docLength** would imply that the very end of the document is at the top of the view and the rest of the view is empty. Instead, the range is 0 – (**docLength** – **viewLength**).

Updating 40.5.4

If the document view changes for some other reason than user interaction with the scrollbar, you can force a scrollbar update by sending it **msgScrollbarUpdate**. The scrollbar will ask its client to provide the information when it needs to repaint.

There is no easy way to programmatically cause a scroll. Your code must perform the scroll and then tell the scrollbar to update, rather than simulating a user action which then causes a scroll.

Normalizing the Scroll 40.6

Even if you know in advance what the offset is, you often need to adjust it. For example, if the window is displaying text, then you may want to change the offset slightly to avoid clipping off the tops or bottoms of characters in a line of text. This is called **normalizing** the scroll.

When the scrollbar client receives either a **msgScrollBarVertScroll** or **msgScrollBarHorizScroll**, it can adjust the offset to avoid splitting up important information at the edge of the window. In a **msgScrollBarVertScroll** or **msgScrollbarHorizScroll**, the scrollbar specifies an offset. The client can pass back a different offset.

You need to adjust offsets and repainting carefully to get this smooth presentation. You can look at the previous offset field to determine the direction in which the user is scrolling, and use this to normalize the top or bottom edge of the screen.

When the user drags the bubble, the scrollbar sends its client **msgScrollbarProvideVertInfo**. The client should respond with the appropriate **docLength**, **offset**, and so on. Then the scrollbar sends **msgScrollbarVertScroll**, with its best guess for the new offset. The client should normalize before doing the scroll, and can modify the offset. The scrollbar will repaint the thumb in that position.

The scrollbar is a border window. If you only need to scroll the display a small amount, you can use **msgWinCopyRect** to copy the pixels on the screen from one region to another. Then you only need to paint the strip of the scrolled thing that has become visible. See *Part 3: Windows and Graphics*, for more information on **msgWinCopyRect**.

Scroll Windows 40.7

The user's model of scrolling is that the window with scrollbars (such as the client window in a frame) provides a porthole looking into the much larger document surface. As he or she uses the scrollbars to scroll around, the porthole moves around to show a different part of that surface.

It's often possible to implement scrolling this way from your program's point of view. In response to a scrolling request, often all you need to do is display a different portion of the same window. **clsScrollWin** lets you do this. An instance of **clsScrollWin** acts as the porthole. It inserts your window as its child, and repositions your window in response to the **msgScrollbarVertScroll** and **msgScrollbarHorizScroll** messages from the scrollbars. Your window is isolated from the scrollbar interface; all it has to do is repaint itself when it receives **msgWinRepaint**, and the correct region of it will appear in the **scrollwin** (scroll window).

The scrollwin has an inner window. Your window, the **client window**, is a child of this inner window and is clipped by it. **msgScrollWinGetInnerWin** passes back a pointer to the UID of this window. You can have more than one client window in a scrollwin; but only one is visible at any time.

clsScrollWin uses your window's size to compute its offset. It handles **sbPageUp** and **sbPageDown** scroll actions by changing the offset by the size of its own window. However, it still can't figure out how much to change the offset for **sbLineUp**, **sbLineDown**, **sbLineLeft**, and **sbLineRight** scroll actions. You can either statically tell it what the delta is for a line motion, or have it send you a message asking you to dynamically compute a new line offset.

A scrollwin can display scrollbars around your window. It can even display a scrollbar only when your window is not entirely visible in that dimension. It responds to the scrollbar request messages **msgScrollbarProvideVertInfo** and **msgScrollbarProvideHorizInfo** by setting the **viewLength** to the size of the inner window to which your window is clipped, and the **docLength** to the size of your window.

Table 40-2 summarizes the messages defined by **clsScrollwin**.

Table 40-2
clsScrollwin Messages

Message	Description
	Class Messages
msgNew	Creates a scrollwin window.
msgNewDefaults	Initializes the SCROLL_WIN_NEW structure to default values.
	Instance Messages
msgScrollWinGetStyle	Returns the current style values.
msgScrollWinSetStyle	Sets the style values.
msgScrollWinGetMetrics	Returns the metrics.
msgScrollWinSetMetrics	Sets the metrics.
msgScrollWinGetClientWin	Returns the current clientWin.
msgScrollWinShowClientWin	Sets the current clientWin.
msgScrollWinAddClientWin	Adds another clientWin.
msgScrollWinRemoveClientWin	The specified client window is extracted from the scrollWin.
msgScrollWinGetVertScrollbar	Returns the vertical scrollbar.
msgScrollWinGetHorizScrollbar	Returns the horizontal scrollbar.
msgScrollWinGetInnerWin	Returns the inner window of the scrollWin.
msgScrollWinProvideDelta	Self-sent when style.getDelta is set to true.
msgScrollWinProvideSize	Self-sent when style.getSize is set to true.
msgScrollWinCheckScrollbars	Determines whether the on/off state of either scrollbar needs to change.

Creating a Scrollwin

40.7.1

Often, you use a scrollwin with a frame, so you make the scrollwin the frame's client window.

clsScrollWin is a kind of layout window although it doesn't inherit from **clsCustomLayout**. You pass **clsScrollWin** your window (**scrollWin.clientWin**) in **msgNew**. This is the window on whose behalf it will manage scrolling. You also need to give it the line offset information mentioned above. Either you supply a **colDelta** and **rowDelta** (for the horizontal and vertical line scrolls), or you supply a **client**. The **getDelta** style flag indicates which method you want to use. You need only set **getDelta** if you want to **normalize** line-by-line scrolling, or the line size. For example, in an icon browser, some lines of icons may be much taller than other lines.

The other style flags for a scrolling window are summarized in Table 40-3.

Table 40-3
SCROLLWIN_STYLE Styles

Styles/Style Flags	Functional Description
getDelta	Specifies style of scroll method to use. Use if you want to normalize line-by-line scrolling or line size.
colDelta	Horizontal line scrolling.
rowDelta	Vertical line scrolling.
horizScrollbar, verticalScrollbar	Specifies style of client for the scrollbar.
autoVertScrollBar, autoHorizScrollBar	Overrides on/off flag; displays the scrollbar if the entire window dimension is not visible.
expandChildHeight, expandChildWidth	Instructs scrollwin to expand child window to fit the inner window.
contractChildHeight, contractChildWidth	Instructs scrollwin to make client window smaller when the scrollwin gets smaller.
forward	Determines what messages to forward to the client.
swForwardNone	Forward nothing.
swForwardGesture	Forward msgGWinGesture.
swForwardXlist	Forward msgGWinXlist (can be combined with swForwardGesture).
xAlignment, yAlignment	Determines how the client window should be positioned if it is smaller.
swAlignLeft/swAlignTop	Client window position combination.
swAlignCenter	Client window position.
swAlignRight/swAlignBottom	Client window position combination.
swAlignSelf	Client window will align itself.
vertClient, horizClient	Specifies style of client for the scrollbar.

The initial offset of a scrollwin is that it is aligned according to **alignment**. By default, it starts out looking onto the top left of the client window, not the usual lower left origin, since the top left is where the minima of the scrollbars are. To scroll the client window elsewhere programmatically, use **msgWinDelta** to move it.

Scrollwin Windows 40.7.2

A scrollwin is a border window with up to three child windows: the vertical and horizontal scrollbar windows, and an **inner window**. **clsScrollWin** inserts your document window to be scrolled as the child of this inner window.

You can retrieve the scrollbar windows and the inner windows using **msgScrollWinGetVertScrollbar**, **msgScrollWinGetHorizScrollbar**, and **msgScrollWinGetInnerWin**. Normally, you set the document window that the scrollwin is positioning at **msgNew** time, but you can also set and get it using **msgScrollWinSetClientWin** and **msgScrollWinGetClientWin**.

Repaint

40.7.3

The scrollwin itself is tiled by the two scrollbars and the inner window. The only area it draws is the square notch at the lower right corner between the two scrollbars. It usually draws this in white: however, **clsScrollWin** inherits from **clsBorder**, so you can change the background ink if you want.

The inner window has no border and is normally filled by the client window, so it does no repainting and relies on the client window painting in it. However, if the client window is smaller than the size of the inner window, part of it will be exposed. By default, it is painted white. The inner window is also a border window, so you can change its style after retrieving it with **msgScrollWinGetInnerWin**.

Although the window in a scrollwin will be clipped to the inner window's boundaries, it's potentially faster to only paint the area that is damaged (this is passed back when you send **msgWinBeginRepaint** to self before starting to repaint).

Layout

40.7.4

A scrollwin lays out its children in response to **msgWinLayoutSelf** (unless the scrollwin is shrink-wrapped in either dimension). If the scrollwin is not shrink-wrapped, you can resize it to any size and it will display as much of its inner window as will fit. Thus, scrollwins are useful when you have a limited amount of screen space available for a large or unbounded window, such as a toolkit table with dozens of labels. In fact, since the user can change the system font to be any size, most windows will not be entirely visible at very large font sizes.

If **autoVertScrollbar** or **autoHorizScrollbar** are set, **clsScrollWin** compares the size of your window with the size of the scrollwin. During layout, if the client window would be entirely visible without scrollbars, it takes down the scrollbars. If either is set, then the scrollwin ignores values you give for the corresponding **vertScrollbar** or **horizScrollbar** field—you give **clsScrollWin** responsibility to figure out when to display the scrollbar(s).

You can find out whether the scrollwin is displaying the scrollbar by sending **msgScrollWinGetStyle** and checking the **vertScrollBar** or **horizScrollbar** field. You can also send **msgScrollWinCheckScrollbars** to see whether the on/off state of either scrollbar needs to change. This takes a pointer to a **Boolean**. If it passes back **true**, then you can cause the scrollbars to reappear or disappear as necessary by:

1 Sending **msgWinSetLayoutDirty** to dirty the layout of the scrollwin.

2 Sending **msgWinLayout** to get the scrollwin to lay itself out again.

clsScrollWin obeys the window shrink-wrap style bits (**wsShrinkWrapWidth** and **wsShrinkWrapHeight**). If set, the scrollwin will size itself around the child window. If the scrollwin is shrink-wrapping, then unless the scrollwin's parent forces it to some size, the scrollwin won't need scrollbars.

Positioning the Client Window 40.7.4.1

clsScrollWin will not allow the left edge of the child (your window) to extend past the right edge of the scrollwin, nor let the bottom edge of the child go past the top edge of the scrollwin. In other words, it keeps your window in view.

If the client window is smaller than the inner window, **clsScrollWin** aligns the client window in the inner window according to the settings of **xAlignment** and **yAlignment** in SCROLL_WIN_STYLE. If the alignment is **swAlignSelf**, then it's up to you to align the child window using **msgWinDelta.**

If you set **expandChildWidth** or **expandChildHeight** in SCROLL_WIN_STYLE, the scrollwin will expand the client window in that direction up to the width or height of its inner window. This makes the alignment settings irrelevant, since the client window will never be smaller than the inner window.

If you set **contractChildWidth** or **contractChildHeight** in SCROLL_WIN_STYLE, the scrollwin will shrink the client window in that direction to be the width of its inner window. The scrollbar for that direction then becomes redundant, which is useful when you want a client window to only scroll in one direction.

Notification 40.7.5

For the horizontal and vertical scrolling motions, you can specify what the **client** of each scrollbar is. The scrollbar sends its standard **msgScrollbarProvideVertInfo**, **msgScrollbarProvideHorizInfo**, **msgScrollbarVertScroll**, and **msgScrollbarHorizScroll** to that client. The default is scrollwin is the notification client (**swClientScrollWin**), so scrollwin figures out how to scroll the window using the relationship of the inner window to the scrolled window. When a scrollwin receives scroll notifications, it uses **msgWinDelta** to move the client window (assuming the client for that direction is **swClientScrollWin**). This preserves the pixels of your window visible on the screen, thereby minimizing the region that your window needs to repaint.

If the **client** style is **swClientWin**, the scrolling is entirely the responsibility of the client window. For example, consider a text view that can't use a scrollwin to do vertical scrolling, since the text view would need to be a window the height of the entire document. Therefore, the text view itself handles vertical scrolling. However, documents are generally not very wide, so the text view can make itself as wide as the document and let **clsScrollWin** scroll it horizontally.

There is an enhancement to this since the scrollwin doesn't know how big a line is. You can either specify a line or column difference when you create the scrollwin, or you can direct the scrollwin to query its **client** (or the scrolled window, if this is **objNull**). However, if **getDelta** is **true**, a scrollwin will send **msgScrollWinProvideDelta** to its client whenever it needs to perform a line scroll. This message takes a SCROLL_WIN_DELTA structure as its message arguments. Many of the fields are the same as in a SCROLLBAR_SCROLL action structure. In addition, there is a **viewRect** structure which gives (in your window's coordinates) the position and size of the scrollwin—the part of your window that the porthole looks onto. You need to figure out where the new origin of **viewRect** should be and pass this back in the **origin** field.

Multiple Windows in a Scrollwin 40.7.6

You can actually display different client windows in a scrollwin, one at a time. Each of the windows is a child of the scrollwin's inner window, but only one has its **wsVisible** window style flag set at any time. The effect is like a deck of cards, with only one on top. To add a new window to a scrollwin, send the scrollwin **msgScrollWinAddClientWin**, passing it the UID of the window you want inserted as a child of the scrollwin's inner window. The new child window's **wsVisible** flag is turned off, so it is invisible.

To switch the scrollwin to displaying a new client window, send it **msgScrollWinShowClientWin**, passing it the UID of the window you want shown. If this window isn't already a child of the scrollwin, the scrollwin will send itself **msgScrollWinAddClientWin** to add it.

Send **msgScrollWinRemoveClientWin** to remove one of the client windows. If you remove all the client windows, the inner window will be visible.

msgScrollWinGetClientWin passes back the current client window (the one last shown with **msgScrollWinShowClientWin**). This takes a pointer to a WIN. You can locate other client windows using **msgWinFindTag** or **msgWinEnum**.

Toolkit Tables 40.7.7

Because it inherits from **clsBorder**, **clsTableLayout** knows how to be the child of a scrollwin; it responds to **msgScrollWinProvideDelta** by normalizing to align with the rows and columns in the table.

Chapter 41 / List Boxes

List boxes provide a scrollable list of windows. The list can be of arbitrary length (up to **maxS16**), useful when presenting a set of toggles or choices where the total number of items is either very large or unknown.

clsListBox inherits from **clsScrollWin**; **clsScrollWin** provides the scrolling ability. When you use a **clsScrollWin** directly, you must supply the client window that is scrolled by **clsScrollWin**. **clsListBox** creates and maintains a client window for you.

There are two standard subclasses of **clsListBox** kinds of list boxes: string list boxes, which display a list of strings that the user can select, and font list boxes, which display a list of the installed fonts. Both are implemented by the descendant classes **clsStringListBox** and **clsFontListBox**. Table 41-1 summarizes the messages clsListBox defines.

Table 41-1
clsListBox Messages

Message	Takes	Description
		Class Messages
msgNewDefaults	P_LIST_BOX_NEW	Initializes the LIST_BOX_NEW structure to default values.
msgNew	P_LIST_BOX_NEW	Creates a list box (initially empty).
		Attribute Messages
msgListBoxGetMetrics	P_LIST_BOX_METRICS	Passes back the metrics for a list box.
msgListBoxSetMetrics	P_LIST_BOX_METRICS	Sets the metrics for a list box.
		Entry Manipulation Messages
msgListBoxAppendEntry	P_LIST_BOX_ENTRY	Appends an entry to the list box after the specified position.
msgListBoxInsertEntry	P_LIST_BOX_ENTRY	Insert an entry to the list box before the specified position.
msgListBoxRemoveEntry	U16	Removes an entry from the list box.
msgListBoxGetEntry	P_LIST_BOX_ENTRY	Gets an entry in a listBox by position.
msgListBoxSetEntry	P_LIST_BOX_ENTRY	Sets an entry's information.
msgListBoxFindEntry	P_LIST_BOX_ENTRY	Finds the position of the given entry window/data.
msgListBoxEnum	P_LIST_BOX_ENUM	Enumerates the entries of a listBox according to the given flags.
msgListBoxEntryIsVisible	P_LIST_BOX_ENTRY	Passes back the visibility of an entry in a listBox.
msgListBoxXYToPosition	P_LIST_BOX_POSITION_XY	Gets the position for a given list box window coordinate.
msgListBoxMakeEntryVisible	P_LIST_BOX_ENTRY	Makes the specified entry visible.

continued

Table 41-1 (continued)

Message	Takes	Description
		Notification Messages
msgListBoxProvideEntry	P_LIST_BOX_ENTRY	Self-sent when a listBox needs a window for display.
msgListBoxDestroyEntry	P_LIST_BOX_ENTRY	Sent to the client for an entry that has lbFreeDataByMessage enabled.
msgListBoxEntryGesture	P_LIST_BOX_ENTRY	Notifies the subclass or client that a gesture occurred over an entry.

Creating a List Box 41.1

You send **msgNew** to **clsListBox** to create a new list box. This takes a pointer to a LIST_BOX_NEW structure for its message arguments. The message arguments include:

- The list box **style**, described below.
- The client to which the list box sends messages (**listBox.client**).
- The number of entries in the list box (**listBox.nEntries**).
- The number of entries that should be visible in the list box (**listBox.nEntriesToView**).

List boxes are not layout windows, so you don't have any control over the size or alignment of the child windows in the list box.

Note that you can't specify the contents of the list box when you create it. The list box asks you to provide entries later, as you will see.

Style Fields 41.1.1

The fields in LIST_BOX_STYLE include:

filing a filing style. The possible values are **lbFileMin**, **lbFileEntryInfo**, and **lbFileAll**. These are explained in "Filing," later in this chapter.

List Box Contents 41.2

The items displayed in a list box must be windows. However, the total number of entries in a list box may be very large, and at any point only a fraction will be displayed on-screen. Having a window for each entry could consume substantial memory. Hence, **clsListBox** supports a protocol for creating and freeing the windows for its items as it needs them on-screen.

This is very different from toolkit tables. Both have child windows. However, in a toolkit table, you can statically specify every "item" in the table, and the toolkit table maintains every item as an inserted child window. In a list box, you have to dynamically supply the child windows for the list box, and the list box may not maintain the child windows. The "items" in a list box are called **list box entries**.

This protocol process saves memory. If a list box has many entries, at any point only a few will be visible in the scrollwin's inner window. So the list box only inserts child windows for those entries that are visible. It asks you (or a descendant class) to provide the windows. Since the list box doesn't need a window for every list box entry, you can ask it to destroy windows that are no longer visible.

The next sections explain the protocol of providing list box entries in more detail. If you're using **clsStringListBox** or **clsFontListBox**, those classes handle the protocol internally.

List Box Entries 41.3

The entries in a list box are indexed by position, starting at zero. There can be up to **maxS16** entries in a list box. **clsListBox** maintains information about each entry, whether or not it has a child window for that entry. If **clsListBox** needs to display the entry at some position and does not have a window for it, it sends itself, and then its client, **msgListBoxProvideEntry**. You can get information about the entry at a position by sending the list box **msgListBoxGetEntry**, and set information about an entry using **msgListBoxSetEntry**. All these messages take a pointer to a LIST_BOX_ENTRY structure. This includes the following arguments:

listBox the UID of the list box.

position the entry position.

win the entry's window, if it has one.

freeEntry the free mode of the entry, indicating what **clsListBox** should do with it when it's no longer visible.

state the state of the entry.

data client data for the entry.

arg a message-specific argument.

Free mode and state are explained in more detail below.

You can also enumerate the entries in a list box with **msgListBoxEnum**; this retrieves the LIST_BOX_ENTRY information for each entry.

Supplying Entries 41.4

When you create a list box, it has no entries. If you don't do anything special when the list box goes on-screen, **clsListBox** will self-send **msgListBoxProvideEntry**. If no descendant responds to this message (**clsFontListBox** and **clsStringListBox** both do), **clsListBox** forwards it to its client. In the LIST_BOX_ENTRY structure, it fills in **listBox**, and sets **position** to the desired window position.

You should respond by passing in the UID of the window to use for client. You can also fill in **state** and **data** if you're using those to keep track of entries.

When the user scrolls the list box back to a previous position, **clsListBox** checks to see if it still has a window for that position. If it does, it inserts the window and does not send out a message. If the window is null, **clsListBox** sends out

msgListBoxProvideEntry as above. The rest of the LIST_BOX_ENTRY fields will be the same as before, so you need only fill in the window.

Scrolling 41.4.1

The same protocol occurs when the user scrolls the list box to a new position, thereby exposing new entries.

If the user scrolls down, **clsListBox** will ask for an entry past **nEntries**. You are free to respond with **stsFailed** if the number of entries is indeed fixed at **nEntries**. However, if you do supply a window, **clsListBox** will insert it and update **nEntries**. This way, you can let the user dynamically extend the list box size by scrolling downwards.

Free Mode 41.4.2

clsListBox will remember the UID of the window you supply. However, if the list box has lots of entries, you want to conserve memory by destroying the windows of off-screen entries.

In LIST_BOX_ENTRY, you can set **freeEntry** to the desired freeing mode for an entry. The possible values are a set of flags (LIST_BOX_DATA_FREE_MODE):

lbFreeDataNotVisible free the entry when it's no longer visible.

lbFreeDataWhenDestroyed free the entry when the list box itself is destroyed.

lbFreeDataByMessage free the entry by sending a message.

The default **freeEntry** mode, **lbFreeDataDefault**, is **lbFreeDataNotVisible | lbFreeDataWhenDestroyed**.

lbFreeDataByMessage 41.4.2.1

By default, **clsListBox** sends **msgDestroy** to an entry's window when it is time for it to be destroyed.

If the **data** field of an entry is a pointer to other storage, then you need to have the list box send you a message, instead of destroying the window directly, so you can free that storage. If you set **lbFreeDataByMessage**, **clsListBox** self-sends (and then its client, if no descendant intercepts the message) **msgListBoxDestroyEntry**. You can then destroy the **win** and free storage associated with **data**. Afterwards, **clsListBox** sets **win** to **objNull**.

You may want to receive this free entry message to implement other management schemes for entries. For example, you could have a scheme where you maintain a fixed-size pool of windows for your list box. When the user scrolls the list box, you need to set the window of the entry that's no longer visible to **objNull**, so that you can provide that window for the new entry that has scrolled into view. (**clsListBox** frees the child windows scrolled off-screen before sending **msgListBoxProvideEntry** asking for the newly visible entries.)

Pre-Loading a List Box 41.4.3

To speed up the initial drawing of a list box, you can pre-load the list box entries of the entries that will be visible. For example, if at creation you set **listBox.nEntries** as 30 and **listBox.nEntriesToView** as 5, then when you use **msgListBoxSetEntry** to specify the windows for the first ten entries in the list box, **clsListBox** will not have to call back to display the initial contents of the list box, nor will it need to when the user scrolls down one "page."

Modifying 41.5

You can send **msgListBoxSetEntry** to change the state of an entry. You don't have to supply a window; if the window you give is **objNull**, **clsListBox** will ask you to provide one with **msgListBoxProvideEntry**, as usual.

However, if that position already has a window, and you specify a different window, then **clsListBox** will extract the old window but will not free it.

Inserting and Removing Entries 41.6

Sending **msgListBoxSetEntry** and responding to **msgListBoxProvideEntry** fill in an existing entry but don't change the number of entries in the list box. You can add a new entry to a list box by inserting it at or after a position using **msgListBoxInsertEntry** or **msgListBoxAppendEntry**. These also take a pointer to a LIST_BOX_ENTRY for their message arguments.

To remove an entry, reducing the number of entries in the list box, send **msgListBoxRemoveEntry**. Again, it takes LIST_BOX_ENTRY.

State 41.7

In LIST_BOX_ENTRY you can set **state** to different values. The possible values are a set of flags (LIST_BOX_ENTRY_STATE):

lbSelected

lbOpen

lbBusy

The default **state**, **lbStateDefault**, is 0, meaning that none of these flags are set.

clsListBox does not interpret **state** at all; **state** is a feature for use by subclasses of **clsListBox**. For example, **clsStringListBox**, a subclass that displays a list of strings, uses the **lbSelected** flag to mark string entries the user has selected.

Notification 41.8

List boxes do not (currently) send client notifications. They are passive by design. The user interacts with the list box, and later your application asks the list box which entries are selected.

Like **msgListBoxProvideEntry**, all of the messages in this section are first sent to the list box itself. This is so that subclasses of **clsListBox** may intercept these messages and process them as desired. If these messages reach **clsListBox**, it forwards them on to the list box's client.

Gestures 41.8.1

The list box handles scrolling and other gestures.

In particular, many list boxes allow the user to select multiple items in the list box. The list box does not handle these itself. It passes them to its client. However, the individual entries in the list box themselves may handle certain gestures, such as tap.

Thus, the list box's client receives all non-scrolling gestures that the target window ignored. **clsListBox** self-sends, then sends its client **msgListBoxEntryGesture**. Like the other messages, this takes a pointer to a LIST_BOX_ENTRY structure. **clsListBox** determines the child window over which the user made the gesture, and supplies its list box entry information. When you receive **msgListBoxEntryGesture, position** is the position of the targeted child window, and **win** is its UID. The gesture information is in **arg**.

Painting 41.9

In **msgNewDefaults**, **clsListBox** sets **border.style.edge** to **bsEdgeAll**. Consequently, it paints a border around the list box.

Each child window in the list box paints itself as normal.

clsListBox maintains a minimum line height for the list box. It does this by remembering the smallest height of a child window that it encounters. If it does not have a child window for a position, and the descendant or client does not supply one in response to **msgListBoxProvideEntry**, **clsListBox** paints an empty "hole" in its place. This region is the minimum height.

Scrolling 41.9.1

For line-by-line scrolling, **clsListBox** uses the minimum line height to figure out how much a line scroll is.

Entry Visibility 41.9.2

You can send **msgListBoxEntryIsVisible** to determine if an entry is currently visible in the list box. Like the other messages, this takes a pointer to a LIST_BOX_ENTRY structure. **clsListBox** determines whether the entry at the **position** you specify is visible or not. If the entry is not visible, **clsListBox** passes back **0L** in the **arg** field, otherwise it passes back a non-zero value. If you set **position** to **maxU16**, **clsListBox** checks the visibility of the window you specify in **win**.

You can send **msgListBoxMakeEntryVisible** to make a specified entry visible. If the item at **position** is not visible, **clsListBox** scrolls the list so that item is visible in the view (you don't have to send **msgWinUpdate** to repaint the list box). Specifying a **position** of **maxU16** causes the list box to find the given **win**.

Layout 41.10

The list box computes its desired height by multiplying its line height, then multiplying that by **nEntriesToView**. If it has not yet computed its line height, it will ask its client to provide one child window (**msgListBoxProvideEntry**) solely to compute its size. Thus, the list box client may receive **msgListBoxProvideEntry** before the list box is on-screen.

If the list box has **wsShrinkWrapWidth** set, its width is the width of its widest child (plus the border and scrollbar region).

Filing 41.11

The setting of the list box **filing** style determines how much state the list box files. You can set the list box to:

lbFileMin file the minimum data necessary.

lbFileEntryInfo file the entry information for each entry but not the windows themselves.

lbFileAll file all the entry information and file the windows of those entries that have a window.

After restoring a list box, it will still send **msgListBoxProvideEntry** to its client, unless **filing** was set to **lbFileAll** and every entry had a valid window UID at the time of filing.

Miscellaneous Messages 41.12

msgListBoxXYToPosition is a utility message that converts an x-y location in the local window coordinates of the list box to the position of the window underneath those coordinates. This takes a pointer to a LIST_BOX_POSITION_XY structure. In this you set the location of the coordinates (**place**, an XY32 structure); **clsListBox** passes back the **position** of the list box entry at that location. Remember that **msgListBoxEntryGesture** provides the same information.

msgListBoxEnum enumerates list box entries. You can restrict the enumeration to just those list box entries with a certain state, for example, **lbSelected.** In this way, a client or descendant can find out which entries in a list box are "selected." (Remember that the list box does not interpret any gestures as indicating selection; this would be up to a descendant or client.)

Toolkit Tables versus List Boxes 41.13

You can achieve much the same functionality as a list box by embedding a toolkit table in a scrollwin. You can set up the latter in advance and you don't have to create the windows in response to a callback. Its performance will probably be better than the list box. The disadvantage is that you consume memory for every item in the table, whether it is visible or not.

String List Boxes 41.14

clsStringListBox is a descendant of **clsListBox**. It only supports putting strings in a list box. Consequently, it has a simpler API. Unlike **clsListBox**, it interprets user gestures on the contents of the list box. You can set up a string list box to behave as a scrolling choice (exclusive or non-exclusive) or as a set of toggles.

Table 41-2 summarizes messages defined by **clsStringListBox**.

Table 41-2
clsStringListBox Messages

Message	Takes	Description
		Class Messages
msgNewDefaults	P_STRLB_NEW	Initializes the STRLB_NEW structure to default values.
msgNew	P_STRLB_NEW	Creates a string listbox window.
		Attribute Messages
msgStrListBoxGetStyle	P_STRLB_STYLE	Passes back the style of the receiver.
msgStrListBoxGetDirty	P_BOOLEAN	Passes back true if the listbox has been altered since dirty was set false.
msgStrListBoxSetDirty	BOOLEAN	Sets the dirty bit of a string listbox.
msgStrListBoxGetValue	P_U32	Passes back the value of a string listbox.
msgStrListBoxSetValue	U32	Sets the value of a string listbox whose role is one of slbRoleChoice.
		Control Messages
msgStrListBoxProvideString	P_STRLB_PROVIDE	This message requests the client (or subclass) to provide a string.
msgStrListBoxNotify	U32	This message is sent out whenever the value of a string list box changes.

Creating a String List Box 41.14.1

You send **msgNew** to **clsStringListBox** to create a new string list box. This takes a pointer to a STRLB_NEW structure for its message arguments. The message arguments are the same as those for **clsListBox**, with the addition of a STRLB_NEW_ONLY structure. The additional fields include:

stringListBox.value an initial value (if the string list box is acting like a choice).

stringListBox.style several style fields.

The fields in STRLB_STYLE include:

Table 41-3
STRLB_STYLE Fields

Fields/Field Values	Functional Description
role	The overall behavior of the string list box.
slbRoleToggle	Act like a toggle table so that zero, one, or more table entries can be activated.
slbRoleChoice1	Act like a choice which has a value, so that one entry is always activated.
slbRoleChoice01	Act like a choice which can have no value, so that either zero or one entities can be activated.
look	The visual appearance of the string list box entries when activated.
slbLookInvert	Invert when activated.
slbLookDecorate	Decorate when activated.
dirty	Determines whether the string list box is dirty. The same notion that controls maintain.

Providing Entries 41.14.2

Just like a standard list box, a string list box has no entries when you create it. When **clsListBox** self-sends **msgListBoxProvideEntry**, **clsStringListBox** responds by sending first self, and then its client, **msgStrListBoxProvideString**. In response, you provide a string. **clsStringListBox** creates a button out of the string. The **look** and **role** style settings of the string list box determine the appearance of the button.

msgStrListBoxProvideString takes a pointer to a STRLB_PROVIDE structure. This is similar to a LIST_BOX_ENTRY structure, and some of the fields are the same. The fields include:

strListBox the UID of the string list box.

position the position of the requested entry.

pString a 256-byte buffer for the string.

data client data for the entry.

Ordinarily, you should copy the appropriate string for **position** into **pString**. If you have a **static** string definition, you can pass a pointer to it in **pString**, but it had better not change. You can supply a U32 of arbitrary data in **data**; **clsStringListBox** copies this into **clsListBox**'s LIST_BOX_ENTRY for the entry.

clsStringListBox does not remember any information about the entry beyond the LIST_BOX_ENTRY information maintained by **clsListBox**. **clsListBox** needs to display a window for an entry, so it self-sends **msgListBoxProvideEntry**. **clsStringListBox** sends out **msgStrListBoxProvideString** and creates a button from that string which it passes back to **clsListBox**.

clsStringListBox does not do fancy tricks to improve performance, such as caching empty button windows, reusing button windows, or storing strings in a heap.

If you subclass **clsStringListBox**, you can either respond to **msgStrListBoxProvideString** or **msgListBoxProvideEntry** (or neither).

Notification 41.14.3

Unlike **clsListBox**, **clsStringListBox** does respond to gestures made over its entries. The only gesture it responds to is a single tap. **clsStringListBox** turns on the string the user tapped, and depending on its role, it turns off any other on entries.

The string list box maintains the "on" state of each string in the LIST_BOX_ENTRY information of its ancestor **clsListBox**.

A string list box doesn't send previewing or other messages to its client. This is true even if you set its **role** to be **slbRoleChoice01** or **slbRoleChoice1**—these make it respond to gestures like a choice, but don't give it an API like a choice. If you want, you can change the buttons that it creates to send button messages to its client.

Value 41.14.3.1

The value of a **slbRoleChoice01** or **slbRoleChoice1** string list box is the **data** of the on string. You can get the value using **msgStrListBoxGetValue**. You provide each entry's data in response to **msgStrListBoxProvideEntry** and can maintain it by modifying the LIST_BOX_ENTRY for that position. If the string list box role is **slbRoleChoice01** and no entry is on, this returns **stsStrListBoxNoValue.**

If the **role** of the string list box is **slbRoleToggles**, **msgStrListBoxGetValue** returns **stsFailed.** To find out those entries that the user has selected, send **msgListBoxEnum** to the string list box, setting **flags** to **lbSelected.**

If the role is **slbRoleToggles**, sending **msgStrListBoxSetValue** will return **stsFailed.** If the role is **slbRoleChoice01** and you set the value to **maxU32**, this will deselect every entry.

Control Dirty 41.14.3.2

A string list box maintains a dirty status in STRLB_STYLE and displays itself differently depending on how it is set. This is similar to the **dirty** field of a control, which indicates whether or not the control has been altered. You can send **msgStrListBoxGetDirty** or **msgStrListBoxGetStyle** to a string list box to find out if the user has altered it. As with most controls, it is up to you to reset the control dirty state of the list box.

Destruction 41.14.4

clsStringListBox destroys the button window it creates for a string when it receives **msgListBoxDestroyEntry.** It doesn't have to free the string since it only passed it to **clsButton** to create the entry's window.

Painting 41.14.5

clsStringListBox doesn't respond to repaint messages. It creates a left-aligned, edgeless button of the appropriate kind in response to **msgListBoxProvideEntry**, and the button paints itself.

Font List Boxes 41.15

clsFontListBox is a descendant of **clsStringListBox**. The strings it supplies are the names of the currently installed fonts. You don't have to respond to any messages to use it.

Creating a Font List Box 41.15.1

You send **msgNew** to **clsFontListBox** to create a new font list box. This takes a pointer to a FONTLB_NEW structure for its message arguments. The message arguments are the same as those for **clsStringListBox**, with the addition of a FONTLB_NEW_ONLY structure. Currently, the only additional field is:

- style fields (**fontListBox.style**).

Currently, the only field in STRLB_STYLE is:

prune the pruning control for the font list display. This is a set of flags. It is defined to be a **U16** in FONTLBOX.H, but is actually a FIM_PRUNE_CONTROL structure defined by the installed font manager in FONTMGR.H. This lets you reduce the number of fonts displayed. You can set **prune** to **fimNoPruning** to get a full list, or OR in the following flags to reduce the font list:

fimPruneDupFamilies remove fonts in the same family, such as Swiss Bold, Swiss Italic.

fimPruneSymbolFonts remove symbol fonts.

At **msgNew** time, **clsFontListBox** gets the list of installed fonts from the font install manager. It stores their short ID's in an array and sets the number of entries in the list box (**listBox.nEntries**) to the number of ID's. When asked to provide a string, it converts the font ID into a name.

Note that **clsFontListBox** does **not** regenerate the list of fonts when the set of installed fonts changes.

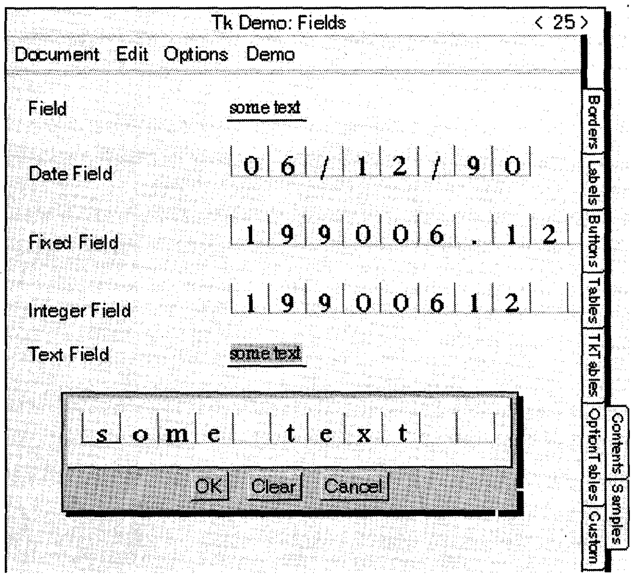
Notification 41.15.2

You do *not* need to respond to any message from **clsFontListBox**.

Chapter 42 / Fields

clsField is a subclass of **clsLabel** representing an editable text field that the user can fill in by handwriting with the pen. Since it inherits from **clsControl** and ultimately from **clsWin**, a field has all the usual properties of windows and controls. In particular, it has a **client** object that receives notification messages for important user actions and events affecting the field.

Figure 42-1
Sample Fields



Field Style Flags

42.1

The actions available to the user for entering or editing the contents of a field depend on the style flags you specify when creating it:

- **In-line fields** provide full handwriting and gesture recognition, allowing the user to write with the pen directly into the field itself. Alternatively, the user can draw a circle gesture on the field to invoke a pop-up insertion pad with more specialized editing capabilities.
- **Overwrite fields** have combed segments, with each character displayed in a separate, outlined box of its own. Writing into a box that already contains a character replaces that character with a new one.
- **Pop-up fields** perform no handwriting or gesture recognition of any kind. Any pen stroke in such a field invokes an insertion pad for editing the field's contents.

Notice that in-line and pop-up fields allow the user the option of popping up an insertion pad for editing the field's contents. An insertion pad has an area for writing, and button controls for accepting, clearing, and canceling the contents of the field.

Messages 42.2

Table 42-1 summarizes **clsField** messages. All of the object messages listed here are defined in the heder file FIELD.H and are discussed in the relevant sections later in this chapter.

Table 42-1
clsField Messages

Message	Takes	Description
		Class Messages
msgNew	P_FIELD_NEW	Creates and initializes a new instance of clsField.
msgNewDefaults	P_FIELD_NEW	Initializes the FIELD_NEW structure to default values.
		Field Attribute Messages
msgFieldGetStyle	P_FIELD_STYLE	Passes back the style value held by the field.
msgFieldSetStyle	P_FIELD_STYLE	Sets the style of the field.
msgFieldGetXlate	P_UNKNOWN	Passes back the translator information for the field.
msgFieldSetXlate	P_UNKNOWN	Specifies the translator information for the field.
msgFieldGetMaxLen	P_U16	Returns the maximum length allowed for input in the field.
msgFieldSetMaxLen	P_U16	Sets the maximum length for input in the field.
msgFieldSetCursorPosition	P_U16	Sets the position of the keyboard insertion point in the field.
msgFieldGetCursorPosition	P_U16	Returns the position of the keyboard insertion point in the field.
		Component Creation Messages
msgFieldCreatePopUp	P_FIELD_CREATE_POPUP	Creates and returns the insertion pad when the pop-up is invoked.
msgFieldCreateTranslator	P_OBJECT	Self-sent to create a translator. Returns the translator.
		Activation and Deactivation Messages
msgFieldActivate	void	Forces activation of the field.
msgFieldDeactivate	void	Forces deactivation of the field.
msgFieldActivatePopUp	P_FIELD_ACTIVATE_POPUP	Sent to cause an insertion pad to be brought up for the field.
msgFieldAcceptPopUp	void	Causes the insertion pad to be accepted. Sent when the user collapses the insertion pad by hitting the OK button or accepts the IP.
msgFieldCancelPopUp	void	Cancels the edit in the pop-up insertion pad. The previous value is unchanged. Sent when the user hits the cancel button or cancels the IP.
msgFieldKeyboardActivate	void	Activates field for keyboard use.

continued

Table 42-1 (continued)

Message	Takes	Description
		Input Processing Messages
msgFieldModified	self	Self-sent when a a field is modified.
msgFieldFormat	void	Self-sent to perform formatting.
msgFieldClear	NULL	Clears the value of the field.
msgFieldReadOnly	self	Self-sent when an attempt is made to modify a read-only field.
		Delayed Input Messages
msgFieldGetDelayScribble	P_OBJECT	Returns the delayed scribble for delayed fields.
msgFieldSetDelayScribble	P_OBJECT	Puts the field in delayed mode with the given scribble.
msgFieldTranslateDelayed	NULL	Translates a field with delayed captured strokes.
		Input Validation Messages
msgFieldValidate	void	Performs the validation protocall for a field.
msgFieldPreValidate	self	Allows clients to pre-process the value of a field before validation occurs. Sent to client if field.style.clientPreValidate is set before validation. Sent to the control.client if clientPreValidate is set before validation.
msgFieldValidateEdit	P_FIELD_NOTIFY	Self-sent to perform validation on the field.
msgFieldPostValidate	self	Self-sent to perform post-validation processing.
msgFieldNotifyInvalid	P_FIELD_NOTIFY	Sent to notify a client that a field was invalid.

Creating a Field 42.3

The **FIELD_NEW_ONLY** structure, which holds the class-specific arguments to **msgNew** for creating a new text field, is defined as follows:

```
typedef struct FIELD_NEW_ONLY {
   FIELD_STYLE style;      // field style, see below
   FIELD_XLATE xlate;      // translator or template
                           //    for handwriting translation
   U16         maxLen;     // maximum text length in characters
   U16         reserved;   // reserved for future use, must be 0
} FIELD_NEW_ONLY, FAR *P_FIELD_NEW_ONLY;
```

The form and meaning of the **style** and **xlate** arguments are discussed below. **maxLen** specifies the maximum number of text characters the field can contain; all text entered in the field will be truncated to this maximum length. The default value set by **msgNewDefaults** is 64 characters.

Style Flags 42.3.1

FIELD_STYLE contains flag settings to control the field's appearance and behavior, as summarized in Table 42-2. The remaining flags are all concerned with input processing and validatioon, and are discussed later in this chapter.

Specific values for some of these style settings are further summarized in Table 42-2. Except for the **editType**, **popUpType**, and **focusStyle** settings, all of these settings are concerned with input processing and validation and are discussed later in this chapter.

The editType Settings 42.3.1.1

The value of **editType** determines the style of text entry and editing the field supports: in-line, overwrite, or pop-up.

The focusStyle Setting 42.3.1.2

The **focusStyle** setting determines whether the field takes control of both the global selection and input focus when activated, the input focus only, or neither. Ordinarily, a field will want to take both, but it may occasionally be more convenient to take only the input focus, leaving the existing selection unchanged. (You might use this option, for example, to avoid disturbing the current selection when placing a temporary pop-up box on the screen. In fact, the **clsField** code itself uses it when displaying a field's insertion pad.) The **fstNone** option is included for completeness, but it's hard to imagine a realistic situation in which it would be useful.

Table 42-2
Field Style Values

Styles/StyleValues	Functional Description
editType	Determines the style of text entry and editing supported by the field.
fstInLine	Supports direct in-line editing.
fstOverWrite	Supports overwrite-style editing.
fstPopUp	Supports pop-up insertion pad only.
popUpType	For backward compatibility, insertion pad type.
fstCharBox	Character box.
fstCharBoxButton	Character box.
xlate	Whether the field uses a translator object or a translation template. See "Custom Handwriting Translation" for more detail.
true	Use a translation template.
false	Use a translator object.
focusStyle	Determines whether field takes control of global selection and input focus. See "The focusStyle Setting" for more detail.
fstInput	Take input focus only.
fstInputSelection	Take both selection and input focus.
fstInputNone	Take neither selection nor input focus.
noSpace	Defines the properties of the fields translator: instructs the translator to suppress all space characters during input translation.
capOutput	Defines properties of the field's translator: determines capitalization style for entered text. Affects handwriting only when user's preference settings call for all uppercase character recognition.
fstCapAll	Capitalize all letters.
fstCapAllWords	Capitlize first letter of each word.
bsDragAsIs	Capitilize exactly as entered.
fstCapFirstWord	Capitlize first letter of first word.

continued

Table 42-2 (continued)

Styles/StyleValues	Functional Description
upperCase	Forces all input to uppercase from any source. Not limited to pen input (not a translator-only property).
delayed	Delay translation until explicitly requested.
clientNotifyModified	Notify client when field's contents are modified.
clientNotifyReadOnly	Notify client on attempt to modify read-only fields.
validatePending	Indicates field's contents have been modified and not yet validated.
clientPreValidate	Notify client before beginning validation.
clientValidate	Notify client to perform validation.
clientPostValidate	Notify client after completing validation.
clientNotifyInvalid	Notify client if validation fails.
dataMoveable	Determines whether the field window or its string gets moved.
dataCopyable	Determines whether the field window or its string gets copied.

Custom Handwriting Translation 42.3.2

Associated with every field is a **translator** for converting the user's input scribbles into meaningful text characters. (Translators are discussed at length in *Part 5: Input and Handwriting Translation.*) When you create a new field, the **xlate** argument in FIELD_NEW identifies the type of translator the field is to use. A null value for this argument calls for a standard translator of **clsXWord**. However, if you have more specific knowledge of the kind of input the field will contain, you can improve the accuracy of the handwriting translation by supplying a custom translator of your own.

The **xlate** argument is defined to be of the following union type:

```
typedef union FIELD_XLATE {
        OBJECT     translator;
        P_UNKNOWN  pTemplate;
} FIELD_XLATE, FAR *P_FIELD_XLATE;
```

This allows you to supply either an existing translator (**translator**) or a template from which to build one (**pTemplate**), as described in *Part 5: Input and Handwriting Translation.* The **xlateType** flag in the FIELD_STYLE structure distinguishes the two options: 0 for the translator itself, 1 for a template.

The FIELD_STYLE flags **noSpace** and **capOutput** define properties of the field's translator. The field code uses these values when creating a translator on your behalf, whether by default (**xlate** = **false**) or from a template you supply (**xlate** != **false**, **xlateType** = **true**). (If you supply your own translator directly by setting **xlate** != **false** and **xlateType** = **false**, these flags are ignored. It is then your responsibility to set the corresponding properties of the translator yourself.

Access to Field Properties

42.4

The messages **msgFieldSetStyle** and **msgFieldGetStyle** allow you to access a field's style flags. Both take a pointer to a FIELD_STYLE structure and either copy it to the field's own style flags or fill it with their current values. **msgFieldSetStyle** will fail (return **stsFailed**) if you attempt to send it to a field that is currently active on the screen.

msgFieldSetXlate and **msgFieldGetXlate** set and retrieve the field's translator information. The argument to both messages is of type P_UNKNOWN. If the field's **xlateType** flag is 0, this is taken to be a P_OBJECT pointing to the translator object itself; if **xlateType** is 1, it is a P_XTEMPLATE pointing to a translator template. **msgFieldSetXlate** accepts a raw (uncompiled) template, while **msgFieldGetXlate** passes it back in compiled form. (Be careful not to send **msgFieldSetXlate** to a field that is currently active or has an insertion pad present on the screen. The results are undefined and probably undesirable.)

msgFieldSetMaxLen and **msgFieldGetMaxLen** manipulate the field's maximum text length via an argument of type P_U16. If **maxLen** is changed to less than the number of characters the field currently contains, the text will be truncated to the new length at the next editing operation. To access or change the current contents of the field itself, use the inherited messages **msgLabelGetString** and **msgLabelSetString**.

msgFieldSetCursorPosition and **msgFieldGetCursorPosition** set and retrieve the cursor position marking the insertion point for keyboard input. Both messages take an argument of type P_U16. The cursor appears on the screen only when the field is activated for keyboard input with **msgFieldKeyboardActivate**. If no cursor position has been set explicitly, **msgFieldSetCursorPosition** reports it as 0.

Component Creation

42.5

Table 42-3
Component Creation Messages

Message	Takes	Description
msgFieldCreatePopUp	P_FIELD_CREATE_POPUP	Creates and returns the insertion pad when the pop-up is invoked.
msgFieldCreateTranslator	P_OBJECT	Self-sent to create a translator. Returns the translator.
msgFieldFieldGetSecondTrans	P_OBJECT	Returns a second translator for editBox IP's.

When the user invokes a field's pop-up insertion pad, the field creates the pad by sending itself **msgFieldCreatePopUp**. Ordinarily, this creates a standard insertion pad of the type called for by the field's **popUpType** setting. If necessary, however, you can customize the appearance or behavior of the insertion pad by creating a specialized subclass of **clsField** and reimplementing **msgFieldCreatePopUp** to suit your needs. This message takes an argument of the form:

```
typedef struct {
    U16     type;
    OBJECT  ip;
    U32     reserved;
} FIELD_CREATE_POPUP, FAR * P_FIELD_CREATE_POPUP;
```

where **type** is one of the values:

```
#define fipReplaceAll    0
#define fipInsert        1
#define fipReplaceRange  2;
```

fipReplaceAll calls for an insertion pad large enough to hold the field's full maximum text length, as specified by its **maxLen** property. **fipInsert** is used in response to an insertion gesture by the user, and calls for only the number of additional characters that the field could actually accommodate (that is, the maximum text length minus the length of the current contents).

fipReplaceRange is intended to replace a range of selected text, but it is not yet implemented.

If you write your own method for **msgFieldCreatePopUp**, it should create an insertion pad of the requested size and pass back its UID in the **ip** field of the FIELD_CREATE_POPUP structure.

Subclasses redefine the standard method for **msgFieldCreateTranslator**, which **clsField** sends itself to create a field's translator object. If the field's **xlateType** flag is 1, the translator is created from the template supplied by the client program via the FIELD_NEW parameter **xlate**. If **xlateType** is 0 and **xlate** is null, **msgFieldCreateTranslator** must create a standard **clsXWord** translator. In either case, the newly created translator is passed back through the method argument, which is of type P_OBJECT.

Activation and Deactivation

42.6

Table 42-4
Activation and Deactivation Messages

Message	Takes	Description
msgFieldActivate	void	Forces activation of the field.
msgFieldDeactivate	void	Forces deactivation of the field.
msgFieldActivatePopUp	P_FIELD_ACTIVATE_POPUP	Sent to cause an insertion pad to be brought up for the field.
msgFieldAcceptPopUp	void	Causes the insertion pad to be accepted. Sent when the user collapses the insertion pad by hitting the OK button or accepts the IP.
msgFieldCancelPopUp	void	Cancels the edit in the pop-up insertion pad. The previous value is unchanged. Sent when the user hits the cancel button or cancels the IP.
msgFieldKeyboardActivate	void	Activates field for keyboard use.

The user normally activates a field by writing into it with the pen, causing the field to send itself **msgFieldActivate**. This allocates some temporary memory and prepares the field to receive the user's input. When the pen input is complete, the field sends itself **msgFieldDeactivate** to deallocate the temporary memory.

msgFieldActivatePopUp is sent when the user invokes a field's pop-up insertion pad. This, in turn, self-sends **msgFieldActivate** to activate the field if necessary, then displays the pop-up and prepares it for editing. The pop-up is normally centered directly over the field, but you can supply a P_RECT32 (in root window coordinates) to reposition it elsewhere.

msgFieldAcceptPopUp signals that the user has completed and confirmed an editing operation in the insertion pad. This deactivates the field by self-sending **msgFieldDeactivate**, removes the insertion pad from the screen, and sends **msgFieldModified** to process the new value. Dismissing the insertion pad without confirmation sends **msgFieldCancelPopUp** instead, deactivating the field but leaving its previous contents unchanged.

msgFieldKeyboardActivate activates a field and prepares it to accept keyboard input. This message is intended to be sent by client programs, and is useful mainly for navigation between fields with the keyboard (for example, when the user presses the z key).

Input Processing

42.7

Table 42-5
Input Processing Messages

Message	Takes	Description
msgFieldModified	self	Self-sent when a a field is modified.
msgFieldFormat	void	Self-sent to perform formatting.
msgFieldClear	NULL	Clears the value of the field.
msgFieldReadOnly	self	Self-sent when an attempt is made to modify a read-only field.

Whenever the contents of a field are modified, it sends itself **msgFieldModified** to process the new value. If the FIELD_STYLE flag **clientNotifyModified** is set, the same message is also sent to the field's client, allowing it to take any actions that may be required to respond to the change. **msgFieldModified** also sets the field's **validatePending** flag, triggering an input validation sequence. The flag will be cleared after successful validation.

When the user enters or edits text in a pop-up insertion pad, **msgFieldModified** is not sent to the client until the user dismisses the pad and confirms its edited contents. When text is entered directly into an in-line or overwrite field, this message may potentially be sent each time the handwriting translator recognizes a character. However, the message is not sent if the field's **dirty** flag (part of the CONTROL_STYLE structure inherited from **clsControl**) is set. That is, it is sent only when the field's contents are modified for the first time from a known, clean state. The standard method for **msgFieldModified** sets the **dirty** flag to suppress the message at the next modification; it is the client's responsibility to re-enable the message by clearing this flag when appropriate. The client can clear the **dirty** flag immediately if it wishes to be notified each time a new character is recognized (for example, to format the character on the screen as soon it is received). Alternatively, the client can choose to leave the flag set, deferring its input processing until some later time (such as when the field is deactivated).

After successfully validating any input, the field sends itself **msgFieldFormat** to format its new contents for display on the screen. Subclasses of **clsField** can redefine this message to perform any special formatting they may require. **msgFieldClear** clears the field's contents, leaving it empty. (This message also has another purpose in connection with delayed pen input; see below for details.)

The **enable** flag in a field's CONTROL_STYLE structure determines whether the field is able to respond to user input. If this flag is not set, the field is considered read-only: any attempt to enter input data into such a field is an error. If the FIELD_STYLE flag **clientNotifyReadOnly** is also set, the field will send **msgFieldReadOnly** to its client, allowing the client to take corrective action such as sounding a beep or displaying an error message.

Delayed Input

42.8

Table 42-6
Delayed Input Messages

Message	Takes	Description
msgFieldGetDelayScribble	P_OBJECT	Returns the delayed scribble for delayed fields.
msgFieldSetDelayScribble	P_OBJECT	Puts the field in delayed mode with the given scribble.
msgFieldTranslateDelayed	NULL	Translates a field with delayed captured strokes.

By setting the **delayed** flag in FIELD_STYLE, you can specify that the user's pen input in a field is to be saved for later processing, rather than translated immediately on entry. In this case, incoming pen strokes are simply buffered as they are received, with no attempt at handwriting translation. You must then signal explicitly when to translate the accumulated input by sending **msgFieldTranslateDelayed**. (For example, you might display an **OK** button on the screen and send this message when the user taps the button.)

If necessary, you can manipulate a field's pending pen input explicitly. **msgFieldGetDelayScribble** passes back a pointer to the accumulated scribble awaiting translation, and **msgFieldSetDelayScribble** takes a pointer to a new scribble and substitutes it for the old one. In addition, **msgFieldClear**, already mentioned earlier, serves a two-fold purpose for delayed fields. If the field currently contains a value, **msgFieldClear** simply clears it to empty, as before. If the field is already empty, this message clears its pending pen input instead. (You might use this message, for example, to implement a **Clear** button for canceling all previous pen input in the field and starting over.)

Input Validation

42.9

Table 42-7
Input Validation Messages

Message	Takes	Description
msgFieldValidate	void	Performs the validation protocol for a field.
msgFieldPreValidate	self	Allows clients to pre-process the value of a field before validation occurs. Sent to client if field.style.clientPreValidate is set before validation. Sent to the control.client if clientPreValidate is set before validation.
msgFieldValidateEdit	P_FIELD_NOTIFY	Self-sent to perform validation on the field.
msgFieldPostValidate	self	Self-sent to perform post-validation processing.
msgFieldNotifyInvalid	P_FIELD_NOTIFY	Sent to notify a client that a field was invalid.

When a field receives a new value, you can send it **msgFieldValidate** to verify the validity of the new value. For example, a field representing a day of the month might want to verify that its value is an integer between 1 and 31, or a field containing a two-letter state abbreviation might check it against a list of known abbreviations.

Input validation occurs automatically whenever a field loses the input focus after its value has changed. You can also force validation by explicitly sending **msgFieldValidate** at other appropriate times, such as the following:

- When the user writes directly into an in-line or overwrite field.
- When a field's insertion pad is accepted and dismissed.
- When a field is given a new value directly with **msgLabelSetString**.

The basic validation message **msgFieldValidate**, in turn, triggers a sequence of subsidiary messages that perform the actual validation processing. Each stage of the validation sequence is controlled by a flag bit in FIELD_STYLE, and can be disabled by clearing the corresponding flag.

If the **clientPreValidate** flag is set, validation begins by sending **msgFieldPreValidate** to the field's client. This allows the client to do any needed initialization to prepare for validation processing.

Next, the field performs the actual validation by sending **msgFieldValidateEdit**. If the **clientValidate** flag is set, this message is directed to the field's client; otherwise it is sent to the field itself. The latter option is particularly useful for subclassing. For example, a field containing a two-letter state abbreviation might be implemented as a subclass of **clsField**, redefining the method for **msgFieldValidateEdit** to check the value against a list of known abbreviations. You would then want the validation message sent to the field itself, to be intercepted by the newly subclassed method. If, on the other hand, you wanted to verify a postal code field by comparing it for validity with the corresponding state field, a subclass wouldn't work because one field's validation method couldn't access the contents of the other field. In this case, you would set the

clientValidate flag to send the validation message to the client, and perform the validation at the application level instead.

msgFieldValidateEdit takes an argument of the form:

```
typedef struct {
    MESSAGE  failureMessage;
    OBJECT   field;
} FIELD_NOTIFY, FAR * P_FIELD_NOTIFY;
```

where **field** is the UID of the field requesting validation; the input value to be validated can be obtained from the field with **msgLabelGetString**. If the validation is successful (that is, if the input value is valid), **msgFieldValidateEdit** returns **stsOK**; otherwise it returns an error status and passes back a failure message in **failureMessage**.

Assuming validation was successful (and provided that the field's **clientPostValidate** flag is set), the client is next notified via **msgFieldPostValidate** to perform any final housekeeping it may require to complete the validation process. Then the field clears its **validatePending** flag and sends itself **msgFieldFormat** to format the new value for display on the screen.

If the **clientNotifyInvalid** bit is set, the client will be notified of any unsuccessful validation with **msgFieldNotifyInvalid**. This message takes an argument of type FIELD_NOTIFY, whose **failureMessage** describes the reason for the failure. The client can then respond in whatever way is appropriate, such as by displaying an error message on the screen.

Layout 42.10

You can set the width of a field by specifying its label width. For example, in FIELD_NEW, you can set **.label.cols** to 3 and **.label.style.numCols** to **lsNumAbsolute**. This will set the label wide enough for the largest characters in the font—the **em-width** of the font. If the field is, for example, only for numerals, the width is often more than is really necessary.

If the field has a pop-up input pad, the user can resize the pop-up as he or she would any other floating window. By setting **.field.maxLen**, you can restrict the number of characters the user can enter.

User Interface 42.11

Even if a field does not allow direct handwritten entry, the user can still make common editing gestures on it. See Chapter 7, Editing and Formatting Text, of the *Using PenPoint* manual for information on the user interface of fields.

Data-Specific Fields

42.12

clsDateField, **clsIntegerField**, **clsFixedField**, and **clsTextField** are descendants of **clsField** tailored to the handwritten entry of dates, integers, fixed-format numbers, and text.

As well as setting and getting the actual text in these fields using **msgLabelSetString** and **msgLabelGetString**, you can also set and retrieve the values of these fields in a canonical format using specific messages:

- **msgDateFieldSetValue** and **msgDateFieldGetValue** take P_TIME_DESC.
- **msgControlSetValue and msgControlGetValue** take P_U32, passes value in YYYYMMDD format.
- **msgDateFieldSetValue** and **msgDatFieldGetValue** take P_TIME_DESC.

For **clsFixedField**:

- **msgControlSetValue** and **msgControlGetValue** take P_U32, passes value in hundredths format.

Chapter 43 / Notes

Notes are windows that appear, present information to the user, and encourage the user to make some response. In other user interfaces, similar functionality is provided by dialog boxes and alerts.

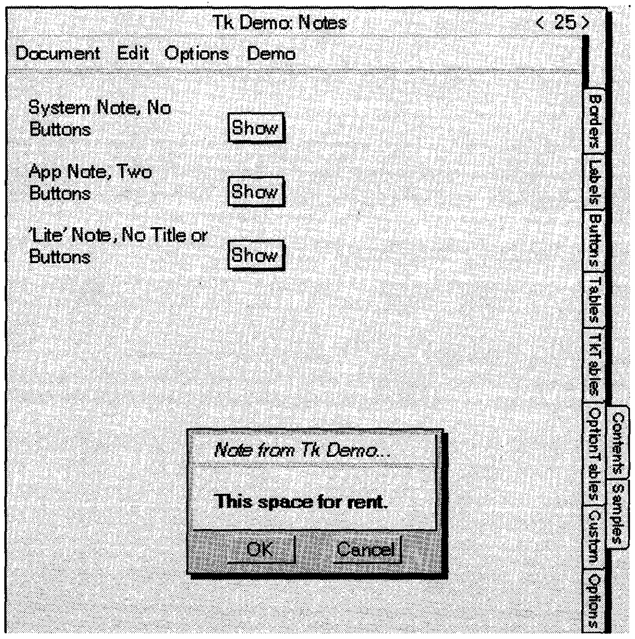
Standardized Messages 43.1

There are many standard messages to present to the user, such as "Low memory," "Disk full," and so on. You can put up standardized notifications, warnings, and requests to the user using a procedural **standard message** interface. Standard messages look exactly like notes, but use a procedural interface that isolates you from the text of the message and its presentation. Notes, on the other hand, are proper objects, controlled via a message interface. The standard message interface is documented later in this chapter.

Kinds of Notes 43.2

There are two broad kinds of notes: system and application. System-modal notes consume all input and prevent the user from continuing until he or she has dismissed the note. Application-modal notes only consume input to their application and so don't lock up the whole user interface.

Figure 43-1
Sample Application-Modal Note



clsNote inherits from **clsFrame**. A note has an optional title, an optional command bar, and contents. To provide a lot of flexibility, you specify the contents as an array of toolkit table entries. You can also tell **clsNote** to get the contents of the note from a resource file.

The input-locking functionality of system-modal notes is provided in part by an instance of **clsModalFilter**, which is described in *Part 5: Input and Handwriting Translation.*

Notes aren't restricted to applications. They are a reasonable way for any piece of code, such as a DLL, to inform the user and interact with the user. For example, the volume support code in the PenPoint file system prompts the user to insert another floppy disk using a note.

clsNote Messages

43.3

Table 43-1 summarizes the messages defined by **clsNote.**

Table 43-1
clsNote Messages

Message	Takes	Description
		Class Messages
msgNew	P_NOTE_NEW	Creates a note.
msgNewDefaults	P_NOTE_NEW	Initializes the NOTE_NEW structure to default values.
		Instance Messages
msgNoteGetMetrics	P_NOTE_METRICS	Get the metrics of a note.
msgNoteSetMetrics	P_NOTE_METRICS	Set the metrics of a note.
msgNoteShow	P_MESSAGE	Displays a note.
msgNoteCancel	P_MESSAGE	Informs a note that it should take itself down.
		Client Notification Messages
msgNoteDone	MESSAGE	Sent to clients when a note is dismissed.

Creating a Note

43.4

You send **msgNew** to **clsNote** to create a new note. This takes a pointer to a NOTE_NEW structure for its message arguments. The NOTE_NEW structure includes the following values:

- **metrics** a NOTE_METRICS structure specifying the metrics of the note.
- **pTitle** an optional string for the title. The title will be preceded with the words "Note from" if **metrics.flags** includes **nfUnformattedTitle.** Otherwise it will appear exactly as specified.
- **pContentsEntries** an array of TK_TABLE_ENTRYs specifying the content of the note.
- **pCmdBarEntries** an optional array of TK_TABLE_ENTRYs specifying the command bar of the note.

clsNote creates labels from the toolkit table entries in **note.pContentEntries**, unless you specify some other class in the **class** field of the TK_TABLE_ENTRYs.

If **note.pCmdBarEntries** is not **objNull**, **clsNote** creates a command bar from it. You should only specify a string and a message for each button in the command bar.

NOTE_METRICS includes:

flags various flags. The flags are described in the following section.

autoDismissMsg the message the note returns or sends if and when it is dismissed.

modalFilter the filter the note uses.

timeout the timeout, in milliseconds, before the note auto-dismisses.

client the client of the note.

Usually, you set the filter to **objNull** and **clsNote** creates the right modal filter, depending on the type of the note.

Flags 43.4.1

metrics.flags can contain any combination of the following flags (the descriptions summarize behavior when the flags are set):

- **nfSystemModal** the note is system-modal.
- **nfAutoDestroy** the note is automatically destroyed after it is dismissed.
- **nfSystemTitle** use system title, ignoring **pTitle**.
- **nfAppTitle** use application name, ignoring **pTitle**.
- **nfUnformattedTitle** use **pTitle** as specified, without prepending the words "Note from."
- **nfTimeout** dismiss on timeout as well as input.
- **nfNoWordWrap** don't word-wrap content labels.
- **nfResContent** **pContentEntries** is specified as a resource ID (a P_NOTE_RES_ID structure).
- **nfNoBeep** disable preferencescontrolled beeping.
- **nfExplicitCancel** note will ignore **cmdBar** buttons.

The default flag setting for a system modal note is **nfDefaultSysFlags**, a combination of **nfSystemModal**, **nfAutoDestroy**, and **nfSystemTitle**. **The default flags setting for an application-modal note is nfDefaultAppFlags**, a synonym for **nfAppTitle**. **nfDefaultFlags** is a synonym for **nfDefaultSysFlags**.

Contents from Resource Files 43.4.2

If **nfResContent** is set, then **pContentsEntries** should not be an array of TK_TABLE_ENTRYs. Instead, it should be a pointer to a NOTE_RES_ID structure.

The intent is to store strings, separate from the note and its toolkit table, as string tables in resource files. This facility is used by the standard message procedural interface for displaying errors to the user. The standard message interface is described later in this chapter.

System Modal vs. Application Modal 43.5

The behavior of a note is profoundly affected by whether it is system-modal or application-modal. A system-modal note filters all input, preventing the user from activating any other part of the user interface until it is dismissed.

An application-modal note filters all input for its process. It allows input processing in other applications to continue. Hence the user can do other things while the note is up, and these other operations may affect the application.

For example, if you display an application-modal "Do you want to abandon changes?" note, the user can still access the Notebook tabs and tap them to turn to another page, and your application will still receive PenPoint Application Framework messages, even though it is dead to input. If you use application-modal notes, you'll probably have to remember in your application's state that it has a note up so you know what parts of the user interface to disable. Note that embedded documents are separate processes and will still be live, although embedded components are in the same process.

If the user doesn't have to respond to a note and can do other things, it's probably better to use an **option sheet** instead of a note.

The **nfSystemModal** flag you specify when creating a note is passed on by **clsNote** to the modal filter it creates. If the note has no buttons, then **clsNote** sets the **mfAutoDismiss** flag in the modal filter. If you specify a modal filter to use, **clsNote** leaves its flags up to you.

Using a Note 43.6

Having created a note, you display it using **msgNoteShow**. This displays the note on the screen.

msgNoteShow uses **msgWinInsert**, not **msgAppAddFloatingWin**, to display the note—the note might not be displayed by an application. If the note is application-modal, you probably should not permit the user to turn the page while the note is displayed.

If **nfSystemModal** is on, then sending this message will block until the note is dismissed. At that time, **msgNoteShow** will set **pArgs** to point to the message sent by the button that was hit (or **autoDismissMsg** if the win was dismissed by its modal filter). Be aware that the entire input system, and therefore the window system, will be blocked while **msgNoteShow** is waiting for completion with **nfSystemModal** on.

Filter 43.6.1

If you supplied a modal filter in **metrics.modalFilter**, **clsNote** uses it to filter input. Otherwise, it creates an instance of **clsModalFilter**.

The filter that **clsNote** creates does not restrict input to its subtree, although that is the perceived effect. It allows input to any children of the root that are menus or insertion pads, on the assumption that these are part of the note. This lets you put pop-up choices and handwriting fields in a note.

Notification 43.7

What Comes Back 43.7.1

If the note is system-modal, then **msgNoteShow** does not return until the note is dismissed. When **msgNoteShow** does return, **clsNote** passes back (not by sending another message) a pointer to a value which indicates what happened. **clsNote** never uses the **client** in the note's metrics.

If the note is application-modal, then **msgNoteShow** returns immediately. Your application and the rest of PenPoint continue to run while the note is displayed. When the note is dismissed, the note's client later receives **msgNoteDone** (as a separate message). The message argument of **msgNoteDone** is a pointer to a value that indicates what happened.

For convenience, you usually use MESSAGE values to indicate the result of displaying the note.

Note Dismissal 43.7.2

A note may be dismissed programmatically or by the user. The message you get back indicates what happened.

If the note has a command bar, the user can only dismiss it by tapping one of the buttons. The message that comes back is the button message of the button that the user activated.

If the note does not have a command bar, the user can dismiss the note by tapping anywhere on it. The message that comes back is the message you specified in **note.metrics.autoDismissMessage**.

If **nfTimeout** is set in **note.metrics.flags**, then **clsNote** will dismiss the note after the timeout in **note.metrics.timeout** expires. Again, the message that comes back is the message you specified in **note.metrics.autoDismissMessage**. This means that you can't tell the difference between the user tapping a note without a command bar and it getting timed-out by the system.

If **clsNote** created its filter, it destroys it when the note is dismissed.

More Detailed Button Notification 43.7.2.1

You should not set the client of the buttons in the command bar or you will get a double message from the button. First the note gets **msgButtonDone** and sends its client **msgNoteDone**, then the button's own notification sequence will begin.

Similarly, don't bother setting data for the buttons in the command bar. **msgNoteDone** only passes back the button's message, not its data.

Painting 43.8

clsNote alters the word-wrap and shrink-wrap styles of any label items in its contents toolkit table to get a pleasing appearance depending on whether the note has a title and command bar or not. You can force the note not to word-wrap by setting the **flags.nfNoWordWrap** flag in the note's metrics.

Layout 43.9

A note lays itself out at **msgNew** time, so that it appears on-screen more quickly when it is shown.

If you supply an origin at new time in **win.bounds.origin**, **clsNote** will put the note at that location. Otherwise, it centers the note on the screen. If you turn off window shrink-wrap for the note, it will use the size you supply in **win.bounds.size**. Otherwise, the note sizes to fit its contents.

Destruction 43.10

If the **nfAutoDestroy** flag in the note's metrics is set, when the note is dismissed, **clsNote** will destroy it. Otherwise, the note still exists.

When the note is destroyed, it removes its modal filter from the filter list, if necessary, and destroys it, if necessary.

If you want to take down a note yourself after creating it, you can use **msgNoteCancel**.

If you supplied your own modal filter, you must destroy it yourself.

Standard Message Interface 43.11

The UI Toolkit provides a standard message interface for displaying standard messages to the user. This uses the same UI components as a note, but is a purely procedural interface. You specify a STATUS or TAG to identify a resource containing the message text, and the procedure creates an instance of **clsNote** with the text and optional command buttons.

There are five kinds of standard messages (associated procedure names are shown in parentheses):

- **Dialogs** (StdMsg()) system and application dialog boxes, including command buttons for interaction.
- **Progress notes** (StdProgressUp()) notes informing the user that a long operation is taking place. There is currently no support for cancelling a progress note, so there are no command buttons in the note.
- **Application errors** (StdError()) notes informing the user that an application error has occurred.
- **System errors** (StdSystemError()) notes informing the user that a PenPoint error has occurred.

- **Unknown errors** (StdUnknownError()) notes informing the user that an error has occurred which your application cannot identify.

The standard message procedure for each of these types of standard messages is discussed in its own section below. Following these discussions is an explanation of how you can customize the text of each message using the format codes defined in CMPSTEXT.H and specify command buttons for some notes using button definitions.

System and Application Dialogs

43.11.1

A **dialog** is a mechanism for allowing the user to choose between several courses of action. To create a dialog, execute the **StdMsg()** procedure. Like most of the standard message procedures, **StdMsg()** has a variable number of arguments. The first argument is a TAG identifying a dialog message string in the process resource file. The remaining arguments, if any, are parameters interpreted for formatted text. Format codes are described in more detail below.

StdMsgRes() behaves exactly like **StdMsg**(), but lets you specify a resource file other than the process resource file to search for the message text.

By default, **StdMsg()** creates a note whose message is the text specified in the resource, with a single OK button. When the user dismisses the dialog by tapping the OK button, **StdMsg()** returns 0. If the text of the message string defines one or more buttons, then those buttons appear instead of the default OK button, and **StdMsg()** returns the button number of the button the user taps to dismiss the dialog. Button definitions are described in more detail below.

StdMsg() returns a negative error status if it had a problem bringing up the note. If **StdMsg()** cannot find a resource matching the specified TAG, it returns **stsResResourceNotFound.**

Progress Notes

43.11.2

A **progress note** is a mechanism for informing the user that a long procedure is taking place. To create a progress note, execute the **StdProgressUp()** procedure. Like most of the standard message procedures, **StdMsg()** has a variable number of arguments. The first argument is a TAG identifying a string resource in the process resource file. The second argument is a P_SP_TOKEN, a pointer to an SP_TOKEN that **StdProgressUp()** will fill in. The remaining arguments, if any, are parameters interpreted for formatted text. Format codes are described in more detail below.

StdProgressUp() creates a note with the text specified in the resource as its message, and no command buttons. If the text of the message string defines one or more buttons, the button definitions are ignored. Button definitions are described in more detail below. **StdProgressUp()** also assigns a token to the SP_TOKEN pointed to by its second argument. This token is used later to take the progress note down, so do not alter it in any way.

Currently, there is no way for the user to dismiss or "cancel" a progress note.

StdProgressUp() returns a negative error status if it had a problem bringing up the note. If **StdProgressUp()** cannot find a resource matching the specified TAG, it returns **stsResResourceNotFound.**

When the procedure that the progress note describes is complete, execute **StdProgressDown()**. StdProgressDown has only one argument, the P_SP_TOKEN filled in when you executed **StdProgressUp()**. It uses this token to identify and take down the correct progress note, so don't alter the token.

Application Errors 43.11.3

An **application error** note is a mechanism for informing the user that an error has occurred within the application. To create an application error note, execute the **StdError()** procedure. Like most of the standard message procedures, **StdError()** has a variable number of arguments. The first argument is a STATUS identifying an error message string in the process resource file. The remaining arguments, if any, are parameters interpreted for formatted text. Format codes are described in more detail below.

__StdErrorRes__() behaves exactly like __StdError__(), but lets you specify a resource file other than the process resource file to search for the message text.

By default, **StdError()** creates a note whose message is the text specified in the resource, with a single OK button. When the user dismisses the dialog by tapping the OK button, **StdError()** returns 0. If the text of the message string defines one or more buttons, then those buttons appear instead of the default OK button, and **StdError()** returns the button number of the button the user taps to dismiss the dialog. Button definitions are described in "Message String Format Codes."

StdError() returns a negative error status if it had a problem bringing up the note. If **StdError()** cannot find a resource matching the specified STATUS, it returns **stsResResourceNotFound.**

System Errors 43.11.4

A **system error** note is a mechanism for informing the user that one of the standard PenPoint errors has occurred. To create an system error note, execute the **StdSystemError()** procedure. Like most of the standard message procedures, **StdSystemError()** has a variable number of arguments. The first argument is a STATUS identifying an error message string in the system resource file (PENPOINT.RES). The remaining arguments, if any, are parameters interpreted for formatted text. Format codes are described in "Message String Format Codes."

By default, **StdSystemError()** creates a note whose message is the text specified in the resource, with a single OK button. When the user dismisses the dialog by tapping the OK button, **StdSystemError()** returns 0. If the text of the message string defines one or more buttons, then those buttons appear instead of the default OK button, and **StdSystemError()** returns the button number of the button the user taps to dismiss the dialog. Button definitions are described in "Specifying Command Buttons."

StdSystemError() returns a negative error status if it had a problem bringing up the note. If **StdSystemError()** cannot find a resource matching the specified STATUS, it returns **stsResResourceNotFound.**

Unknown Errors 43.11.5

An **unknown error** note is a mechanism for informing the user that your application has encountered an error it does not know how to handle. To create an unknown error note, execute the **StdUnknownError()** procedure. Unlike most of the standard messages, **StdUnknownError()** has just one argument, the STATUS of the error encountered.

StdUnknownError() creates a note whose message is the text specified in the resource, with a single OK button. When the user dismisses the dialog by tapping the OK button, **StdUnknownError()** returns 0. If the text of the message string defines one or more buttons, the button definitions are ignored. Any format code included in the message string is replaced with "???". Button definitions and format codes are described in "Specifying Commands Buttons" and "Message String Format Codes."

If **StdUnknownError()** cannot find a resource matching the specified STATUS, it creates a standard "Error not found" message.

Formatted Message Text 43.11.6

You specify the text of standard messages in resource files. For dialogs and progress notes, you specify the TAG associated with the resource for the message text. For error messages, you specify the STATUS identifying the resource for the message text. The message string resources may specify the text of one or more command buttons to appear in the note. In addition, the text of the message string may contain format codes, as specified in CMPSTEXT.H.

Specifying Command Buttons 43.11.6.1

Message strings may contain optional button definitions. A **button definition** is a series of characters enclosed in square brackets ([]) before the text of the message. The text between the square brackets appears in a command button on the displayed note. You may define any number of buttons, but all buttons must be defined at the beginning of the string, before the text of the message. Multiple button definitions appear in the same left-to-right order on the displayed note as they do in the message string. If you do not define any buttons, the standard message procedures will display a single button with the text OK.

Button numbers increase from left to right, starting with 0 for the left-most button. **StdMsg()**, **StdError()**, and **StdSystemError()** return the number of the button pressed to dismiss the note. **StdUnknownError()** and **StdProgressUp()** ignore button definitions. **StdUnknownError()** always displays a single OK button. **StdProgressUp()** does not display any command buttons.

Message String Format Codes 43.11.6.2

Following any button definitions, the text of a message string resource may contain any combination of literal text and the format codes defined in CMPSTEXT.H. A **format code** is a caret (^), followed by one or more digits, followed by a single character. The digits identifies one of the procedure arguments following the format string (recall that the standard message procedures have a variable number of arguments), and the single character specifies how to interpret the argument.

A typical example of a format code is **^2s**, which indicates that the second argument (identified by the 2) should be interpreted as a string (**s**) and the format code replaced with the result. As a further example, suppose a TAG called **tagMyAppDialog1** identified the string "**Could not find a ^1s called ^2s.**" and you executed the following procedure:

```
buttonHit = StdMsg(tagMyAppDialog1, "document", "Policy");
```

This would create a dialog box displaying the message, "Could not find a document called Policy." Since the resource string does not define any buttons (see above), **StdMsg()** would create a single OK button and return its button number, 0, when the user tapped it to dismiss the note.

To include a literal caret (^) in the format string, use two consecutive carets (^^). Otherwise, format code types include the following:

- **s** the argument is a string.
- **r** the argument is the resource ID of a string resource.
- **l** the argument is the group number and indexed list resource ID for a string list.
- **d** the argument is a U32 which should be printed as a decimal number.
- **x** the argument is a U32 which should be printed as a hexadecimal number.
- **{** the argument is a number which selects between a singular and a plural term.

The left brace ({) character indicates that a singular and a plural term are to follow, separated with a vertical bar (|) and terminated with a right brace (}), as in ^3{*singular*|***plural***}. If the specified argument is 1, the format code is replaced with the singular term; otherwise, it is replaced with the plural term.

For example, suppose the string resource tagged with tagMyAppDialog1 is "**There ^1{is|are} ^1d ^1{slot|slots} remaining.**" and you executed the following procedure:

```
buttonHit = StdMsg(tagMyAppDialog1, 1);
```

The displayed note would read: "There is 1 slot remaining." On the other hand, if the second argument were 2 instead of 1, the displayed note would read: "There are 2 slots remaining."

Chapter 44 / Frames

Nearly every application in PenPoint has a frame. By default, the PenPoint Application Framework automatically creates and files a frame for an application. Even the simplest sample application (Empty Application, described in the *Application Writing Guide*) has a fancy frame.

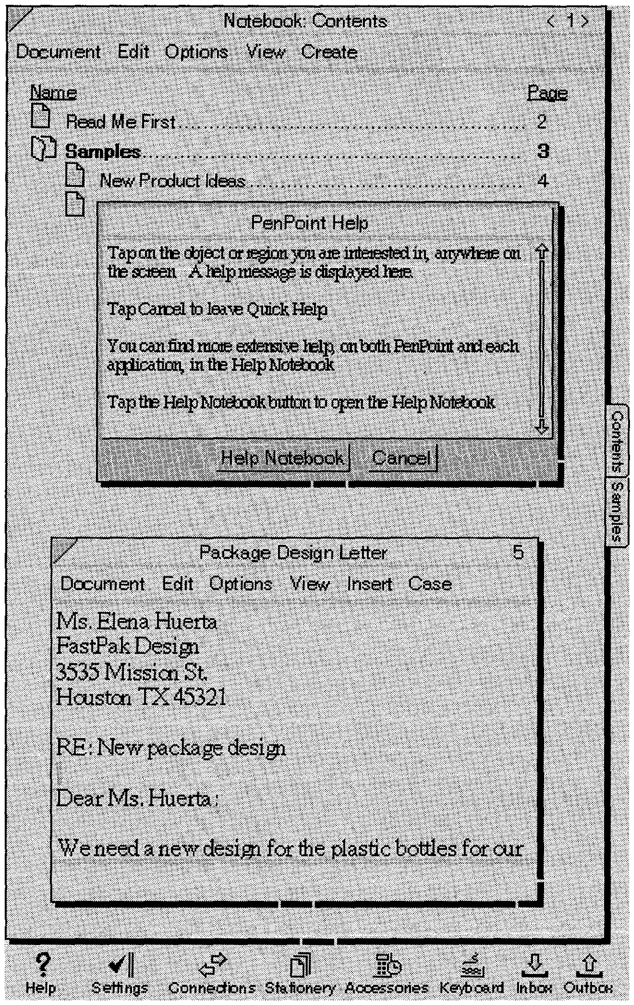
A frame maintains a host of child windows. The most important one is the client window, which you supply. This is where the application or component displays its user interface. This is surrounded by several decoration windows that give frames their familiar appearance. The decoration windows may include any or all of the following components:

- Close box (the triangular corner at the left of the title bar).
- Title bar at the top.
- Page number.
- Menu bar.
- Tab bar.
- Cork margin.
- Command bar.

For document frames, some of these are controllable by the user. The user can turn some of these on and off, either by setting options on the Options Controls... option sheet or by making gestures in the frame title bar. Other decorations are under the control of the PenPoint Application Framework. For example, pages in the regular Notebook don't have close corners if the system Preference for zooming documents is turned off, and the PenPoint Application Framework decides which documents have page numbers.

There are other components of a frame which it picks up from its ancestors. Frames can have shadows from **clsBorder** (and **clsShadow**, described below), and resize handles from **clsBorder**.

Figure 44-1
Different Frame Styles



Tap on the object or region you are interested in, anywhere on the screen. A help message is displayed here.

Tap Cancel to leave Quick Help.

You can find more extensive help, on both PenPoint and each application, in the Help Notebook.

Tap the Help Notebook button to open the Help Notebook.

Ms. Elena Huerta
FastPak Design
3535 Mission St.
Houston TX 45321

RE: New package design

Dear Ms. Huerta:

We need a new design for the plastic bottles for our

Note that scrollbars aren't part of the frame. If you want scroll bars, you must put your window in a custom layout with some scrollbars, or use **clsScrollWin**.

Using clsFrame Messages

44.1

Table 44-1 summarizes the messages defined by **clsFrame**. The following sections provide a more detailed discussion.

Table 44-1
clsFrameMessages

Message	Takes	Descriptions
		Class Messages
msgNew	P_FRAME_NEW	Creates a new frame window, setting pArgs->frame.
msgNewDefaults	P_FRAME_NEW	Initializes the FRAME_NEW structure to default values.
		Property Manipulation Messages
msgFrameGetMetrics	P_FRAME_METRICS	Passes back the metrics.
msgFrameSetMetrics	P_FRAME_METRICS	Sets the metrics.
msgFrameGetStyle	P_FRAME_STYLE	Passes back the current style values.
msgFrameSetStyle	P_FRAME_STYLE	Sets the style.
msgFrameGetClientWin	P_WIN	Passes back metrics.clientWin.
msgFrameSetClientWin	WIN	Sets metrics.clientWin.
msgFrameGetMenuBar	P_WIN	Passes back metrics.menuBar.
msgFrameSetMenuBar	WIN	Sets metrics.menuBar; sets style.menuBar as appropriate.
msgFrameDestroyMenuBar	VOID	Sets style.menuBar to false and destroys the menu bar, if any.
msgFrameSetTitle	P_CHAR	Sets the string in the metrics.titleBar.
msgFrameGetClient	P_OBJECT	Passes back metrics.client.
msgFrameSetClient	OBJECT	Sets metrics.client.
msgFrameGetAltVisuals	P_BORDER_STYLE	Passes back the alternate border visuals.
msgFrameSetAltVisuals	P_BORDER_STYLE	Sets the alternate border visuals.
msgFrameGetNormalVisuals	P_BORDER_STYLE	Passes back the normal border visuals.
msgFrameSetNormalVisuals	P_BORDER_STYLE	Sets the normal border visuals.
msgFrameSelect	VOID	Selects the frame.
msgFrameShowSelected	BOOLEAN	Makes the frame look selected or not.
msgFrameMoveEnable	BOOLEAN	Enables or disables UI for moving.
msgFrameResizeEnable	BOOLEAN	Enables or disables UI for resizing.
msgFrameZoom	BOOLEAN	Zooms the frame up or down.
msgFrameIsZoomed	P_BOOLEAN	Passes back true if the frame is currently zoomed.
		Client Responsibility Messages
msgFrameDelete	pNull	Asks the frame's client to delete the frame.
msgFrameClose	pNull	Asks the frame's client to close the frame.
msgFrameFloat	VOID	Asks the frame's client to float the frame.
msgFrameZoomOK	P_FRAME_ZOOM	Sent to the client when msgFrameZoom is received.
msgFrameSelectOK	FRAME	Sent to the client when msgFrameSelect is received.
msgFrameZoomed	P_FRAME_ZOOM	Sent to client and observers after frame is zoomed.

Creating a Frame 44.2

The FRAME_NEW structure has fields for the UID's of all these child windows. In addition, it has a FRAME_STYLE structure. This contains bit fields indicating whether each child window is present. You can plug your own decoration windows into a frame, but **clsFrame** assumes that its windows have certain behavior. For example, it assumes that its title bar is a label.

If you set the style bit for the appearance of a frame component, and do not supply one to **msgNew**, **clsFrame** creates a default component of that type for you.

Usually, **clsApp** creates a frame for your application in response to **msgAppProvideMainWin**, which it self-sends during **msgAppInit** processing. Application frames are explained in more "PenPoint Application Framework and Frames."

Multiple Windows, Multiple Frames 44.2.1

Frames only support a single client window. If you want to have more than one window in your application, you have two choices:

- Use a layout window to position your windows. The layout window is the frame's client window, and its children are your windows.
- Create multiple frames. The PenPoint Application Framework supports a single application main window, and it is this frame that it puts on-screen, assigns a page number to, and so forth. However, your application is free to create other frames outside this frame.

If you use the second approach, you can either insert your extra windows in the window hierarchy yourself, or you can use **msgAppAddFloatingWindow** to manage them. This is the method used by PenPoint to keep track of system windows such as option sheets and pop-up insertion pads.

Modifying a Frame 44.2.2

If you later turn off the style bit for one of the frame decorations, **clsFrame** hides the decoration window. When you turn it on again, **clsFrame** reinserts the decoration window. If you want to save memory, you should destroy it. You must lay out the frame again at some point.

You can set and get the frame metrics using **msgFrameSetMetrics** and **msgFrameGetMetrics**, set the frame title, set and get the frame style fields with msgFrameSetStyle and **msgFrameGetStyle**, and set the client window with **msgFrameSetClientWin** and **msgFrameGetClientWin**,.

Frame Layout 44.3

clsFrame is a descendant of **clsCustomLayout**. During layout, the frame looks at its FRAME_STYLE bits and specifies constraints for each of its child windows present.

If **wsLayoutResize** is set in the message arguments to **msgWinLayoutSelf** and you have turned on shrink-wrap, the frame will fit around its components and client window, leaving the latter as is.

clsFrame aligns the client window so that it is inset from the surrounding decorations (it uses **clBefore** and **clAfter** rather than **clSameAs** in its custom layout child alignment specifications). This prevents the client window from overlapping the borders of some controls.

A visible border on your client window may yield double lines when it is next to other children of the frame.

Notification

44.4

A frame does not know what to do with most messages from controls, so you should never make it the client for controls in your application; instead, your application object should be the client for your controls. Frames receive messages, self-send messages, and notify their clients of messages.

Frames receive messages from their decorations. One way this occurs is through simple button notification. The only example of this is the default frame close corner. **clsFrame** sets the button message of the close corner to be **msgFrameClose** and so it receives this message when the user taps on the close triangle.

Another way a frame responds to user actions in it is through gestures. A frame *receives* forwarded gestures from all its child windows. However, the frame *accepts* forwarded gestures only from its title bar. It forwards forwarded gestures from other child windows to its client. Thus, if you make an **xgsCross** gesture on the title bar, the frame receives this and acts on it, but the frame ignores the same gesture made in other windows, merely passing them on to its client.

Another way a frame responds to user actions in it is through subclass handling of messages. Frames are borders and turn on resizing and dragging, so the user can drag and resize the frame using the functionality provided by **clsBorder**.

Usually the frame doesn't know how to respond to a message, so it forwards the message onto its client. For example, frames don't know what to do with **msgFrameDelete**, so **clsFrame** sends this message to its client.

Like a control, a frame has a client to which it sends some messages. The FRAME_METRICS structure inclues a **client** field. If **clsApp** creates your frame, the client is your application object, or you can set the frame's client to some other object during **msgNew** or with **msgFrameSetClient**.

Frame notifications are not the same as control notifications. The frame client get predefined messages with fixed arguments. Also, if a frame has observers, it sends them some of the same messages that it sends its client.

Table 44-2 summarizes the frame action messages. Remember that resizing and dragging a frame and bringing a frame to the front are handled by **clsFrame**'s ancestor **clsBorder**. Frames respond to recognized gestures in their title bars by sending themselves these frame messages. If **clsFrame** doesn't recognize a gesture in the title bar, it forwards the gesture to the frame's client.

Table 44-2
Frame Action Messages

Message	Description
msgFrameDelete	Sent to self and forwarded to client in response to delete gestures (xgsCross) in the title bar.
msgFrameClose	Sent to frame by its close box.
msgFrameFloat	Sent to self and forwarded to client in response to float gestures (xgs2Tap) in the title bar.
msgFrameZoom	Sent to self and forwarded to client in response to zoom gestures (xgsFlickUp, xgsFlickDown) in the title bar.
msgFrameSelect	Sent to self and forwarded to client in response to selection gestures (xgsPlus) in the title bar.
triple-tap	Upon receiving a triple tap (xgs3Tap), frames currently turn off MaskWrapWidth/Height, and lay out again. This allows windows that the user has resized to resize themselves to their desired size.
triple-flick-up	In the debugging version of the toolkit DLL, frames send msgWinDumpTree to self when you triple-flick upwards on the title bar. In debugging versions of the windows DLL, this prints out an informative dump of the window tree.

clsFrame can perform the bring-to-front operation itself because it inherits from **clsBorder**. But it has to ask its client to do the other actions. For most, it just sends the message to the client and the client must implement the action. For zooming and selecting, **clsFrame** has special protocols.

Selection 44.4.1

The user can select a frame. When a frame receives a forwarded **xgs1Plus** gesture from its title bar, it sends itself **msgFrameSelect**. **clsFrame** responds to this by sending **msgFrameSelectOK** to its client.

When the client receives **msgFrameSelectOK**, the client should determine if it is appropriate to acquire the selection, and acquire the selection if possible by interacting with **theSelectionManager**. If the client is able to acquire the selection, it should send its frame **msgFrameShowSelected** with **true** as the message argument. Conversely, if the frame client detects that the frame has lost the selection, it should send **msgFrameShowSelected** with **false** as the message argument. Usually the frame's client is an application object, and **clsApp** does this for you. By default, you cannot select the frame itself.

When a frame receives **msgFrameShowSelected** it should indicate that it is selected or not, depending on the message argument. **clsFrame** does this by drawing the frame's title bar (if the instance has one) with a double underline.

Zoom 44.4.2

The user can expand frames to fill the screen. This is called **zooming**. When a frame receives a forwarded **xgsFlickUp** or **xgsFlickDown** gesture from its title bar, it checks its **zoomable** style field and the Allow Zooming system preference. If zooming is allowed, it sends itself **msgFrameZoom**. **clsFrame** responds to this by sending **msgFrameZoomOK** to its client.

When the client receives **msgFrameZoomOK**, the client should determine if it is appropriate zoom or unzoom, and set the window to zoom/unzoom to accordingly. **msgFrameZoomOK** takes a FRAME_ZOOM structure. In this the frame specifies:

frame the frame's UID.

up whether it wants to zoom (**up** is **true**) or unzoom (**up** is **false**).

The frame client can either veto the operation (by returning **stsRequestDenied**), or allow it. If the client allows a zoom operation, it must pass back the window to which the frame should zoom to (**toWin**).

If the frame is zooming, then it determines the dimensions of the window to which it is zooming, then sizes and positions itself so that its border and shadow are not visible. To do this, it sends itself **msgBorderGetOuterOffsets**. If the frame is unzooming, it returns to its previous size. The frame also sets its tab bar window to be opaque.

Finally, the frame sends **msgFrameZoomed** to its client and its observers.

Close, Float, Bring-to-Front, Delete 44.4.3

The button message of the close box is **msgFrameClose**, so that when the user taps on it, it will tell the frame to close. Other gestures in title bars map to frame float, close, and delete messages.

clsFrame can't respond to these messages, so it sends them to its client in the hope that the client can implement them. Naturally, **clsApp** can and does.

Filing 44.5

Frames file their state and all their windows. They file their decoration windows if they exist and have **wsSendFile** set in their window style flags. There are some special tricks for menu bars: **clsFrame** checks to see if the frame's menu bar files. If it does not, **clsFrame** will not file the menu bar object, and will file the menu bar style flag as off. Because **clsFrame** inherits from **clsWin**, it will create a default menu bar when it restores. **clsFrame** uses the same trick with command bars and tab bars.

If the client window has **wsSendFile** set, **clsFrame** tells it to file (this behavior also is inherited from **clsWin**). If the frame's notification client is the application, then the frame will restore its client to be the new application UID (using **OSThisApp**). Otherwise, you have to specify the client after a restore.

Frame Menus 44.5.1

You send **msgFrameSetMenuBar** to a frame to change its menu bar, or you can get its metrics and change the **menuBar** UID and style flag.

PenPoint Application Framework and Frames 44.6

Application Main Window 44.6.1

The PenPoint Application Framework has a notion of an application's **main window**. This is the window that the application framework fills a page with, or floats, or embeds in another application. Usually, this is a frame; **clsApp** will create a frame for your application by default. Your application instance can retrieve its frame by sending **msgAppGetMetrics** to self; in the APP_METRICS structure, **mainWin** is the UID of the frame.

Creating a Custom Main Window 44.6.1.1

While processing **msgAppInit**, **clsApp** normally creates a frame. It does this by sending itself **msgAppProvideMainWin**, to which it responds by telling **clsFrame** to create a frame with the standard defaults. If you want to create a different application main window, you have several choices:

- You can create your own frame when your application receives **msgAppInit** (before you **ObjectCallAncestor**), and use **msgAppSetMainWin** to inform **clsApp** about it. When you pass the message to **clsApp**, it will see that the application has a main window already and will leave it alone.
- You can also create your frame when your application receives **msgAppProvideMainWin**.
- You could create your own kind of window altogether instead of a frame, but that's a risky maneouver since there are so many frame messages.
- You can change the frame metrics to have a different set of windows after the frame is created, for example, in **msgAppOpen**.

If your application's frame is a page in the Notebook, the Notebook's window is an ancestor of your frame in the window tree. It captures size changes of notebook pages, and vetoes them. Thus, pages (frames) in the Notebook don't change size unless the user floats them or drags the Notebook's resize handle.

Standard Application Menus 44.6.2

Standard application menus (**SAMs**) are Document, Edit, and the other menus that appear automatically for any instance of **clsApp**.

Applications should use this menu bar since it promotes visual consistency and ease of learning and ease of use. You can disable those menu items that do not apply to your application, and add others.

You can send **msgAppCreateMenuBar** to an application, and **clsApp** will pass back a pointer to a SAM menu bar. If you pass in a pointer to an existing menu, **clsApp** appends the supplied menu to the standard application menus.

clsApp defines unique tags (using **MakeTag(clsApp,** *nnn*)) for the submenus and menu buttons in the standard application menu, such as **tagAppMenuPrint** and **tagAppMenuSelectAll**. These distinguish them from all the other items that could be in an application's menu bar. For the list of common tags, see \PENPOINT\SDK\INC\APPTAG.H.

If some of the items in the SAM are never applicable to your application's current state, you should remove them. If a menu item is sometimes applicable, but is not currently, you can disable it. See the sections on "Control Enable" in the chapters on Controls, Toolkit Tables, and Menus, and Menu Buttons. **clsApp** implements default enabling behavior for some of the SAM items.

Border Adjustment 44.6.2.1

The standard application Document menu has lines in it to break it into sections. It does this by setting top and bottom margins in its menu items (**tkBorderEdgeTop** and **tkBorderEdgeBottom** in **clsTkTable**). If you delete items, the menu break lines may overlap or end the menu. After removing or adding items to the SAMs, you should send **msgTblLayoutAdjustSections** to the menu. This takes a **Boolean** as its message argument; if **true**, the menu will self-send **msgWinLayout** after adjusting its breaks.

Subclasses of Frames 44.7

Option sheets are a special kind of frame. You use them to display the properties, or attributes, of the selected object. If the selected object has several different sets of properties (for example, it is a span of characters, and also a paragraph), then the option sheet has multiple "cards," one for each set of options.

Option sheets are covered in more detail in Chapter 46, Option Sheets.

Chapter 45 / Frame Decorations

Close Box 45.1

clsCloseBox is a descendant of **clsMenuButton**. It implements the small triangular area at the top left of frames. When the user taps on the close box, the frame closes.

Creating a Close Box 45.1.1

Usually you let **clsFrame** create this for you. **clsCloseBox** has no tailorable **msgNew** arguments of its own.

clsFrame sets the close box's message (maintained by **clsButton**) to **msgFrameClose**, so that when the user taps the box, it sends this to its parent.

Notification 45.1.2

Close boxes send button notifications and put up a menu just like a regular menu button. **clsFrame** does not supply a menu and sets the button message to **msgFrameClose**.

clsCloseBox determines whether the user tapped in the shaded part of the triangle: if not, it doesn't send a message. It disables gestures.

Title Bars 45.2

clsTitleBar is a simple subclass of button. It has no instance data or metrics. **clsTitleBar** cemters its string (the document title) relative to the top edge of the frame, so that it includes the close box size in its centering calculation. To get this opportunity, **clsTitleBar** sets self's horizontal alignment to **lsAlignCustom**, and responds to **msgLabelAlign**.

Creating a Title Bar 45.2.1

Normally, you let the frame create a title bar for you. **clsTitleBar** sets its border fields so that when the user taps and holds the pen over the title bar, it goes into drag mode.

User Interface 45.3

If the user has used the Settings notebook to enable, zooming, the user zooms a frame, drawing an flick up | on its title bar, and unzooms it by drawing a flick down | on its title bar.

The user deletes a frame by writing the cross-out χ gesture on its title bar.

Tab Bars 45.4

Creating a Tab Bar 45.4.1

clsTabBar inherits from **clsTkTable**. You specify the buttons in the tab bar as a set of TK_TABLE_ENTRYs. Consequently, the most important field in TAB_BAR_NEW is **tkTable.pEntries**.

In TAB_BAR_NEW_ONLY, you specify:

style various style fields.

incrementalLayout how to re-lay out the tab bar when new tabs are added.

You can get and set the style fields alone using **msgTabBarGetStyle** and **msgTabBarSetStyle**.

clsFrame creates an empty tab bar for you if **tabBar** in the frame style fields is set and the frame doesn't have a UID for a tab bar.

The tab bar window itself is usually invisible. Only the buttons in the tab bar are visible.

Adding Items 45.4.2

You send **msgTkTableAdd...** messages to add tabs to a tab bar. If you set **incrementalLayout** in TAB_BAR_STYLE, then the tab bar will alter its layout to get the new child window inserted correctly, without causing a full re-layout. The latter would "crunch" all the children at one end.

Layout 45.4.3

When there are too many child windows in a tab bar for them all to be fully displayed, **clsTabBar** crunches the children together, causing them to overlap. The user can flick on tabs to rearrange the overlapping of tabs.

clsFrame positions a frame's tab bar carefully so that it is outside the frame's apparent shadow if the frame is not zoomed.

Command Bar 45.5

clsCommandBar is another class inheriting from **clsTkTable**. It creates the command bars at the bottom of option sheets and other floating frames. It turns off gestures in its nested buttons, and sets their button **feedback** style to **bsFeedback3D**. **clsCommandBar** is also used to implement the document cork margin.

There are (currently) no fields in COMMAND_BAR_NEW_ONLY that are interesting for application development. As usual, you specify the buttons in the command bar as a set of TK_TABLE_ENTRYs.

You can use **clsOption** directly to get an option sheet with a close corner and a command bar with **Apply** and **Apply & Close** buttons.

Page Number

45.6

The PenPoint Application Framework tells **clsFrame** to create a page number for Notebook pages.

If the page is floating ("torn out of the Notebook"), the page number is an instance of **clsPageNum**. Page numbers are labels that display a number. The user can flick sideways on the button to increase or decrease the number.

The PenPoint Application Framework changes the page number by getting the frame's metrics, and then sending messages to the page number.

If a page is in the Notebook, the user can navigate to the next page. So the PenPoint Application Framework creates an instance of **clsCounter**. A counter is a variation on page number. It has arrows on either side that the user can tap on to increment or decrement the number. **clsCounter** inherits from **clsTableLayout**.

Page numbers are an esoteric class used internally in the Notebook. For more information, see PAGENUM.H and COUNTER.H.

Shadow

45.7

The shadow drawn by **clsBorder** is inside the window's edge, so if the notched areas are damaged, they may not be painted properly. **clsShadow** displays a true shadow if you set the trueShadow style bit. Frames, a subclass of **clsShadow**, use this feature to draw a true shadow—a transparent painted effect.

clsFrame inherits from **clsShadow**. The frame window itself includes the shadow. It has to do special things to handle its tab bar if it has a shadow.

A shadow is a transparent window and never draws anything. A shadow contains two children and the children draw. The window being shadowed is any kind of border window, which draws in the regular fashion. The shadow window positions it at the top left of itself. The transparent shadow window places a second window behind the border window, slightly below and to the right, to provide a drop-shadow effect. The shadow window sets the second window's **shadow** border style and **shadowGap** border style.

clsShadow inherits from **clsBorder**. **clsBorder** actually draws the shadow, and **clsShadow** just sets some specialized options in BORDER_STYLE to get the right area drawn.

Creating a Shadow

45.7.1

You create a shadow by sending it **msgNew**. In SHADOW_NEW_ONLY, you specify:

- **borderWin** the window to be shadowed.
- **style** various style fields. The only one is:
  - **trueShadow** whether or not to create a separate window for a true shadow effect.

The window being shadowed must be a border window so that **clsShadow** can intercept its setting of its shadow bits and do the right thing.

Chapter 46 / Option Sheets

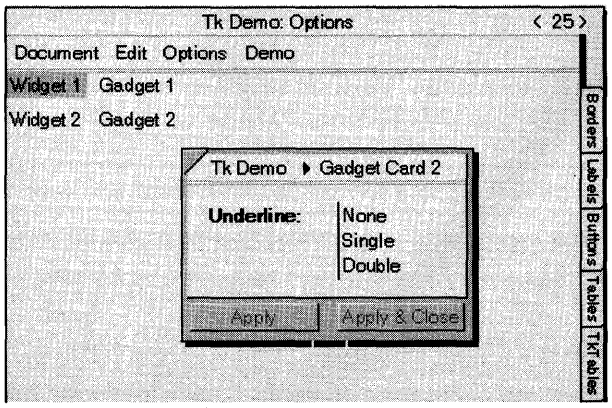
Much of the PenPoint user interface uses a noun-verb, selection-oriented, property sheet interaction model. The user selects something, then makes a gesture (usually a check mark) to see the properties of the selection. **clsOption** and **clsOptionTable** support the standard user interface for displaying the properties of the selected object.

clsOption 46.1

clsOption inherits from **clsFrame;** option sheets are a special kind of frame. You use them to display the properties of the selected object. If the selected object has several different sets of properties (for example, it is a span of characters, and also a paragraph), the option sheet has several windows stacked in it like a deck of cards, each with a menu button in the pop-up choice at the top that allows the user to go to a different set of options. Each of these windows is called an **option card,** although it can be any kind of window.

The frame client window of an option sheet is a scrollwin. This means that option cards you display in the option sheet can be of any size. **clsOption** also uses **clsScrollWin**'s ability to maintain several windows at once while only displaying one.

Figure 46-1
Option Sheets and Option Cards



In this screen shot, note that both **Apply** buttons are gray. The card is not applicable because it is in an option sheet for Gadgets, but a Widget is selected. The **Apply** won't be enabled until the user selects a Gadget. The code to create the option cards shown in this screen shot is from \PENPOINT\SDK\SAMPLE\ TKDEMO\OPTIONS.C.

clsOption Messages

46.2

Table 46-1 summarizes the messages defined by **clsOption**.

Table 46-1
clsOption Messages

Message	Takes	Description
		Class Messages
msgNew	P_OPTION_NEW	Creates an option or command sheet.
msgNewDefaults	P_OPTION_NEW	Initializes the OPTION_NEW structure to default values.
msgSave	P_OBJ_SAVE	Causes an object to file itself in an object file.
msgRestore	P_OBJ_RESTORE	Creates and restores an object from an object file.
		Instance Messages
msgOptionGetStyle	P_OPTION_STYLE	Passes back the style of the receiver.
msgOptionSetStyle	P_OPTION_STYLE	Sets the style of the receiver.
msgOptionGetNeedCards	P_BOOLEAN	Passes back the value of style.needCards.
msgOptionSetNeedCards	BOOLEAN	Sets style.needCards.
msgOptionGetCard	P_OPTION_CARD	Passes back some information about a card in the receiver.
msgOptionGetTopCard	P_OPTION_CARD	Passes back some information about the top card in the receiver.
msgOptionGetCardAndName	P_OPTION_CARD	Passes back some information about a card in the receiver.
msgOptionEnumCards	P_OPTION_ENUM	Enumerates the tags of the cards in the option sheet.
msgOptionSetCard	P_OPTION_CARD	Changes an existing card in the receiver.
msgOptionAddCard	P_OPTION_CARD	Adds a card to the receiver.
msgOptionAddLastCard	P_OPTION_CARD	Adds a the last card of a group to the receiver.
msgOptionAddFirstCard	P_OPTION_CARD	Adds a the first card of a group to the receiver.
msgOptionAddAndInsertCard	P_OPTION_CARD	Adds a card to the receiver and inserts it into the sheet.
msgOptionRemoveCard	P_OPTION_CARD	Removes a card from an option sheet and destroys that card.
msgOptionExtractCard	P_OPTION_CARD	Extracts a card's window from an option sheet.
msgOptionShowCard	P_OPTION_CARD	Causes the given card to be displayed as the current card in the receiver option sheet. Will cause msgOptionRefreshCard to be sent to that card.
msgOptionShowTopCard	VOID	Shows the client-defined top card.
msgOptionGetCards	VOID	Results in msgOptionAddCards to the option sheet's client.
msgOptionApply	nothing	Tells the receiver to initiate the Apply protocol.
msgOptionApplyAndClose	nothing	Tells an option sheet to run the Apply protocol and then close itself.
msgOptionRefresh	nothing	Tells an option sheet to refresh its card settings.
msgOptionApplicable	nothing	Tells an option sheet to ask the top card if it is applicable.

continued

Table 46-1 (continued)

message	Takes	Description
msgOptionDirty	nothing	Tells an option sheet to ask the top card to dirty its controls.
msgOptionClean	nothing	Tells an option sheet to ask the top card to clean its controls.
msgOptionToggleDirty	nothing	Tells an option sheet to toggle the dirty state of the cards.
msgOptionClose	nothing	Tells an option sheet to close itself.
msgOptionGetCardMenu	P_MENU	Passes back the card navigation menu.
msgOptionCardMenuDone	MENU	Indicates the caller is finished with the card menu.
		Client Responsibility Messages
msgOptionShowSheet	P_OPTION_TAG	Asks the client of the option sheet to show the option sheet.
msgOptionProvideCardWin	P_OPTION_CARD	Asks the client of the card to provide the window for the card.
msgOptionProvideTopCard	P_OPTION_CARD	Asks the client of the option sheet to provide the tag for the top card.
msgOptionProvideCardDirty	P_OPTION_CARD	Asks the client of the card to provide the dirtiness of the card window.
msgOptionApplyCard	P_OPTION_CARD	This is sent to a card client when the card should apply its settings.
msgOptionRefreshCard	P_OPTION_CARD	Tells a card client to refresh its settings from the current selection.
msgOptionApplicableCard	P_OPTION_CARD	Asks a card whether it is applicable to the current selection.
msgOptionDirtyCard	P_OPTION_CARD	Sent to a card client when the card should dirty all its controls.
msgOptionCleanCard	P_OPTION_CARD	Sent to a card client when the card should clean all its controls.
msgOptionUpdateCard	P_OPTION_CARD	Sent to a card client every time the card is about to be shown.
msgOptionRetireCard	P_OPTION_CARD	Sent to a card client every time the current shown card is about to be un-shown.
msgOptionClosed	OPTION	Sent to an option sheet's frame client when the sheet is closed.
msgOptionCreateSheet	P_OPTION_TAG	A message to be sent by convention by clients creating option sheets.
msgOptionAddCards	OPTION_TAG	Supplies the second part of the conventional way of creating option sheets. Can be self-sent by an application to fill in a sheet with some cards, and allow subclasses of the sheet creator to modify subclass cards or add different ones.

Creating an Option Sheet 46.3

You send **msgNew** to **clsOption** to create an option sheet. This takes a pointer to an OPTION_NEW structure. This includes all the fields in FRAME_NEW, together with OPTION_NEW_ONLY fields. The fields in OPTION_NEW_ONLY include:

style various style fields, described below.

pCmdBarEntries an optional pointer to a set of TK_TABLE_ENTRYs for the buttons in the command bar, if you want to override the default set.

Option Sheet Styles 46.3.1

In OPTION_STYLE you specify:

senseSelection whether the option sheet should observe **theSelectionManager.**

modality whether the sheet is modal, and if so, whether system- or application-modal.

cardNav whether to use a tab bar along the side of the option sheet frame or the standard pop-up choice to navigate from one card to another.

getCards whether cards are static or dynamic. If dynamic, option sheet will send **msgOptionAddCards** to client when cards are needed.

needCards whether the current list of cards is invalid.

needTopCard whether the top card is invalid.

Manipulating Cards 46.4

clsOption defines messages that support its user interface, including **msgOptionShowCard**, **msgOptionApply**, **msgOptionClose**, and **msgOptionApplyAndClose**.

The API also allows you to add a card to an option sheet, get a card, set a card, and remove a card. All these messages take a pointer to an OPTION_CARD structure as their message arguments. In this, you specify:

option when a card receives an OPTION_CARD structure as an argument, this is the option sheet sending the message.

tag a tag to use for the option card's menu button in the option sheet's pop-up choice.

win the UID of the option card window.

pName a pointer to the name of the card, which also appears in the menu or tab bar button.

nameLen maximum length permitted for **pName.**

client the client of the card that receives apply messages.

clientData arbitrary client data.

You add cards to an option sheet using **msgOptionAddCard**. You specify the UID of the card window, a tag for its tab, a client for the card, and a name for the window (and its tab). Usually, option cards are instances of **clsOptionTable**, which is a kind of toolkit table that implements the standard two-column appearance of option cards. **clsOptionTable** is described below.

You don't have to supply a UID to **msgOptionAddCard**. If the option sheet is about to display a card, and the UID of that card is **objNull**, then **clsOption** will send the card's client **msgOptionProvideCard**.

You can remove a card by sending **msgOptionRemoveCard**. This searches by tag for an option card to remove.

To display a particular card, send **msgOptionShowCard**. Again, this searches by tag for the card to display, then it retrieves the card's window.

You can set card information with **msgOptionSetCard**, and get it with **msgOptionGetCardWin**.

Current Card 46.4.0.1

The displayed card in the option sheet is the client window of the option sheet's scrollwin. Thus, you could determine the current card by sending **msgFrameGetClientWin** to the option sheet to retrieve its scrollwin, then sending **msgScrollWinGetClientWin** to the scrollwin. However, **clsOption** defines **msgOptionGetTopCard** as a more convenient way to get information about the displayed card.

Uniqueness 46.4.0.2

It's very important that the card tag you specify for a card is unique. You can use **MakeTag** specifying your application class or some other well-known class in order to guarantee uniqueness.

You can only reuse the same window for two option cards if you are sure that they cannot both be asked to be on-screen at the same time—one window cannot be inserted at two places!

Layout 46.4.1

When you add a card to an option sheet, it internally converts this to a **msgScrollWinSetClientWin** to set the top window in its scroll window. **clsScrollWin** checks to see if the window is already one of its children. If not, **clsScrollWin** inserts the window in itself and sends **msgWinLayout**.

Painting 46.4.2

The option sheet displays a pop-up choice in its title bar, with a button for each option card. The title bar displays the name of the currently displayed card.

The option sheet displays three buttons in its command bar: **Apply**, **Apply & Close**, and **Close**. You can override these by supplying your own TK_TABLE_ENTRY array in **pCmdBarEntries**.

Notification 46.4.3

Whenever a card is shown (by the user flicking the pop-up choice button, by tapping on its menu, by a client sending **msgOptionShowCard**, or by the card being the visible card), **clsOption** sends the **client** of that card the sequence:

msgOptionApplicableCard

msgOptionProvideCard, if needed

msgOptionRefreshCard, if needed

msgOptionUpdateCard

msgOptionRefreshCard takes the familiar OPTION_CARD message arguments. The client should modify the card as necessary to indicate the properties of the selection. Note that this message is sent each time the card is shown. If **win** is **objNull**, when the option sheet tries to show a card, **clsOption** sends **msgOptionProvideCard** to that card's **client**.

Option sheets can take a long time to lay out, but can be restored from files quickly. For example, you could create a card, insert it, file it, then destroy it.

Usually, the user closes the option sheet by tapping one of the three buttons. However, you can programmatically drive this by sending **msgOptionApply**, **msgOptionApplyAndClose**, or **msgOptionClose**.

When **clsOption** receives **msgOptionApply** or **msgOptionApplyAndClose**, it gets the top option card and sends that card's **client msgOptionApplyCard**. Several cards may have the same client, so the message argument for **msgOptionApplyCard** is a OPTION_CARD structure identifying the option card. The client should figure out the settings of the option card and do whatever it takes to apply them to the selection.

When **clsOption** receives **msgOptionClose**, it sends the frame client of the card **msgOptionClosed**. The client should extract or destroy the card.

Destruction 46.4.4

When you destroy an option sheet, **clsOption** destroys each option card that you defined.

If you want to preserve a card window after the option sheet is destroyed, you can either set its tab's window to **objNull**, or remove the card and its tab with **msgOptionExtractCard**.

Performance 46.4.5

Creating an option sheet and its option cards is fairly slow. You can increase performance by creating option cards and option sheets in advance. When a sheet comes down, you can choose to destroy the sheet or file it, or maybe only save certain cards within the sheet. When your process is terminated, you should either destroy or file any saved sheets or cards.

Another approach is to create option sheets and option cards in process 0 of your application code, then file them as resources. You can then use **msgResFindResource** to read in the option sheet or cards. If the page orientation and default font haven't changed, the windows will not need to be relaid out.

This is a general technique for improving performance; it is also covered in Chapter 31, Concepts and Terminology.

One possible trade-off between memory, start-up time, and display time is to create the option sheet, install each card, but only provide the window for the first card. Tell the option sheet to lay out, then file it with a well-known resource ID. Create and lay out the other cards separately, and save them under separate resource IDs. This way, you can read the option sheet in quickly when needed, since it doesn't have many child windows.

Option Sheet Protocol 46.5

Option sheets must interact with the selection holder so that the currently displayed card shows the correct properties for the selection. Also, the option sheet must notify the correct client if the user chooses to **Apply** changes in properties. Moreover, option sheets are (usually) modeless—while an option sheet is displayed the user may select something else. The option sheet must figure out whether it still applies to the new selection.

The user can display an option sheet by choosing **Options...** from the Edit menu, or by making a check ✓ gesture. The latter changes the selection and refreshes the option sheet if it's already displayed.

Check Gesture Processing 46.6

In order for your option sheets to have the correct behavior, you must follow a complex protocol when using option sheets. To illustrate how this protocol works, here's a run-through of what happens when the user makes a check gesture in an application window. In this example, the gesture is received by **clsMyView**, an application-specific subclass of **clsTextView**. The protocol is the same for any application- or component-level subclass of a built-in window class which attaches meaning to the check gesture.

1. The instance of **clsMyView** receives a check gesture (**msgGWinGesture** with gesture ID of **xgsCheck**) and calls its ancestor **clsTextView**.
2. **clsTextView** determines whether to change the selection. If it does not, the processing resumes with step 4, below.
3. **clsTextView** could go about changing the selection in two ways: either by directly changing the selection, or by self-sending a public message and changing the selection in response to that message. The latter method would allow subclasses like **clsMyView** to get into the game and perhaps do something different.

Suppose **clsTextView** just changes the selection. By default, option sheets have **senseSelection** set in their style fields, and hence, observe **theSelectionManager**. Thus, any displayed option sheets receive **msgSelChangedOwner** when the selection owner changes. Each does step 3a, and processing resumes with step 4.

3a When a displayed option sheet receives **msgSelChangedOwner**, it determines whether the state of its **Apply** and **Apply & Close** buttons should be enabled and active (black) or disabled and inactive (gray). It figures out the new state by:

- Testing whether the new selection owner is in the same process as the sheet. If it is not, the new button state is gray/inactive—option sheets only apply to their own process.
- If the selection owner is in the same process, then the option sheet sends **msgOptionApplicableCard** to the current card. The status value returned determines the new button state: **stsOK** means that **Applying** that option card makes sense for the current selection; **stsFailed** means that it does not.

The card changes its buttons as appropriate. If the selection is in the same process, and the sheet remains applicable, it self-sends **msgOptionDirtyCard**. This indicates to the user that every setting on the card will be applied if the user chooses **Apply**.

4 **clsTextView** now calls its ancestor with the original **msgGWinGesture**. Assuming **gestureForward** is set in the gesture window style fields, **clsGWin** uses **msgGWinForwardedGesture** to pass the check gesture to the parent window of the text view. Most classes should not need to handle the check gesture specially, so they should call ancestor. The gesture message eventually winds up in **clsEmbeddedWin**.

5 The process stops at **clsEmbeddedWin**, because it does not call ancestor when it receives **msgGWinForwardedGesture**. If it's a check gesture, as in this case, then **clsEmbeddedWin** sends the application **msgOptionRefresh**.

6 Application classes usually don't need to respond to **msgOptionRefresh**, because **clsApp** responds by enumerating all the floating windows that inherit from **clsOption** and sending each **msgOptionRefresh**. At this point, each displayed option sheet in the same application has been told to refresh.

7 When an option sheet receives **msgOptionRefresh**, the sheet checks the state of its Apply buttons, and will send the current card **msgOptionRefreshCard** if the Apply buttons are active (and do nothing if they're inactive).

8 **clsEmbeddedWin** then gets the current selection owner (the instance of **clsTextView/clsMyView**) and sends it **msgSelOptions**.

After all this, the processing unwinds back to **clsEmbeddedWin** and finally **clsTextView** (which called ancestor with **msgGWinGesture**).

9 **clsMyView** receives **msgSelOptions** and calls ancestor (**clsTextView**). **clsTextView** checks to see if an option sheet of the correct type is already up (probably by checking a UID in some instance data). If one is, then nothing more needs to be done. If not, then we go to step 12.

10 **clsTextView** self-sends **msgOptionCreateSheet**. It fills in the OPTION_TAG structure with the tag it wants for the option sheet and **objNull** for the option sheet UID. A descendant class like **clsMyView** could choose to intercept **msgOptionCreateSheet** to create its own sheet and plug its UID into **option**. The logic in each class that responds to **msgOptionCreateSheet** should be: if the **option** UID in OPTION_TAG is not **objNull**, then do nothing assuming some descendant created the sheet, otherwise maybe create a sheet.

Assuming that **clsMyView** does not create a custom sheet, othen **msgOptionCreateSheet** reaches **clsTextView** with the UID in **option** still **objNull**. **clsTextView** creates a sheet by sending **msgNew** to **clsOption**.

We now have an option sheet for the selection, but no cards in it.

11 **clsTextView** self-sends **msgOptionAddCards**, passing the option sheet tag and UID. Again, **clsMyView** could add cards to the sheet. The usual handler for **msgOptionAddCards** would first call ancestor, then add/change the cards in the sheet and return.

When the message reaches **clsTextView**, it adds its cards for the paragraph and character options, then **clsMyView** adds its cards, and so forth.

12 The last step **clsTextView** takes in response to **msgSelOptions** is to display the new option sheet by sending **msgAppAddFloatingWin**.

13 The process now unwinds to **clsEmbeddedWin** (which sent **msgSelOptions**), to **clsGWin** (which forwarded the gesture with **msgGWinForwardedGesture**, to **clsTextView** (which called ancestor with the original **msgGWinGesture**), and finally to **clsMyView** (which received the initial check gesture).

When an option sheet comes down, it sends **msgOptionClosed** to its frame client. When the client receives this message, it should use **msgAppRemoveFloatingWin**. It can then send **msgDestroy** to the sheet if it does not want to cache the sheet.

What the Card Client Does 46.6.1

Applicability to the Selection 46.6.1.1

The card's client receives **msgOptionApplicableCard**. It must figure out whether or not the card is applicable to the selection.

A card client can find out whether it can apply protocol to see whether the selection holder recognizes its tag. The card client can send **msgSelOptionTagOK** to the selection holder, passing it its tag. If the selection holder recognizes the tag, and judges that it is applicable to the selection, it should return **stsOK**. This technique relies on you (as the developer of the option sheet) publishing the tags of your option cards as part of your API. In practice, few option cards will be applicable to anything other than their own "native" selection type.

Applying 46.6.1.2

When a card client receives **msgOptionApplyCard**, it should apply all those settings that are dirty (in the **control dirty** sense). To find all its settings, it can either enumerate its child windows or find them by tag, using **msgWinFindTag**. It can send each control **msgControlGetDirty**, and if the argument passed back is **true**, it should apply that setting. The card client must know how to apply the settings to the selection, since it acknowledged **msgOptionApplicableCard**.

The card client will respond with one of the following actions:

- Send a message to the selected object to get its current attributes.
- Change some attributes to the new values in dirty settings on the option card.
- Send a message to the object to set the new attributes.

Multiple Card Types per Object Type 46.6.2

Since the selection owner responding to **msgSelOptions** is at complete liberty to put any cards in the sheet, anything goes. This API does not imply any correspondence between the type of selection and the number of card types.

Indicating Mixed Attributes 46.6.3

Often, the selection may extend to have mixed attributes. For example, the user may select several sentences in which some characters are bold, some are underlined, and some are plain. Should the **Bold** control in the character format option card be on or off?

The option sheet user interface does not indicate whether objects have non-homogeneous attributes. Thus, **Bold** may or may not be on, depending on how **clsText** figures out what the character format is. For example, **clsTextView** might look only at the first character of the selection.

clsOption does keep track of which controls on the card would be applied, and gives the user some visual feedback about this. In this example, the **Bold** control would not be dirty, indicating to the user that it would not be applied to the selection. The user would have to touch that control in order to dirty it and make it apply to the selection. Controls in cards in option sheets should have the **showDirty** control style bit set in order for the visual distinction to show up.

When the card in an option sheet changes from inactive to active (its **Apply** button becomes active), **clsOption** sends **msgOptionDirtyCard** to the current card's client. If the card's client doesn't respond and the card is a toolkit table, **clsOption** sends **msgBorderSetDirty** to the card window. **clsBorder** responds to this by self-sending **msgBorderSetDirty**.

Nested Components 46.6.4

Applying an option sheet will work across nested components that are in the same process, so long as every object associated with a sheet is in the process that created the sheet.

Multiple Option Sheets Up at Once 46.6.5

It is up to the components (such as **clsTextView**) that receive **msgSelOptions** to figure out whether to use an existing displayed option sheet or to create a new one.

Dimmed Controls 46.6.6

Card clients can mark their controls as dirty to indicate whether or not they apply to the current selection.

Selection Interaction 46.6.7

While an option sheet is up, the user may select items in the option sheet. The option sheet preserves the selection using **msgSelPromote** and **msgSelSetOwnerPreserve**.

Option Tables 46.7

You are free to put any kind of window in an option sheet. However, the *PenPoint UI Guidelines* encourage you to use a standard style for the appearance of an option card. Typically, each of the "cards" in an option sheet is a table of option settings. These adopt a standard form with a label on the left and the component to the right, baseline-aligned.

clsOptionTable supports this layout. It inherits from **clsTkTable**. It organizes toolkit components on the card as a table of label-item pairs. It sets the default toolkit table style to be a bold label, and sets the table layout to be two column.

All **clsOptionTable** does is set up the appropriate table layout defaults in **msgNewDefaults**. It has no **msgNew** arguments of its own. Use **clsTkTable** messages to add and remove items in an option table.

Code to create a complex nested option table is in \PENPOINT\SDK\SAMPLE\TKDEMO\OPTIONS.C and is excerpted in Chapter 32, Toolkit Tables.

Command Sheets 46.8

Command sheets are just like option sheets except that they have different buttons in the command bar at the bottom of the frame. The format of an option sheet is useful even if you don't need the entire API for **Apply**, **Apply & Close**, **Close**, and so on. Consequently, there is no separate class for a command sheet.

The **Export**, **Import**, and **Search** and **Replace** dialogs are examples of command sheets.

Creating a Command Sheet

46.8.1

All you need to do is supply a TK_TABLE_ENTRY array in **option.pCmdBarEntries** which specifies the buttons in the command bar. By default, this is **pNull**, and **clsOption** creates the standard **Apply/Apply & Close** command bar. **clsOption** sets the client for the buttons in the command bar to be the frame's client.

If you don't want to play with all the selection protocols, you can turn off **senseSelection** in OPTION_STYLE. If the frame doesn't have multiple tabs and client windows, doesn't need to scroll its client window, and doesn't interact with the selection, then you're better off getting the same visual appearance by modifying a standard frame.

Chapter 47 / Icons

clsIcon draws a picture and some text in a label. PenPoint uses icons extensively in the icon bookshelf below the Notebook, and in the browser windows of the Disk Viewer and tables of contents.

Icons inherit from **clsMenuButton**. An icon displays a picture as well as a string. It can have a pop-up menu associated with it.

Messages

47.1

Table 47-1 summarizes the messages defined by clsIcon.

Table 47-1
clsIcon Messages

Message	Takes	Description
		Class Messages
msgNew	P_ICON_NEW	Creates an icon window.
msgNewDefaults	P_ICON_NEW	Initializes the ICON_NEW structure to default values.
		Instance Messages
msgIconGetStyle	P_ICON_STYLE	Passes back the current style values.
msgIconSetStyle	P_ICON_STYLE	Sets the style values.
msgIconGetPictureSize	P_SIZE16	Passes back the picture size.
msgIconSetPictureSize	P_SIZE16	Sets the picture size.
msgIconGetActualPictureSize	P_SIZE16	Computes and passes back the actual picture size.
msgIconFreeCache	pNull	Frees the cached picture, if any.
msgIconGetRects	P_RECT32	Passes back the bounds for the picture in pArgs[0] and the label in pArgs[1].
		Client Notification Messages
msgIconProvideBitmap	P_ICON_PROVIDE_BITMAP	Sent to control client when icon needs the picture bitmap.
msgIconCopyPixels	P_ICON_COPY_PIXELS	Causes the icon to copy pixels from pArgs–>srcWin to a pixelmap.
msgIconSampleBias	P_ICON_SAMPLE_BIAS	Computes the sample-biased size for a given picture size.

Creating 47.2

The icon's string is maintained by **clsLabel**. You specify it in the LABEL_NEW_ONLY arguments. You don't specify the picture at creation; instead, you specify the **picture style**.

In ICON_NEW_ONLY, you specify:

style the style of the icon.

pictureSize the picture size in device units.

The fields in ICON_STYLE include:

transparent whether the icon background should be transparent.

picture the type of picture in the icon.

freeBitmap whether to send **msgDestroy** to the bitmap after providing the icon.

open whether to modify the picture to make the icon look as though the user has opened the icon by tapping it.

sizeUnits the units in which **pictureSize** is specified. This can be **bsUnitsDevice** or **bsUnitsLayout**, as defined in BORDER.H.

sampleBias whether to round the icon size to a multiple of the bitmap size.

aspect how to determine the aspect ratio of the picture. Possible values are **isAspectWidthFromHeight** (compute width based on sample size and height), **isAspectHeightFromWidth** (compute Height based on sample size and width), and **isAspectAsIs** (use the sample height and width as is).

The **picture** field in ICON_NEW_ONLY's **style** field indicates the style of picture for the icon. The possible picture styles are:

isPictureBitmap the picture is in a bitmap.

isPictureNone there is no picture.

isPicturePixelmap the picture is a pixelmap.

Bitmap Picture 47.2.1

If the **picture** style is **isPictureBitmap**, then **clsIcon** sends the icon's client **msgIconProvideBitmap** when it needs the bitmap for the icon. **clsIcon** fills in a ICON_PROVIDE_BITMAP structure for the message arguments, specifying:

icon the UID of the icon requiring a bitmap.

tag the tag of the icon requiring a bitmap.

device the device on which the bitmap will be rendered.

pictureSize the size of the picture.

You should pass back a bitmap optimized for **device** and for size. In practice, the two common icon sizes are ten layout units and 21 layout units. The constants **iconSizeSmall** and **iconSizeNormal** define these two sizes. **clsIcon** uses the sampled image operator to render it into a cached image, so your image will be scaled and dithered if your bitmap isn't the right size or depth.

If **freeBitmap** is **true**, **clsIcon** will free the **bitmap** you pass back. This is useful if you read the bitmap in from a resource file.

clsBitmap is a useful class for storing sampled images as objects. It and the sampled image operator are described in *Part 3, Windows and Graphics.*

Pixelmap Picture 47.2.2

If the **picture** style is **isPicturePixelmap**, then you can get **clsIcon** to grab its picture from the pixels of some window. You do this by sending **msgIconCopyPixels** to the icon. This takes an ICON_COPY_PIXELS structure, in which you specify:

srcWin	the source window to copy pixels from.
srcXY	the origin of the area to copy, in LWC of the source window.

clsIcon gets the icon's picture from the pixels in **srcWin**. It pulls in the same number of pixels as you specified for the icon size.

Now, the pixels in the area of the source window to be copied may not all be visible. **clsIcon** forces any hidden areas of the source window to repaint, even if in front of of other windows, in order to get the pixels for its image.

Painting 47.3

clsIcon uses the bitmap caching facilities of the Windows and Graphics system to get good performance.

Invalidation 47.3.1

When it is about to paint an icon's picture, **clsIcon** checks to see if it has a cached picture. If the picture is not cached, it sends **msgIconProvideBitmap** to its client if the **picture** style is **isPictureBitmap**. If **clsIcon** does have a cached image, it checks the orientation and resolution of the output device. If these have changed, the cached image is no good any more, so **clsIcon** invalidates it.

You can programmatically invalidate the cached picture by sending **msgIconFreeCache**.

Notification 47.4

Icons can have an associated pop-up menu. The icons below the Notebook do not have a menu, so they only send their button notification messages, but you can supply a menu.

Layout 47.5

The various layouts of icons are controlled by **clsLabel**'s alignment style flags. If the label alignment is **lsAlignCenter**, the string appears below the icon. If the alignment is **lsAlignRight** or **lsAlignLeft**, the string appears to the side of the icon.

Chapter 48 / Trackers and Grab Boxes

Trackers provide transient drawing feedback while the user is dragging the pen, such as when resizing or moving objects. **clsTrack** handles some simple rectangular drawing styles directly, but it sends client notifications so that you can draw any figure in response to pen movements.

Note that trackers draw, but aren't windows.

To track the pen, trackers grab input.

clsTrack has several style flags specifically for drawing frames. If you drag or resize a floating document or option sheet, notice how the outline includes the tab bar and command bar.

Table 48-1 summarizes the messages defined by **clsTrack**.

Table 48-1
clsTrack Messages

Message	Takes	Description
		Class Messages
msgNew	P_TRACK_NEW	Creates a tracker.
msgNewDefaults	P_TRACK_NEW	Initializes the TRACK_NEW structure to default values.
		Instance Messages
msgTrackGetStyle	P_TRACK_STYLE	Passes back current style values.
msgTrackSetStyle	P_TRACK_STYLE	Sets style values.
msgTrackGetMetrics	P_TRACK_METRICS	Passes back the current metrics.
msgTrackSetMetrics	P_TRACK_METRICS	Sets the metrics.
msgTrackStart	P_XY32	Starts the tracker.
		Client Messages
msgTrackDone	P_TRACK_METRICS	Sent to metrics.client when the track is done.
msgTrackUpdate	P_TRACK_METRICS	Sent to metrics.client when the pen moves.
		Third-Party Notification Messages
msgTrackProvideMetrics	P_TRACK_METRICS	Sent to a tracker client before tracker is created.
		Self-Sent Messages
msgTrackConstrain	P_XY32	Constrains a point.
msgTrackShow	P_TRACK_METRICS	Displays the tracker visuals at pArgs->rect.
msgTrackHide	P_TRACK_METRICS	Removes the tracker visuals at pArgs->rect.
msgInputEvent	P_INPUT_EVENT	Notification of an input event.

Drawing 48.1

If you set **tsDrawViaMessages**, the tracker forwards **msgTrackShow** and **msgTrackHide** to its client. These take TRACK_METRICS as their message arguments. From these the client can figure out what to draw.

Notification 48.2

If you set **tsDrawViaMessages**, you receive **msgTrackUpdate**. The tracker passes you a pointer to a TRACK_METRICS structure that gives you enough information to paint appropriate feedback.

Between each **msgTrackUpdate**, you receive **msgTrackHide**. You must remove the old tracker visuals. The most common way to do this is to draw dynamically using XOR or **sysDcDrawDynamic**.

At pen-up, you receive **msgTrackDone**.

Destruction 48.3

If **autoDestroy** is set in the tracker's style field, it will destroy itself when it's done (on pen up).

You can create a tracker on the fly, or keep the object around for reuse. A tracker maintains a drawing object in order to draw on the screen, which is a large object.

Grab Boxes 48.4

Grab boxes are objects that implement the pop-up handles on borders. **clsGrabBox** uses **clsTrack** internally. Border windows use grab boxes to handle resizing. Grab boxes draw, but aren't windows.

clsBorder watches for pen proximity events and checks the location of the pen to see if it falls in certain "hot" regions. If so, **clsBorder** creates a grab box to track the pen.

It's unlikely that you would ever want to use **clsGrabBox** directly, but Table 48-2 summarizes the messages and procedures defined by **clsGrabBox**.

Table 48-2
clsGrabBox Messages and Procedures

Message	Takes	Description
		Class Messages
msgNew	P_GRAB_BOX_NEW	Creates a grab box object.
msgNewDefaults	P_GRAB_BOX_NEW	Initializes the GRAB_BOX_NEW structure to default values.
		Instance Messages
msgGrabBoxGetStyle	P_GRAB_BOX_STYLE	Passes back current style values.
msgGrabBoxSetStyle	P_GRAB_BOX_STYLE	Sets style values.
msgGrabBoxGetMetrics	P_GRAB_BOX_METRICS	Passes back current metrics.
msgGrabBoxSetMetrics	P_GRAB_BOX_METRICS	Sets metrics.
msgGrabBoxShow	P_GRAB_BOX_INFO	Puts up or takes down the grab box.
		Procedures
GrabBoxIntersect()		Determines where pRect is in win. Returns a grab box location, for example, gbLocLRCorner.
GrabBoxLocToRect()		Computes the rectangle of the grab box at the given location.
GrabBoxPaint()		Paints the grab box at the specified location.
		Messages from Other Classes
msgInputEvent()	P_INPUT_EVENT	Notification of an input event.
msgTrackDone()	P_TRACK_METRICS	Sent by a tracker when it's done.

Chapter 49 / Progress Bars

clsProgressBar is a descendant of **clsControl** that implements a progress indicator in the form of a dynamic bar graph. A progress bar's major axis can be horizontal or vertical, with or without tick marks. Progress bars can also include numeric or custom labels indicating the maximum, minimum, and current values represented by the progress bar. Additionally, **clsProgressBar** supports flexible layout for the dimensions and units of the bar itself and its associated labels, if any.

The following topics are covered in this chapter:

- Progress bar concepts.
- Progress bar style and metrics structures.
- How to use **clsProgressBar** messages.
- Some messages **clsProgressBar** inherits from ancestor classes.

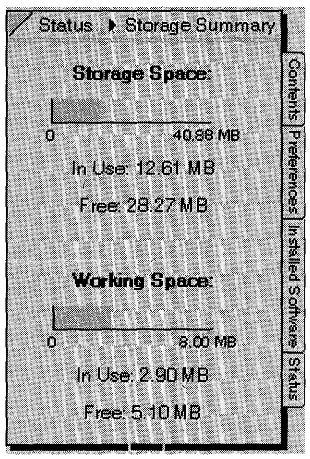
Progress Bar Concepts 49.1

A **progress bar** is a visual indicator of a **value** relative to its minimal and maximal possible values. It represents this information in the form of a bar graph. The **major axis** of the progress bar is a line representing a range of possible values, from zero to an arbitrary **maximum value**. A gray bar called the **filled region** extends from zero to a point on the axis corresponding to the represented value. That is, if the represented value is one third of the maximum value, then the filled region is one third the length of the major axis. The **minor axis** of the progress bar is a line extending from the zero end of the major axis through the thickness of the filled region.

You can include decoration including tick marks and labels. **Tick marks** mark regular intervals along the major axis of a progress bar. **labels** are strings identifying the minimum and maximum values represented. You can specify numeric labels or you can have the progress bar query its client for custom labels, arbitrary strings to identify the minimum and maximum values. You can control the color of the filled region as well as the remainder of the progress bar rectangle, the **unfilled region**. Also, you can specify what combination of top, bottom, left, and right **edges** of the rectangle the progress bar should draw.

Figure 49-1 shows a progress bar indicating the amount of disk space and memory available in the system. The major axis represents the range of possible values, from zero to the total amount of memory installed. The gray filled region represents the number of megabytes still available in the system. If more memory is consumed, the filled region will shrink to indicate the reduction in available memory.

Figure 49-1
Progress Bars



Storage Space:

0 40.88 MB

In Use: 12.61 MB

Free: 28.27 MB

Working Space:

0 8.00 MB

In Use: 2.90 MB

Free: 5.10 MB

The minimum internal value of a progress bar is zero. It is up to the client of the progress bar to map actual values to a scale that begins at zero, but the labels may indicate the actual values represented by that scale. If numeric values are not sufficient (for example, if you wish to display units as in the figure), you can instruct the progress bar to ask its client to specify **custom labels**, arbitrary strings that the progress bar will display.

Progress Bar Style and Metrics 49.2

Like many toolkit classes, progress bars have associated style and metrics structures that define or modify its behavior and appearance. Each instance of **clsProgressBar** maintains its own set of metrics in a PROGRESS_METRICS structure. The first field in a PROGRESS_METRICS structure is an inline PROGRESS_STYLE structure called **style**. This section describes the meaning of the PROGRESS_STYLE fields, then the remaining PROGRESS_METRICS fields.

The PROGRESS_STYLE Structure 49.2.1

The **style** field of a PROGRESS_METRICS structure describes the overall visual style of a progress bar in an inline PROGRESS_STYLE structure. A PROGRESS_STYLE structure describes only the overall visual style of a progress bar, not the values and measurements that make it meaningful.

A PROGRESS_STYLE structure includes the following bit fields:

Table 49-1
PROGRESS_STYLE Styles

Styles/Style Values	Functional Description
labels	Describes what kind of label to use for a progress bar.
psLabelsNumeric	Use numberic labels. The default.
psLabelsNone	Do not display labels.
psLabelsCustom	Query client with msgProgressProvideLabel to determine text of text of labels.
ticks	Determines kind of tick marks to paint along the major axis.
psTicksSmall	Use small tick marks. The default.
psTicksFull	Use full-height tick marks.
psTicksNone	No tick marks.
direction	Determines the orientation of the major axis, relative to the system.
psDirectionHorizontal	Horizontal (left-to-right axis). The default.
psDirectionVertical	Vertical (bottom-to-top axis).
units	Determines the units with which to scale progress bar components other than the labels.
bsUnitsPoints	The default. But any of the clsBorder unit specifications can be used. Note that progress bar labels have a scale value, labelScaleUnits, which is independent of units.
thickness	Determines the tick mark thickness style.
psThicknessRelFont	Thickness varies with size of system font.
psThicknessFixed	Thickness is fixed.
labelRotation	Determines the angle at which to draw the label text.
lsRotationNone	The default. But any of the clsLabel rotation specifications are available.
labelScaleUnits	Determines the units with whch to scale progress bar labels.
bsUnitsLayout	The default. But any of the clsBorder unit specifications can be used. Note that value is independent of units, which control the scale of progress bar components other than the labels.
edge	Determines which edges of the progress bar to draw. Edges are pixels next to the inner rectangle occupied by the filled and unfilled region regions (the inner rectangle does not intersect with the edge). Can be default, or any combination of the other flags.
psEdgeNone	No edges drawn.
psEdgeMinLat	Draw edge perpendicular to the major axis at the minimum value.
psEdgeMaxLat	Draw edge perpendicular to the major axis at the maximum value.
psEdgeMinLong	Draw the bottom edge on horizontal progress bars, or the right edge on vertical progress bars.
psEdgeMaxLong	Draw the top edge on horizontal progress bars, or the left edge on vertical progress bars.
psEdgeAll	All edges drawn. The default.
labelFontType	Determines what font to use for displaying the labels.
lsFontSystem	The default. But any of the clsLabel font specifications can be used.

Progress Bar Metrics

49.2.2

In addition to the overall visual style a PROGRESS_STYLE structure describes, a progress bar is further defined by a number of measurements and values. The PROGRESS_METRICS structure holds this information. The first field of a PROGRESS_METRICS structure is an in-line PROGRESS_STYLE structure called **style**. Thus, a PROGRESS_METRICS structure contains all of the information in a PROGRESS_STYLE structure, as well as additional information that defines the remaining metrics.

A PROGRESS_METRICS structure includes the following fields (data types are in parentheses):

style (an in-line PROGRESS_STYLE structure) PROGRESS_STYLE is described above.

numIntervals (S32) how many tick marks to include along the major axis.

ticksPerLabel (S32) how frequently to attach a label to tick marks. For example, if you set **ticksPerLabel** to 5, then every fifth tick mark will have a numeric label.

minNumericLabel (S32) the value of the numeric label to identify the minimum value. This value is ignored unless **style.labels** is **psLabelsNumeric**.

maxNumericLabel (S32) the value of the numeric label to identify the maximum value. This value is ignored unless **style.labels** is **psLabelsNumeric**.

thicknessBase (U16) the thickness of the progress bar, perpendicular to the major axis. If **style.thickness** is **psThicknessRelFont**, **thicknessBase** is a multiplier against the system font size. If **style.thickness** is **psThicknessFixed**, **thicknessBase** is a fixed number of **style.units**.

latitude (U16) when the progress bar is shrink-to-fit along the minor axis, the minimum size of the minor axis in **style.units**.

longitude (U16) when the progress bar is shrink-to-fit along the major axis, the minimum size of the major axis in **style.units**.

maxvalue (S32) the maximum internal value of the progress bar. Although progress bar labels may display any range of values, the internal value is always between zero and **maxvalue**, inclusive. It is the client's responsibility to map the represented value to a zero-based scale.

value (S32) the current value of the progress bar. See the note above regarding mapping the represented value to a zero-based scale.

Progress Bar Messages 49.3

Table 49-2 summarizes the messages defined by **clsProgressBar**. The following text describes these messages in more detail.

Table 49-2
clsProgressBar Messages

Message	Takes	Description
		Class Messages
msgNew	P_PROGRESS_NEW	Creates a progress indicator.
msgNewDefaults	P_PROGRESS_NEW	Initializes the PROGRESS_NEW structure to default values.
		Style and Metrics Messages
msgProgressGetStyle	P_PROGRESS_STYLE	Passes back the current style.
msgProgressSetStyle	P_PROGRESS_STYLE	Sets the style.
msgProgressGetMetrics	P_PROGRESS_METRICS	Passes back the current metrics.
msgProgressSetMetrics	P_PROGRESS_METRICS	Sets the metrics.
		Region Messages
msgProgressGetFilled	P_PROGRESS_REGION	Passes back the current filled region color and pattern.
msgProgressSetFilled	P_PROGRESS_REGION	Sets the current filled region color and pattern.
msgProgressGetUnfilled	P_PROGRESS_REGION	Passes back the current unfilled region color and pattern.
msgProgressSetUnfilled	P_PROGRESS_REGION	Sets the current unfilled region color and pattern.
msgProgressGetVisInfo	P_PROGRESS_VIS_INFO	Passes back information about the current size of the filled and unfilled regions.
		Client Responsibility Messages
msgProgressProvideLabel	P_PROGRESS_PROVIDE_LABEL	When style.labels is psLabelsCustom, sent to client when progress bar labels are required.

Creating a Progress Bar 49.3.1

You create a progress bar just as you create any other PenPoint object:

1. Send **msgNewDefaults** to **clsProgressBar** to fill a PROGRESS_NEW structure with default values.
2. Modify the default **metrics** and **style** fields, if necessary.
3. Send **msgNew** to **clsProgressBar**, with a pointer to the modified PROGRESS_NEW structure as its argument.

When **msgNew** completes successfully, the PROGRESS_NEW structure contains the UID of the new progress bar. When you send a message to an object, you identify the object by its UID.

Manipulating Style and Metrics Fields 49.3.2

The purpose of the **style** and **metrics** fields is described earlier in this chapter. This section explains how to manipulate the style and metrics fields to read and modify characteristics of the progress bar.

Determining Progress Bar Style 49.3.2.1

To determine the state of the progress bar **metrics.style**:

1. Declare a PROGRESS_STYLE structure.
2. Send **msgProgressGetStyle** to the progress bar, with a pointer to the PROGRESS_STYLE structure as its argument.

When **msgProgressGetStyle** completes successfully, the PROGRESS_STYLE structure will reflect the state of the progress bar **style** at the time you sent **msgProgressGetStyle.**

Modifying Progress Bar Style 49.3.2.2

To modify the state of the progress bar **metrics.style**:

1. Declare a PROGRESS_STYLE structure.
2. Set the fields of the PROGRESS_STYLE structure to reflect the desired progress bar **style.**
3. Send **msgProgressSetStyle** to the progress bar, with a pointer to the PROGRESS_STYLE structure as its argument.

When the progress bar receives **msgProgressSetStyle,** it sets all of its **style** fields equal to those of the referenced PROGRESS_STYLE structure. If necessary, the progress bar will set its layout bit dirty (as if with **msgWinSetLayoutDirty**) or send itself **msgWinDirtyRect** after you modify its style. However, it is the client's responsibility to send **msgWinLayout** to the progress bar when the style change might affect the layout.

If you wish to set just a subset of the **style** fields, you must first initialize the PROGRESS_STYLE structure with **msgProgressGetStyle,** make the necessary changes to the structure, then use the structure with **msgProgressSetStyle** to set the progress bar **style.**

Determining Progress Bar Metrics 49.3.2.3

To determine the state of the progress bar **metrics**:

1. Declare a PROGRESS_METRICS structure.
2. Send **msgProgressGetMetrics** to the progress bar, with a pointer to the PROGRESS_METRICS structure as its argument.

When **msgProgressGetMetrics** completes successfully, the PROGRESS_METRICS structure will reflect the state of the progress bar **metrics** at the time you sent **msgProgressGetStyle.**

Modifying Progress Bar Metrics 49.3.2.4

To modify the state of the progress bar **metrics**:

1. Declare a PROGRESS_METRICS.
2. Set the fields of the PROGRESS_METRICS structure to reflect the desired progress bar **metrics**.
3. Send **msgProgressSetMetrics** to the progress bar, with a pointer to the PROGRESS_METRICS structure as its argument.

When the progress bar receives **msgProgressSetMetrics**, it sets its **metrics** fields equal to those of the referenced PROGRESS_METRICS structure. If necessary, the progress bar will set its layout bit dirty (as if with **msgWinSetLayoutDirty**) or send itself **msgWinDirtyRect** after you modify its **metrics**. However, it is the client's responsibility to send **msgWinLayout** to the progress bar when the style change might affect the layout.

If you wish to set just a subset of the **metrics** fields, you must first initialize the PROGRESS_METRICS structure with **msgProgressGetMetrics**, make the necessary changes to the structure, then use the structure with **msgProgressSetMetrics** to set the progress bar **metrics**.

You can read and modify **metrics.value** independently with **msgControlGetValue** and **msgControlSetValue**.

Manipulating Region Appearance 49.4

The main body of the progress bar indicator is composed of the **filled region** and the **unfilled region**. The filled region represents the value of the progress bar; its length in relation to the major axis is proportional to the progress bar's current value in relation to its maximum value. The unfilled region fills the rest of the progress bar's inner rectangle. By default, the filled region color is set to **sysDcRGBGray66**, with pattern **sysDcPatForeground**. The unfilled region defaults are **sysDcRGBTransparent** with pattern **sysDcPatNil**.

The ***edges*** of the progress bar do not intersect the inner rectangle containing the regions.

Structures for Manipulating Regions 49.4.1

The following sections explain how to manipulate the region colors and patterns, and how to determine the size of both regions. The messages for reading and modifying these data do not let you reach into the internals of the progress bar. Instead, the arguments are passed in structures designed for passing the information into and out of the progress bar. PenPoint provides two data structures for this purpose: PROGRESS_REGION for color and pattern data, and PROGRESS_VIS_INFO for region size information.

Region Color and Pattern 49.4.1.1

The PROGRESS_REGION structure has two fields (field data types are shown in parentheses):

rgb	(U32) the RGB color of the region.
pattern	(SYSDC_PATTERN) the pattern of the region.

Region Size 49.4.1.2

The PROGRESS_VIS_INFO structure also has two fields:

filledRect (RECT32) the rectangle of the filled region.

unfilledRect (RECT32) the rectangle of the unfilled region.

Determining Region Color and Pattern 49.4.1.3

To determine the color and pattern of the filled region:

1. Declare a PROGRESS_REGION structure.
2. Send **msgProgressGetFilled** to the progress bar, with a pointer to the PROGRESS_REGION structure as its argument.

When **msgProgressGetFilled** completes successfully, the PROGRESS_REGION structure will reflect the color and pattern of the filled region at the time you sent **msgProgressGetFilled**.

To determine the color and pattern of the unfilled region, follow the same steps, but use **msgProgressGetUnfilled** instead of **msgProgressGetFilled**.

Modifying Region Color and Pattern 49.4.2

To modify the color and pattern of the filled region:

1. Declare a PROGRESS_REGION structure.
2. Set the fields of the PROGRESS_REGION structure to reflect the desired color and pattern.
3. Send **msgProgressSetFilled** to the progress bar, with a pointer to the PROGRESS_REGION structure as its argument.

When the progress bar receives **msgProgressSetFilled**, it sets its filled region color and pattern equal to those in the referenced PROGRESS_REGION structure. The progress bar will send itself **msgWinDirtyRect** as necessary. However, it is the client's responsibility to send **msgWinLayoutSelf** to the progress bar.

If you wish to modify just the color or the pattern, you must first initialize the PROGRESS_REGION structure with **msgProgressGetFilled**, make the necessary changes to the structure, then use the structure with **msgProgressSetFilled** to set the filled region color and pattern.

To modify the color and pattern of the unfilled region, follow the same steps, but use **msgProgressGetUnfilled** instead of **msgProgressGetFilled**.

Determining Region Bounds 49.4.3

To determine progress bar value, use **msgControlGetValue**.

It is possible to determine the sizes of the filled and unfilled regions, using **msgProgressGetVisInfo**. To determine the sizes of the filled and unfilled regions:

1. Declare a PROGRESS_VIS_INFO structure.
2. Send **msgProgressGetVisInfo** to the progress bar, with a pointer to the PROGRESS_VIS_INFO structure as its argument.

When **msgProgressGetFilled** completes successfully, the two rectangles (RECT32s) within the PROGRESS_VIS_INFO structure will reflect the origins and sizes of the filled and unfilled regions at the time you sent **msgProgressGetVisInfo**.

Responsibilities of Progress Bar Clients 49.5

The client of a progress bar has two primary responsibilities:

- To send **msgWinLayoutSelf** to the progress bar when appropriate (the progress bar properly maintains its layout and dirty bits).
- When using custom labels (**style.labels** is **psLabelsCustom**), to provide label strings to the progress bar when the progress bar requests them.

Part 3: Windows and Graphics provides more information on layout and window repainting. The remainder of this section explains the protocol for providing custom labels.

Providing Custom Labels 49.5.1

If you write code that uses a progress bar, your code is a **client** of the progress bar. A progress bar provides a lot of service on its own. For example, if you request it to display numeric labels (**style.labels** is set to **psLabelsNumeric**), you can specify numbers to label the minimum and maximum values. The progress bar will handle the work of converting the numbers to labels and rendering them in the label font. If you ask it to, it will even create a series of numeric labels at intervals along the major axis.

However, if you tell the progress bar that you want custom labels (**style.labels** is set to **psLabelsCustom**), it cannot guess at what the labels should be. The progress bar does as much as it can, but it must call on the client for the actual text of the labels. The client must respond with this information on demand, since the progress bar may ask for it at any time.

PenPoint provides the PROGRESS_PROVIDE_LABEL structure to facilitate the custom label protocol between the progress bar and its client. The PROGRESS_PROVIDE_LABEL structure includes the following fields (field data types are shown in parentheses):

progressBar (CONTROL) the progress bar requesting the custom label string.

position (U16) the major axis position of the label (zero at a minimum).

pString (P_CHAR) a pointer to a 256-byte buffer which the progress bar provides to hold the label string.

When a progress bar needs a custom label, it creates a pointer to a PROGRESS_PROVIDE_LABEL structure. The progress bar sets the **progressBar** field to its own UID, the **position** field to the major axis value for which the label is required, and the **pString** field to point to a 256-byte buffer. The progress bar then sends **msgProgressProvideLabel** to the client, with a pointer to the PROGRESS_PROVIDE_LABEL pointer as its argument.

When a progress bar client receives **msgProgressProvideLabel**, it should check the **progressBar** and **position** fields of the PROGRESS_PROVIDE_LABEL structure to determine what the label string should be. The client should then copy the label string into the buffer to which **pString** points. At that point, the progress bar can take over, converting the string to a label and drawing it in the label font, just as it does with numeric labels.

Custom labels can be no longer than 256 characters, including the terminating null.

Useful Inherited Messages

49.6

Like most UI Toolkit classes, **clsProgressBar** inherits from a chain of ancestor classes. For **clsProgressBar**, this chain begins at **clsObject** and continues through **clsWin**, **clsGWin**, **clsEmbeddedWin**, **clsBorder**, and **clsControl**. You can read about these ancestors of **clsProgressBar** in more detail in other chapters, but Table 49-3 summarizes a few useful messages **clsProgressBar** inherits from these classes.

Table 49-3
Useful Inherited Messages

Message	pArgs	Description
msgControlGetValue	P_S32	Passes back the progress bar's value.
msgControlSetValue	S32	Sets the progress bar's value. The progress bar will self send msgWinDirtyRect as necessary.
msgSave	P_OBJ_SAVE	Causes the progress bar to file itself in an object file.
msgRestore	P_OBJ_RESTORE	Creates and restores a progress bar from an object file.
msgWinLayoutSelf	P_WIN_METRICS	Tells the progress bar to recompute its layout parameters.

If the progress bar that is shrink-to-fit in either dimension receives **msgWinLayoutSelf**, it will use the **latitude** or **longitude** metric, as appropriate, to determine the interior dimension of the progress bar (this does not include the inked edges of the bar). If the progress bar is not shrink-to-fit in a dimension, it ignores the corresponding **latitude** or **longitude** metric.

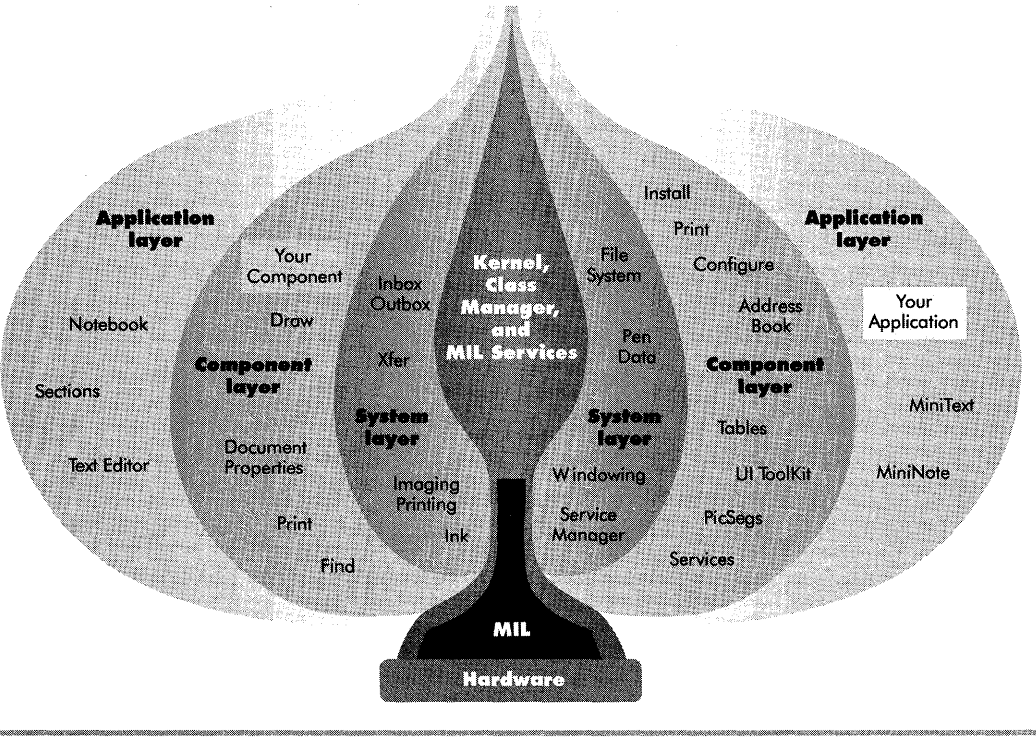
Part 5 / Input and Handwriting Translation

PENPOINT ARCHITECTURAL REFERENCE / VOL I
PART 5 / INPUT AND HANDWRITING TRANSLATION

Chapter 50 / Introduction

The PenPoint™ operating system is distinguished by its unique pen-driven user interface. PenPoint provides user interface tools such as gesture windows and insertion pads that your applications incorporate to recognize pen-based commands and to capture handwritten text. You use three PenPoint subsystems to implement this technology in your applications: input, windows and graphics, and handwriting translation. PenPoint is designed to handle device driver input from the pen and from other types of hardware that may be connected to the PenPoint computer. PenPoint fully supports keyboard and hardware timer events, and it has the flexibility to interface to third-party device drivers. Figure 50-1 shows the relationship of these subsystems to the overall PenPoint software architecture.

Figure 50-1
PenPoint Subsystem Hierarchy



The **input subsystem** converts device driver function calls into messages that are handled by the class manager. The input subsystem determines which device driver is sending an event, and then routes the event to the appropriate object. If the event originated from the pen driver, the input subsystem routes the event through the window tree. If the event originated from an attached keyboard (or other device), the input subsystem routes the event to the object that is currently assigned input focus. The input and the windows and graphics subsystems provide all of low-level coordinate system and dispatch loop handling that most applications need.

The **handwriting translation subsystem** operates at the class level. Your applications use these classes to handle accumulated pen input and do shape recognition, gesture (command) interpretation, or handwriting translation. A set of special window classes is used to capture handwriting input, and another set of translator classes is used to translate the captured pen stroke data.

The **window and graphics subsystem** handles conversion from hardware coordinates to local window coordinates. It maintains a window tree that represents which windows are "contained" in parent windows, and it handles the routing of input events based on that hierarchy. All window objects have a set of flags that optionally enable or disable sensitivity to different classes of pen events, giving your applications a great deal of flexibility in defining the visual behavior of the user interface. Many of the input and handwriting translation classes take advantage of windows and graphics features other than window input flags. See *Part 3: Windows and Graphics* for details.

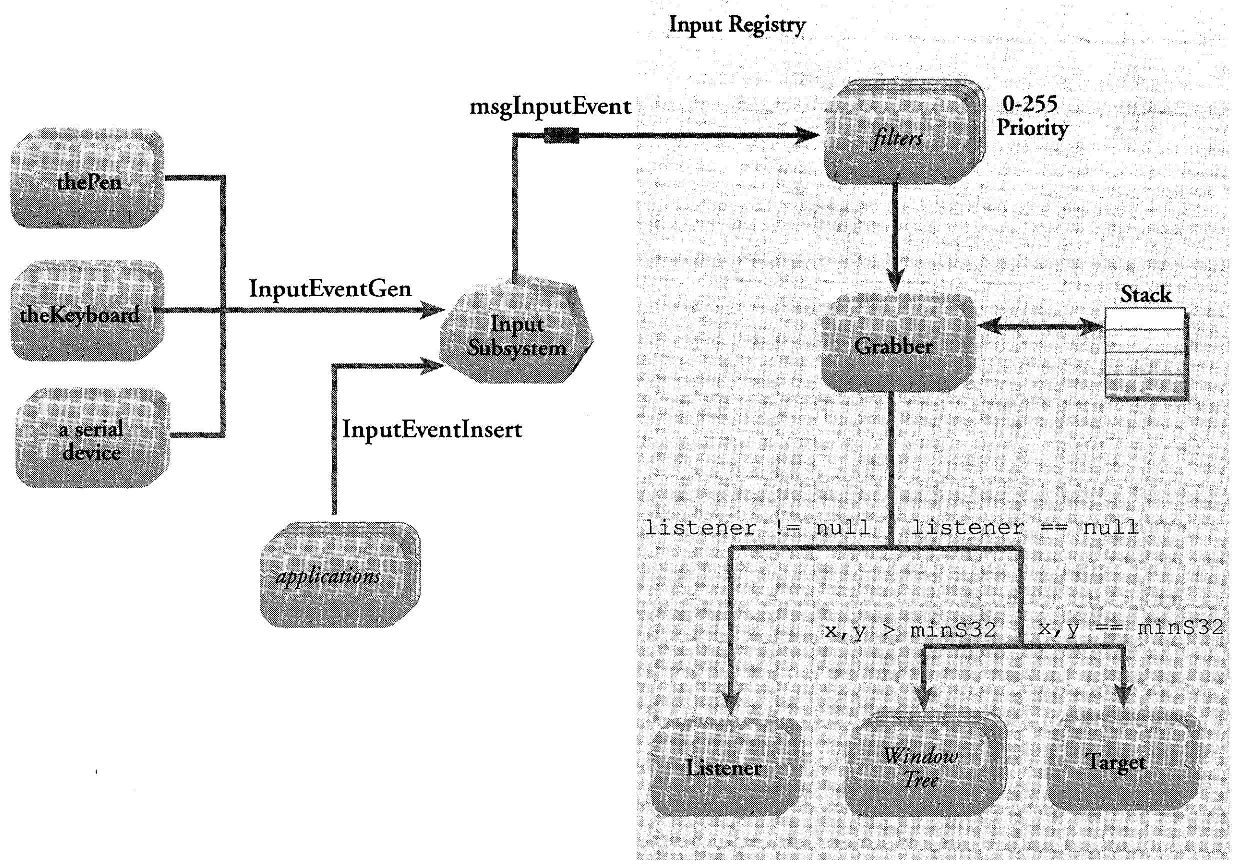
The Input Subsystem 50.1

The input subsystem is the central mechanism for handling user input events. An input event is generated by a hardware device driver to indicate the occurrence of an action by the user such as the pen touching the screen. Device drivers make function calls to the input subsystem to communicate state changes. The input subsystem translates the calls into **msgInputEvent** messages. The input event messages are routed through, the **input registry**, a set of objects that have expressed interest in receiving input. Any object in the input registry can process any event message it receives, and it can either pass the message along the chain for further processing or terminate processing by returning **stsInputTerminate** to the input subsystem.

msgInputEvent has an argument structure that describes the type of event, the time it occured, and x-y coordinate information if the event was generated by the pen driver. Device drivers use this same data structure when making a function call to the Input subsystem. Objects receiving the event message use this information to do the appropriate processing such as rendering in a window, accumulating strokes for the translation classes, or changing the application's mode due to a key event.

Figure 50-2 shows how events are sent from device drivers to the input subsystem, and how the input subsystem routes them to your application as event messages.

Figure 50-2
Event Routing



Input Registry

50.1.1

After a call from a device driver has been translated into a **msgInputEvent**, the message is routed through the **input registry**, the set of objects that have expressed interest in receiving input messages. These are the objects shown in a shaded rectangle on the right side of Figure 50-2. Event messages are always routed through the input registry recipients in the following order (each of these recipients is described in more detail later):

1 **Filter objects.** You register an object as a filter object with the **InputFilterAdd**() function. The Input subsystem maintains a list of filter objects, and always gives them the first crack at processing an event message.

2 **Grabber object**. At any time, a single object may be registered as the grabber object. The grabber is similar to a filter in that it receives all input messages that haven't been terminateed by the filters ahead of it. The grabber is different from filters in that there is only one active grabber at a time. Grabbing the input stream is meant to be a temporary, dynamic operation.

3 **Listener object**. If the listener field in the event data structure is filled in by the device driver when it calls the input subsystem (with a valid object UID), the outgoing event message is sent directly to that object.

4 **Window tree objects**. If the x-y coordinate field in the event data structure is filled in by the device driver when it calls the input subsystem, the outgoing event message is routed through the hierarchy of window objects. You can optionally limit what types of pen events a particular window is interested in by setting the window input flags field. This technique is demonstrated in Chapter 51. The window input flags are described in Chapter 53.

5 **Target object**. If the x-y coordinate field in the event data structure is not filled in by the device driver, the event message is routed to the target object. At any time a single object can be registered as the target object. The target is a special object that has been singled out to receive non-x-y events such as keyboard or modem input (this is similar to the **input focus** in some other systems).

Routing 50.1.2

The input subsystem expects a status code reply from each of the objects which receives the event message. The reply can specify that the input event should be terminated (all processing completed), or continued (passed on to objects further down the input registry). The status return is also used to set and release the grabber object.

The input subsystem maintains an internal queue for events coming in from the device drivers (and applications), and it parcels out event messages utilizing the class manager **ObjectSend** mechanism. Events are serialized within the object hierarchy because the input subsystem doesn't start processing another event until the current event is terminated somewhere in the registry, or falls through and is terminateed by the input subsystem itself (the input subsystem ignores such events).

Filters 50.1.3

You use filters to provide behavior which persists over multiple input events. Filters get the first opportunity to process each input event that enters the system. Filters have priorities that determine the order in which multiple filters receive an event. Filters return a status to terminate an event, or a status to allow the event to continue to the next filter (or to the remainder of the input registry if there are no more filters).

The Quick Help system and UI Toolkit menus provide two examples of the use of input filters. When the user starts the Quick Help system, the Quick Help system creates a high-priority filter to trap input events. The Quick Help system determines which window falls under the user's tap, and gets and displays the Quick Help message for that window. The filter prevents taps from activating the window the user tapped on, and this behavior persists until the user quits Quick Help.

UI Toolkit menus use filters in a similar fashion. When the user brings up a menu by tapping on a menu button, the menu inserts a filter to trap input events. If the user taps within the menu, the menu processes the tap. If the user taps outside of the menu, the menu takes itself down and terminates the input event. Again, the filter prevents taps outside the menu from activating the window the user tapped on, and this behavior persists until the menu comes down.

Writing input filters can be complicated, because the filters can modify the input stream to the rest of the objects in the input registry. These other objects may depend on particular sequences of input events, and may exhibit unexpected side effects if new filters modify the input stream in unexpected ways.

The Grabber 50.1.4

An object can establish itself as the grabber by returning **stsInputGrab** as the result of receiving an event message (synchronously) or by calling the input subsystem directly (with the **InputGrab()** function). Until the grab is terminated, the grabber receives all input event messages that have passed through the filters and must return status indicating whether an event should be passed on to the rest of the input registry or if an event should be terminated. Grab termination is usually controlled by the grabber object returning status to the input subsystem without the **stsInputGrab** flag set.

A grab can also be terminated when one object requests a grab while another object is already grabbing input events. The second grab request overrides the first. The input subsystem maintains a stack of grab requests. Whenever the current grabber relinquishes control, the previous grabber object on the stack is handed back the grab. To prevent thrashing (two applications repeatedly overriding one another's grabs), each client can override the grab only once.

Whenever a grab is terminated, the input subsystem sends **msgInputGrabTerminated** to the previous grab object. This allows the new client to determine if it really wants to continue looking at the input stream.

Listener Objects 50.1.5

If a driver has information about the current state of the object hierarchy in PenPoint, it can request that input events be sent directly to a particular object. It does this by setting the **listener** field of the input event structure to the UID of a valid object when it places an input event in the input subsystem with **InputEventGen**. The event is still passed to the filter objects and the grabber. If none of these objects terminates the event, it is next passed to the listener object as designated by the event data structure itself. If the input system routes an event to a listener object, the event terminates there.

Window Tree 50.1.6

If an input event has made it past the filters and grabber without being terminated, it is next passed through the window tree to see if any of the open windows on the PenPoint display want to react to the event.

The **window tree** is extended whenever you create a window object and fill in its **parent** field. The hierarchy of windows and parent windows should not be confused with the inheritance hierarchy of classes and superclasses. The first window object in the display screen window tree is called **theRootWindow**. It defines the total area of the computer's display. See *Part 3: Windows and Graphics* to learn more about the window tree and its implementation.

A window can be **extracted** from the tree, in which case the window disappears from the screen. It still exists in memory, but it does not receive input event messages. When a window is **inserted** into the tree it appears on the screen and may again receive input event messages as part of the input registry.

Any window in the window tree can selectively express interest in or ignore different types of pen events. Windows express their interest in different types of pen event through the **win.flags.input** field. This field includes flags to express interest in events such as pen-out-of-proximity, pen-moved-while-down, pen-moved-out-of-window, and so on. Chapter 53 describes the available input flags. Chapter 51 demonstrates their use.

Target Object 50.1.7

The **target object** is an object that is designated to receive input events that are not associated with a specific area of the display (for example, a keyboard event). The input subsystem routes an event to the target object when all of the following circumstances are true:

- The x-y field is **null**.
- The filters and grabber did not terminate the event.
- The listener field is **null**.

You use the **InputSetTarget()** function to make an object the target object. Typically, the target is an object that is designated to receive and process keyboard events. Only one object at a time can be designated as the target.

Inserting Events into the Input Stream 50.1.8

The input subsystem also allows events to be inserted into the input stream by applications through a procedure-call interface. Events may be added at the end of the input queue (processed after all of the events currently in the input queue) or at the head of the input queue (processed before the events currently in the input queue). Inserted events are treated the same as events generated by devices.

The Handwriting Translation Subsystem 50.2

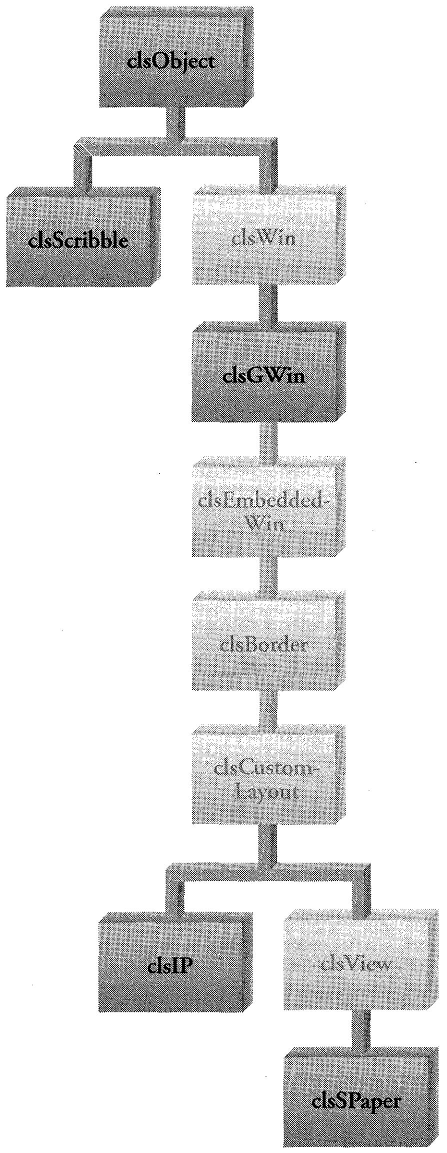
Several PenPoint classes handle the capture and processing of handwriting. Some specialized subclasses of **clsWin** capture pen input. **clsXtract** and its subclasses translate the captured input.

Window Subclasses 50.2.1

Several subclasses of **clsWin** capture pen input. Figure 50-3 shows the hierarchical relationship of the window subclasses that handle handwriting capture.

The figure shows the complete inheritance ancestry of the handwriting capture classes. Not all of these classes are important to the discussion of handwriting capture and translation. The principal classes that your application will interact with are introduced in the following paragraphs.

Figure 50-3
Handwriting Capture Classes



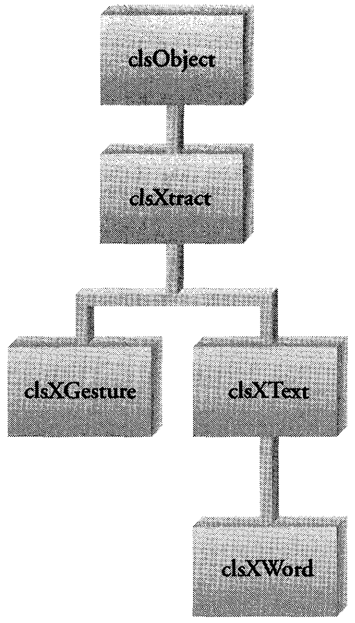
- **clsGWin** is a special lightweight subclass of **clsWin** that automatically creates and attaches a gesture translator from **clsXGesture**. The application decides what kind of data is to be displayed under the gesture capture region, and what (if any) effects the gestures will have on the data. **clsGWin** instances also maintain a reference to a quick help resource file, so that a help gesture drawn over a **clsGWin** instance will cause a contextually appropriate help text to be displayed.
- **clsView** is used to allow user interaction with different data objects in PenPoint; it gives you a view on your data by serving as the connection between a window and the actual data. This allows your application to perform operations on data without having to worry about updating windows. The **view object** manages all window interaction, both input and display, while your application is concerned primarily with the algorithms for processing data.
- **clsSPaper** is a subclass of **clsView**. **clsSPaper** (scratch paper) objects have the capability of accumulating "scribbles." An **clsSPaper** object is always attached to a window, and it maintains a scribble data object.
- **clsScribble** objects hold pen stroke data. It is a direct descendant of **clsObject**. A scribble is a list of pen vectors strokes. It is the scribble that is passed to a translation object to be converted into a meaningful gesture or ASCII character.
- **clsIP** provides a class of powerful user-interface components called **insertion pads**. An insertion pad is a window that accepts handwriting input, performs on-the-spot translation, and displays the result. Insertion pads are used for various kinds of text data entry such as text-insertion during word processing or mini-graphics capture within the context of a text document.

Chapter 56, Using clsIP, Chapter 57, Using clsSPaper, and Chapter 12, Using clsGWin, show how to use these classes to capture pen input.

Translation Classes 50.2.2

clsXtract and its subclasses are used to execute the translation of captured scribbles. Each specialized subclass provides one type of translation object which is attached to a capture object (described above). Figure 50-4 shows the hierarchical relationship of the handwriting translation classes in PenPoint.

Figure 50-4
Handwriting Translation Classes



- **clsXtract** is the parent of all the translator classes. It contains the functional interface into the feature extraction engine. It observes a given scribble and handles strokes as they are added to the scribble, as well as the determination of when a scribble has been completed by the user. When it completes the extraction of a scribble from the user interface, it sends a message to itself. The specialized subclasses respond to the message differently to process the stroke information in different ways.
- **clsXGesture** interprets the information from a scribble to determine if it is one of a set of defined gesture shapes. A **clsXGesture** translator is automatically created whenever a **clsGWin** object receives input.
- **clsXText** provides the basic interface for processing ASCII characters written in English-form. **clsXText** can process horizontally split, left-to-right sequences of words. **clsXText** chains lists of characters together and has a number of heuristic analysis modes available: trigram, vertical placement, overlapping segments, and common words.
- **clsXWord** provides translator objects that are used to recognize words.

Chapter 58, Using the Translation Classes, shows how to use these classes in your application to translate captured pen input.

Chapter 51 / Developer's Quick Start

This chapter shows you how to add handwriting recognition to the user interface for your application. The example uses UI Toolkit components that are standard in the PenPoint™ SDK. In a second example, you are shown how to add direct pen handling to the user interface of your application. This allows you to track the pen in a window for rendering, placement, or control tasks.

Capturing and Translating Handwriting 51.1

If you want to capture handwriting as input for your application, the application sends **msgNew** to one of the handwriting capture classes to create a **handwriting capture object**, which is inserted into the window tree as a child of your application's window. You must then connect a **translator object** to receive the captured **scribbles** and translate them into ASCII characters which are then delivered to your application's data manipulation algorithms.

This section uses an example application to demonstrate a simple use of the handwriting capture subsystem. The application is a simple arithmetic sum expression calculator. The user writes an expression such as 5–2 into an insertion pad. After translation, the application parses the expression, does the required calculations, and returns a value for display.

The following steps highlight the actions an application must perform to setup and execute handwriting input:

- Initialize a structure defining a new insertion pad by sending **msgNewDefaults** to **clsIP**.
- Initialize a structure defining a new translator by sending **msgNewDefaults** to **clsXText**.
- Specify and compile a template that allows only the desired characters to be accepted for input. The template is then added as a part of the translator **msgNew** arguments.
- Create the translator by sending msgNew to **clsXText**.
- Add the UID for the new translator as a part of the insertion pad **msgNew** arguments.
- Create the insertion pad by sending **msgNew** to **clsIP**.
- Make the insertion pad visible on the screen by inserting it into the application's main window.

Example 51-1 shows how these steps are implemented in the Adder application. You can find the source code for the Adder application in the SDK distribution directory \PENPOINT\SDK\SAMPLES\ADDER. Example 51-1 is from the **CreateInsertWindow()** function defined in ADDERAPP.C.

Example 51-1 Creating and Inserting an IP Window

Adder sets itself up as an observer of the insertion pad (by setting the **ipNew.ip.client** field to **self** in the **msgNew** arguments as shown in the example. Notice also that the physical appearance of the insertion pad is determined by setting style fields in the **msgNew** arguments.

```
STATUS LOCAL CreateInsertWindow (
    P_ADDER_APP_INST    pInst,
    OBJECT              self)
{
    STATUS          s;
    WIN_METRICS     wm;
    IP_NEW          ipNew;
    P_UNKNOWN       pNewTemplate;
    XLATE_NEW       xNewTrans;
    U16             xlateFlags;
    XTM_ARGS        xtmArgs;
    //
    // Create an insertion pad, which is the standard mechanism
    // for accepting handwritten input.
    //
    ObjectCall(msgNewDefaults, clsIP, &ipNew);
    // Do not show the resize button.
    ipNew.border.style.resize   = bsResizeNone;
    // Translate when the user lifts the pen out of proximity
    ipNew.ip.style.buttonType   = ipsProxButton;
    ipNew.ip.style.embeddedLook = true;
    // set the listener field for notifications
    ipNew.ip.client             = self;
    //
    // Create a translator for the insertion pad
    //
    ObjectCall(msgNewDefaults, clsXText, &xNewTrans);
    //
    // Create a template for the insertion pad
    //
    xtmArgs.xtmType      = xtmTypeCharList;
    xtmArgs.xtmMode      = 0;                    // no special modes
    xtmArgs.pXtmData     = "0123456789+-.";      // ascii template
    StsRet(XTemplateCompile(&xtmArgs, osProcessHeapId, &pNewTemplate), s);
    xNewTrans.xlate.pTemplate = pNewTemplate;
    //
    // The handwriting engine is geared primarily towards text
    // translation. We can improve numeric translation by
    // disabling these context assumptions:
    //
    // alphaNumericEnable - enables character recognition that is
    //      geared towards text-processing (e.g., most characters
    //      are assumed to be letters, and numbers are separated from
    //      letters by spaces.)
    // punctuationEnable - enables punctuation rules that are geared
```

continued

Example 51-1 (continued)

```
    //      towards text-processing (e.g., periods are always followed
    //      by a space).
    // verticalEnable - enables rules that help recognize a character
    //      based on its vertical orientation (e.g., "t" versus "+").
    //
    // By disabling these flags, we get far fewer unrecognized characters
    // in our numeric expressions.
    //
    xNewTrans.xlate.hwxFlags &=
            ~(alphaNumericEnable | punctuationEnable | verticalEnable);
    ObjCallRet(msgNew, clsXText, &xNewTrans, s);
    ipNew.ip.xlate.translator = xNewTrans.object.uid;
    // give our template veto power during the translation
    ObjCallRet(msgXlateGetFlags, xNewTrans.object.uid, &xlateFlags, s);
    xlateFlags |= xTemplateVeto | spaceDisable;
    ObjCallRet(msgXlateSetFlags, xNewTrans.object.uid, (P_ARGS)xlateFlags, s);
    ObjCallRet(msgNew, clsIP, &ipNew, s);
    pInst->iPad = ipNew.object.uid;
    //
    // Insert the insertion pad into our adderWin window
    //
    wm.parent   = pInst->adderWin;
    wm.options  = wsPosTop;
    ObjCallRet(msgWinInsert, ipNew.object.uid, &wm, s);
    return stsOK;
} /* CreateInsertWindow */
```

Note that the IP notifies the application with **msgIPDataAvailable** whenever the IP receives and translates input. In Adder, the method to handle this message is **GetInsertPadData**(). Example 51-2 shows its code.

Example 51-2
Translating and Displaying Captured Scribbles

GetInsertPadData() gets a list of translated characters from the insertion pad by sending **msgIPGetXlateString** to the insertion pad. **GetInsertPadData**() next tries to clean up some common handwriting translation errors. After that it sends the string to the expression analyzer engine with **msgAdderEvaluatorEval**. Finally, it displays the result in a label window with **msgLabelSetString**.

```
MSG_HANDLER GetInsertPadData (
    const MESSAGE              msg,
    const OBJECT               self,
    const OBJECT               pArgs,
    const CONTEXT              ctx,
    const PP_ADDER_APP_INST    pData)
{
    IP_STRING          ipStr;
    STATUS             s;
    char               display[MAX_DISP];
    EVAL_FRAME         ex;
    P_ADDER_APP_INST   pInst;
    pInst = *pData;
```

continued

Example 51-2 (continued)

```
    //
    // Get the text from our instance's insertion pad into ex.expresssion...
    //
    ipStr.len = SizeOf(ex.expression);
    ipStr.pString = ex.expression;
    ObjCallRet(msgIPGetXlateString, pInst->iPad, &ipStr, s);
    StsRet(RemoveNewLines (ex.expression), s);
    //
    // ...and evaluate the expression.
    //
    ObjCallRet(msgAdderEvaluatorEval, pInst->evalObj, &ex, s);
    Debugf("GetInsertPadData() returned from msgAdderEvaluatorEval: ex.badExpr = %s,"
           "  value = %g  valueStr = <%s>", ex.badExpr? "true":"false",
           ex.value, ex.valueStr);
    //
    // Construct the string to display
    //
    sprintf(display,"%s = %s", ex.expression, ex.valueStr);
    //
    // Display the string
    //
    ObjCallRet(msgLabelSetString, pInst->label, display, s);
    return stsOK;
    MsgHandlerParametersNoWarning;
}  /* GetInsertPadData */
```

Handling Low-Level Pen Input

51.2

In some cases, you may want to handle low-level pen input events directly. You may want to provide visual user feedback, or you may want to control your own rendering processes. To do this, you subclass **clsWin** (the window class), and not one of the more specialized subclasses such as **clsIP** or **clsSPaper** which automtically provide pen handling and input interpretation.

This example shows how the **input flags** are set for a window to track particular pen input events. When one of these events occures, a method is activated that renders a simple cursor in the window to give visual feedback for the location of the pen.

The following steps highlight the actions an application must perform to setup and respond to low-level pen input.

- ◆ Subclass **clsWin** and add the functionality for the responses to pen input that you need in your application.
- ◆ Add a drawing context to the window that will render the user feedback.
- ◆ Add the methods that will call the drawing context appropriately according to the type of pen events that are detected in the window.
- ◆ Install this new **clsWin** subclass.
- ◆ Create and install an application class that uses an instance of the **clsWin** subclass as its main window.

When you launch the application, it comes up with the window ready to receive input, and responds according to the methods in your special window class.

Example 51-3 shows how a specialized subclass of **clsWin** handles **msgInputEvent**. The code comes from INPUTAPP.C, part of a demonstration application in the SDK distribution directory \PENPOINT\SDK\SAMPLE\INPUTAPP.

Example 51-3
Handling Low-Level Pen Events

INPUTAPP.C defines **clsInWin** as a local subclass of **clsWin**. **clsInWin** handles **msgInputEvent** with the **InWinInput()** method. **msgInputEvent** always arrives with an input event data structure pointed to by **pArgs** (Chapter 53 describes the data structure in detail). The structure fields indicate what kind of device initiated the event, spatial data, modal data, and so on.

pArgs–>devCode is a standard message token defined with the **MakeMsg()** macro. **MakeMsg()** binds a class UID and a message number to create a unique token. In the case of input events, however, the second value represents an event type rather than a message number. The **case** statement below produces different on-screen behavior depending on the message number (the type of pen event).

InWinInput() handles **msgInputEvent** by drawing a small square at the location of the input event.

```
MsgHandlerArgType(InWinInput, P_INPUT_EVENT)
{
    INWIN_INST inst;
    RECT32 box;
    inst = *(P_INWIN_INST)pData;
    box.size.w = 14;
    box.size.h = 14;
    ObjCallWarn(msgWinBeginPaint, inst.dc, Nil(P_ARGS));
    switch (pArgs->devCode) {
        case msgPenDown:
            /* draw a rectangle with the origin at the point */
            box.origin = pArgs->xy;
            ObjectCall(msgDcDrawRectangle, inst.dc, &box);
            inst.prevLoc = pArgs->xy;
            ObjectWrite(self, ctx, &inst);
            break;
        case msgPenExitDown:
        case msgPenOutProxDown:
        case msgPenUp:
            /* redraw the rect at the last location to clear it */
            box.origin = inst.prevLoc;
            ObjectCall(msgDcDrawRectangle, inst.dc, &box);
            inst.prevLoc.x = minS32;
            ObjectWrite(self, ctx, &inst);
            break;
        case msgPenMoveDown:
            if (inst.prevLoc.x != minS32) {
                /* redraw the rect at the last location */
                box.origin = inst.prevLoc;
                ObjectCall(msgDcDrawRectangle, inst.dc, &box);
            }
```

continued

Example 51-3 (continued)

```
            /* draw a rectangle with the origin at the point */
            box.origin = pArgs->xy;
            ObjectCall(msgDcDrawRectangle, inst.dc, &box);
            inst.prevLoc = pArgs->xy;
            ObjectWrite(self, ctx, &inst);
            break;
        default:
            break;
    }
    ObjectCall(msgWinEndPaint, inst.dc, Nil(P_ARGS));
    return (stsInputTerminate);     // indicates completion of the event
    MsgHandlerParametersNoWarning;
} /* InWinInput */
```

In the case where the user has placed the pen down on the screen (**msgPenDown**) a square is drawn at the location of the event. Note how easily the units are handled. The input subsystem provides the x-y location of the event in local window coordinates (pixels), and the drawing context which is bound to this window (shown in a later fragment) also knows how to handle these coordinates without any scaling.

It is useful to see how rendering capability was added to this otherwise unembellished subclass of **clsWin**. Example 51-4 shows how **clsInWin** initializes its instances when it receives **msgNew** or **msgRestore**.

Example 51-4
Initializing a Window with Rendering Capability

clsSysDrwCtx is a standard Window and Graphics class that is used to create a drawing context (DC) object. A DC manages rendering in a window. **InWinInput**(), shown in Example 51-3, sends **msgDcDrawRectangle** to the DC to render a small rectangle in the window. You can render in a window under programmatic control or, using the technique shown here, you can allow input events to drive the rendering process.

InWinInit(), shown here, creates a DC and sets the DC to operate in raster XOR mode (**sysDcRopXOR**). In this mode, drawing the rectangle a second time in the same position restores the pixels to their original state. Using this feature, **InWinInput**() can animate the rectangle by first drawing at the old location to XOR it out, and then drawing it at the new location.

```
MsgHandler(InWinInit)
{
    INWIN_INST inst;
    SYSDC_NEW dcNew;
    STATUS s;
    // Ancestor called in method table
    // Clear the local instance data
    memset(&inst, 0, sizeof(inst));
    // Create a drawing context to perform the drawing
    ObjectCall(msgNewDefaults, clsSysDrwCtx, &dcNew);
    ObjCallRet(msgNew, clsSysDrwCtx, &dcNew, s);
    // Tie the window and the drawing context together
    ObjectCall(msgDcSetWindow, dcNew.object.uid, self);
    // we'll only deal in screen coordinates in this example
    ObjectCall(msgDcUnitsDevice, dcNew.object.uid, Nil(P_ARGS));
    // Tell the DC how the drawing will be done
    ObjectCall(msgDcSetRop, dcNew.object.uid, (P_ARGS)sysDcRopXOR);
```

continued

Example 51-4 (continued)

```
        // Write out the instance data
        inst.dc = dcNew.object.uid;
        inst.prevLoc.x = inst.prevLoc.y = minS32;
        return ObjectWrite(self, ctx, &inst);
        MsgHandlerParametersNoWarning;
    } /* InWinInit */
```

That's how a drawing context is bound to a window, and how the window handles input events when they are handed to it. To see how the window object is told what input events to be interested in, we must look at how it is inserted into the window tree, and thus entered in the input registry.

The application is responsible for inserting the window. Example 51-5 shows how **clsInputApp** inserts an instance of **clsInWin** as its main application window.

Example 51-5

Inserting a Custom Window as the Main Application Window

clsInputApp calls the initialization method **InputMsgAppOpen**() whenever it receives msgAppOpen (for example, when you launch a new instance of **clsInputApp** by tapping on its entry in the stationery menu).

The application uses **msgNewDefaults** to initialize the **msgNew** argument structure **inNew**, then modifies the window input flags field, **inNew.win.flags.input**. This field determines to which pen input events the window responds (Chapter 53 describes window input flags in detail). In this case, the input system will send only the **msgPenUp**, **msgPenDown**, **msgPenMoveDown**, **msgPenMoveUp**, **msgPenOutProxUp**, **msgPenExitDown**, **msgPenExitUp**, and **msgInProxUp** pen events to the window. **msgNew** creates the new **clsInWin** object. The window input flags filter pen events only. They do not filter out events from other input sources.

The application sends **msgFrameGetMetrics** to the main window of the application to copy the application frame metrics to **frameMetrics**, sets the client window (**frameMetrics.clientWin**) to the new instance of **clsInWin**, then sends **msgFrameSetMetrics** to establish these changed metrics as the metrics of the application frame. As soon as the application manager displays your application's UI on the screen, the window can receive input event messages.

```
    MsgHandler(InputMsgAppOpen)
    {
        STATUS          s;
        WIN_NEW         inNew;
        FRAME_METRICS   frameMetrics;
        APP_METRICS     appMetrics;
        WIN_METRICS     winMetrics;
        // Ancestor called in method table
        // Create an instance of the inWin class
        ObjCallRet(msgNewDefaults, clsInWin, &inNew, s);
        // set the input flags to get tip & move events
        inNew.win.flags.input = inputTip | inputMoveDown | inputMoveUp|
                                inputOutProx | inputExit | inputInProx |
                                inputMoveDelta | inputAutoTerm;
        ObjCallRet(msgNew, clsInWin, &inNew, s);
```

continued

Example 51-5 (continued)

```
    // Tell the frame of the application about the client window
    ObjCallJmp(msgAppGetMetrics, self, &appMetrics, s, Error1);
    ObjCallJmp(msgFrameGetMetrics, appMetrics.mainWin, &frameMetrics, \
            s, Error1);
    frameMetrics.clientWin = inNew.object.uid;
    ObjCallJmp(msgFrameSetMetrics, appMetrics.mainWin, &frameMetrics, \
            s, Error1);
    // Relayout the window
    winMetrics.options = wsLayoutDefault;
    ObjCallJmp(msgWinLayout, appMetrics.mainWin, &winMetrics, \
            s, Error1);
    return stsOK;
    // Recover from errors here. In particular, free resources.
Error1:
    (void) ObjCallWarn(msgFree, inNew.object.uid, pNull);
    (void) ObjCallAncestorWarn(msgDestroy, self, pNull, ctx);
    return s;
    MsgHandlerParametersNoWarning;
} /* InputMsgAppOpen */
```

Chapter 52 / Event Processing

The input system translates the event data provided by device drivers into event messages and distributes them according to standard mechanisms. The input system uses **ObjectSend()** to send msgInputEvent to the first object in the input registry. This object processes the event, then either terminates the event or allows the input system to send the input event to the next object in the input registry.

Event Generation 52.1

Events normally enter the system through the **InputEventGen()** interface. Device drivers use this interface to deposit event information in the input system's event queue. The event information includes, as a minimum, the **devCode**, a message that identifies the device driver and the type of event. Optionally, the event information may include an x-y coordinate in local window units, a specific listener object, and up to 24 bytes of other event-specific data.

For example, when the pen touches the screen in a window, the event data might include **msgPenDown** as the devCode, and the local window coordinates of the pixel the pen touched. Depending on the design of the device driver and the capabilities of the hardware, the event-specific data might include such information as the hardware device coordinates of the touched pixel, pen pressure, and so on.

Event Handling 52.2

When the input system sends an input event message to an object, the object processes the message by switching control to the message handler for **msgInputEvent**. The method does the necessary processing, typically based on the **devCode** value of the input event, then returns an input event status return value. Table 52-1 summarizes the possible return values and their meanings.

Table 52-1
Input Event Status Codes

Status Code	Result
stsInputContinue	The input system processes the event normally, passing it to the next object in the input registry.
stsInputTerminate	The input system does not pass the event to other objects in the input registry.
stsInputGrabContinue	The input system gives the grab to the object returning this status and continues to pass the event to other objects in the input registry.
stsInputGrabTerminate	The input system gives the grab to the object returning this status and does not pass the event to other objects in the input registry.
stsInputGrab	Identical to **stsInputGrabTerminate**. The input system gives the grab to the object returning this status and does not pass the event to other objects in the input registry.
stsInputIgnored	The input system interprets this status identically to **stsInputContinue**. An ancestor class can use **stsInputIgnored** instead of **stsInputContinue** to inform subclasses that the ancestor was not interested in the input event.
stsInputGrabIgnored	The input system interprets this status identically to **stsInputGrab**. An ancestor class can use **stsInputGrabIgnored** instead of **stsInputGrab** to inform subclasses that the ancestor was not interested in the input event.
For Filters Only	
stsInputSkip	The input system passes the event to the next object in the input registry that is not filter.
stsInputSkipTo2	The input system passes the event to the next object in the input registry that is not a filter in the first range (zero through 63) of filter priorities.
stsInputSkipTo3	The input system passes the event to the next object in the input registry that is not a filter in the first range (zero through 63) or second range (64 through 127) of filter priorities.
stsInputSkipTo4	The input system passes the event to the next object in the input registry that is not a filter in the first range (zero through 63), second range (64 through 127), or third range (128 through 191) of filter priorities.
stsInputTerminateRemoveStroke	The input system does not pass the event to other objects in the input registry. Furthermore, the input system removes any remaining input events from the same stroke.
stsInputGrabTerminateRemoveStroke	The input system gives the grab to the object returning this status and does not pass the event to other objects in the input registry. Furthermore, the input system removes any remaining input events from the same stroke.

An object receiving an input event message must return one of these status codes in response to every input event it receives. An object that is not the grab object should send **stsInputContinue** to continue normal processing of the event through the input registry, **stsInputTerminate** to stop the processing of the event, or **stsInputGrab** to become the grab object. A grab object should return **stsInputGrabTerminate** to keep the grab and terminate the input event, or **stsInputGrabContinue** to both keep the grab and let the event continue through the input registry.

The input system attempts to return the status and event data to the device driver that created the event. This feature allows device drivers to determine when the processing of the event is complete. For example, the pen driver uses this feature to free up the memory it allocates for stroke events.

X-Y Distribution Mechanism 52.3

Due to the spatial nature of window-based input, a sophisticated distribution mechanism for processing events is provided. This mechanism allows child windows to pass events to their parent windows for processing. The mechanism is activiated for any event with a x-y coordinate other than (**minS32**, **minS32**), whether the event is the result of an **InputEventGen**() call from a device driver, or an **InputEventInsert**() call from an application.

The input system uses a leaf-to-root model of x-y distribution. This means that when an event occurs in a window, that window receives the event message first. The window processes the message, then terminates the event or allows it to continue. If the window does not terminate the event, the input system sends the message to the window's parent, which in turn processes the message, then either terminates it or allows it to continue. Thus, if no window terminates the event, the input system will send the message to each window from the window in which the input occurred (the **leaf** window) up the chain to the root window.

The input system uses **ObjectSend**() to send the input event message to each window in the chain, and it always transforms the event coordinates into the window's local coordinates before sending the message. Thus, the input event appears to penetrate any window that does not terminate it, and is finally processed as if the event had occurred in the same screen position in a window behind the child window.

For more details on the PenPoint™ window system, see *Part 3: Windows and Graphics.*

Pen Input Sampling 52.4

The input system uses the window system to locate the frontmost window which contains the digitizer x-y coordinates for an event, and to access the window tree to determine the window ancestor chain of that frontmost window. In addition, each window has a **win.input.flags** field to optimize event processing by filtering pen events. The **win.input.flags** field provides a means for each window to limit what types of pen events it receives.

Chapter 53 describes the possible input flag values. The input flags flags are used for filtering only pen events generated by the standard PenPoint pen driver. Other input events with x-y coordinates will always find their way to the window tree if not sent to a listened or terminated by a filter or grabber.

In addition to the pen event input flags that control which pen events the input system sends to a window, the input system defines a number of special flags that control how the input system samples pen input events. The more interesting of these special flags follow (see \PENPOINT\SDK\INC\INPUT.H for the others):

inputMoveDelta controls when **msgPenMoveUp** and **msgPenMoveDown** events are sent. With this flag set, the pen will send out move events only when the previous move event has been fully processed. This helps to prevent a backlog of unprocessed move events.

inputInk controls inking in the acetate plane. Acetate inking provides immediate feedback when writing with the pen. Because the acetate exists in a different drawing plane than normal windows, it can be erased without affecting the underlying display. When the pen goes out of proximity (or after a brief timeout on hardware that does not support proximity detection), the system erases the acetate plane.

inputInkThrough controls inking in the window receiving the input event. With this flag set, the input system deposits ink directly onto the window. Unlike ink in the acetate plane, this ink is not erased on out-of-proximity. The window need not draw the strokes until it becomes dirty and must repaint.

inputNoBusy controls whether the system displays the busy clock if the message recipient does not return a status before a certain period of time.

inputResolution controls the resolution at which the points are reported. With this flag set, the input system sends pen events when the pen moves at least one digitizer point. With this flag clear, the input system sends pen events are sent when the pen moves at least one screen pixel.

inputTransparent forces the window system to ignore the client window when determining the location of an event.

Chapter 53 / Input Subsystem API

clsInput is a descendant of **clsObject** that provides the interface between low-level input **device drivers** and the object-oriented PenPoint™ operating system **input registry**. Recall from Chapter 50, Introduction, that the input registry is the set of objects that can process input events.

clsInput uses procedural APIs for interacting with device drivers, and message-based APIs for interacting with the input registry.

Event Data Structure 53.1

When a device driver sends an input event to the input subsystem (with **InputEventGen()**), it uses an INPUT_EVENT structure to describe the input event. Similarly, when the input subsystem sends **msgInputEvent** to the objects in the input registry, it also uses an INPUT_EVENT structure. An INPUT_EVENT structure includes the following elements:

length the length of the event packet.

flags various flags affecting the distribution of the input event.

devCode the event type, encoded as a message corresponding to the event. For example, the **devCode** for a pen-down event is **msgPenDown**. The Input Subsystem Constants section, below, further discussed the creation of **devCode** messages.

timestamp the time at which the event entered the input queue, measured in milliseconds since system startup.

xy the location of the event local window coordinates (pixels) from the lower-left corner of the window in which the input event occurred. For keyboard events and other events with no specific screen location, the device driver sets both the x and y coordinates to **minS32**.

listener the listener object. After the input system passes the input event through any input filters or grabbers in the input registry, it routes the input event directly to the listener object.

destination the frontmost window enclosing the input event **xy** location. Currently, the pen driver is the only input device driver to set the **destination**.

originator the object that generated the event. For example, the pen device driver sets **originator** to **thePen**.

eventData an array containing information device-specific event information. For keyboard events, **eventData** may contain key codes and key translations. Each device driver specifies the contents of the **eventData** array as appropriate for the particular device.

Device drivers calling **InputEventGen()** or objects sending **msgInputEvent** fill in the structure's fields according to the event type. For example, a keyboard event sets the xy field to (**minS32**, **minS32**) and uses different **devCode** values than a pen event.

PenPoint includes device drivers for the pen (described in Chapter 54) and the keyboard (described in Chapter 55).

Input Subsystem Constants

53.2

This section describes the various constants that the input system uses to communicate event types to the input registry.

Input Subsystem UIDs

53.2.1

PenPoint uses well-known UIDs to refer to the standard pen and keyboard device drivers, and for references to the input subsystem itself.

In each case, the device and class UIDs are synonymous and refer to the same class manager object. The device is instantiated during the boot process—only one instance of it exists in the system.

- **theInputManager** and **clsInput** represent the Input subsystem.
- **thePen** and **clsPen** represent the pen device.
- **theKeyboard** and **clsKey** represent the keyboard device.

The class UIDs are never subclassed. However, they are used to define messages in the class manager macro **MakeMsg()**, as described in the next section.

Standard Pen Event Codes

53.2.2

Table 53-1 lists the standard event codes generated by the PenPoint pen device driver.

Table 53-1
Standard Pen Event Codes

Event	Meaning
eventTipUp	Pen tip in proximity
eventTipDown	Pen tip touches the screen.
eventMoveUp	Pen moved while in proximity.
eventMoveDown	Pen moved while touching the screen.
eventEnterUp	Pen entered a window in proximity.
eventEnterDown	Pen entered a window touching the screen.
eventExitUp	Pen exited a window in proximity.
eventExitDown	Pen exited a window touching the screen.
eventInProxUp	Pen entered proximity while not touching the screen.
eventOutProxUp	Pen exited proximity while not touching the screen.
eventStroke	Pen made a stroke.
eventTap	Pen made a tap.
eventHoldTimeout	Pen down and hold timed out.

These event codes are *not* used to set the INPUT_EVENT **devCode** for pen events. The **devCode** is a device message derived from the UID of the device object and the event code. For example, when the user touches the pen to the screen, the pen device driver generates an INPUT_EVENT with **devCode** set to **msgPenDown**. The PEN.H header file defines msgPenDown with the MakeMsg() macro, using the UID of the pen device and the unique event code:

```
#define msgPenDown          MakeMsg(clsPen, eventTipDown)
```

Input Event Status Codes 53.2.3

A method for handling an input event must return an event status. For example, suppose your client code receives **msgInputEvent** and determines that an **eventOutProxUp** event has occured. The client switches to a method that does whatever processing is appropriate for that event. That method could return **stsInputGrabContinue** when it has processed the event to indicate that the client wants to grab subsequent events until further notice and that the input system should continue passing the event through the input registry. Chapter 52, Event Processing, discusses input event status values in more detail.

Window Input Flags 53.2.4

These flags enable the dispatch only of pen events.

The creator of a window must set the window input flags to indicate what types of pen input events the input system should send to the window. After creating a window, you can read and modify these flags with **msgWinGetFlags** and **msgWinSetFlags**. Some of these flags correspond to a type of pen event; when a window has such a flag set, it receives pen events of the type corresponding to the flag. Other flags indicate a particular type of input system behavior. Table 53-2 summarizes the available pen input flags for windows.

Table 53-2
Window Input Flags

Flag	Meaning
inputTip	Enables TipUp and TipDown events.
inputMoveUp	Enables MoveUp events.
inputEnter	Enables EnterUp and EnterDown.
inputExit	Enables ExitUp and ExitDown.
inputInProx	Enables InProxUp and InProxDown.
inputOutProx	Enables OutProxUp and OutProxDown.
inputStroke	Enables Stroke events.
inputMoveDown	Enables MoveDown events.
inputHoldTimeout	Enables holdtimeout events.
inputTap	Enables tap events.
inputNoBusy	Disables default busy UI processing.
inputChar	Enables character events.
inputMultiChar	Enables multiple character events.
inputMakeBreak	Enables receipt of make/break events.

continued

Table 53-2 (continued)

Flag	Meaning
inputMoveDelta	Enables compression of move events.
inputDestOnly	Send if destination == self.
inputLRContinue	Allows LR dist to continue.
inputDisable	Disables input to the window.
inputResolution	0 pixel, 1 digitizer.
inputInk	1 ink on, 0 ink off.
inputInkThrough	1 to ink in the window instead.
inputEnableAll	1 to allow ALL event to be sent to grabbers.
inputAutoTerm	1 to automatically terminate events if Grab doesn't have the event flag enabled..
inputGrabTracker	1 to disable hit detect during grab.
inputInkDisable	1 to disable all pen inking.
inputTransparent	1 invisible to hit detect (WIN).
inputSigVerify	1 to switch to high-speed sampling.

Messages 53.2.5

The input subsystem is primarily procedural, but there are a few messages that it sends to objects in the input registry. If you create a class of object that is intended to handle input, it will need to handle **msgInputEvent**, and may need to handle some of the other messages summarized in Table 53-3.

Table 53-3
Input System Messages

Message	pArgs	Description
msgInputEvent	P_INPUT_EVENT	Requests that the input registry object process the specified input event.
msgInputFilterTerminated	NULL	Notifies that an input filter is terminated.
msgInputGrabPushed	OBJECT	Notifies the input registry object that it is losing the input grab to the specified object.
msgInputGrabPopped	OBJECT	Notifies the input registry object that the specified object is giving up the input grab.
msgInputTargetActivated	OBJECT	Notifies the input registry object that it is the target object.
msgInputTargetDeactivated	OBJECT	Notifies the input registry object that it is no longer the target object.

Input Subsystem Procedures 53.3

The remainder of the input system API is based on a procedural interface. This section describes all of the input system procedures.

Inserting a Message into the Event Queue 53.3.1

To insert a message into the event queue, call the function **InputEventInsert()**.

Applications use **InputEventInsert()** to insert event messages into the input stream and utilize the input system's distribution mechanisms. You can add an event at the end of the input queue (to be processed after all events already in the queue) or at the head of the queue (to be processed before other events in the queue). The prototype for the function is:

```
STATUS EXPORTED0 InputEventInsert(
    P_INPUT_EVENT pEvent,   // pointer to the event structure
    BOOLEAN stamp           // true for end of queue, false for head
);
```

pEvent is a pointer to an event data structure with at least the **devCode** and **originator** fields filled in.

If you want to add the event to the end of the queue, set **stamp** to TRUE. This causes **InputEventInsert()** to stamp the event with the current system clock value.

If you set **stamp** to FALSE, **InputEventInsert()** will not stamp the event with the current system clock value. This will insert the input event at the head of the input queue.

Adding a Filter 53.3.2

To add an event to the input filter list, call the function **InputFilterAdd()**. The prototype for the function is:

```
STATUS EXPORTED InputFilterAdd(
    OBJECT listener,            // object to add to the list
    U8 priority                 // priority within the list, 0 high, 255 low
);
```

listener is the UID of the filter object to be placed on the filter list.

priority is a value from 0 to 255 that indicates the relative priority of the filter. This value specifies the position of the filter in the list.

Filters are inserted into the list in priority order, the higher the priority, the closer to the head of the list. More than one filter can have the same priority; within a single priority, filters are sorted in the order in which they are added.

Removing a Filter 53.3.3

To remove an object from the filter list, call the fuction **InputFilterRemove()**. The function prototype is:

```
STATUS EXPORTED0 InputFilterRemove(
    OBJECT listener             // object to be removed
);
```

listener is the UID of the filter object that you want to remove from the list.

Setting the Input Grabber 53.3.4

To set an object that grabs all input events as they are popped from the event queue, call the function **InputSetGrab()**. This function grabs input events rather than returning the **stsInputGrab** code from an event. The input system will send **msgInputGrabPushed** to the prior grab object, if any.

This function may be called during the processing of an input message even if another object currently is grabbing input. The system will correctly create the new grab object after the response for the input message is returned.

The function prototype is:

```
STATUS EXPORTED InputSetGrab(
    OBJECT grabber,         // object Id for new grabber
    U32 flags               // flags for use during grab (ORd with windowflags)
);
```

grabber is the object to send input events.

flags are flags specific to the grab object.

If the grab was successful, the function returns **stsOK**.

Getting Grab Information 53.3.5

To get information about the grab object, call the function **InputGetGrab()**. The function prototype is:

```
void EXPORTED InputGetGrab(
    P_OBJECT pGrabber,      // object Id for graber
    P_U32   pFlags          // current Grab flags
);
```

InputGetGrab() sets **grabber** to the UID of the current grab object, and **flags** to the current grab flags. If there is no grabber, the function sets **grabber** to NULL.

Setting the Input Target 53.3.6

To make an object the target of input system messages that are not redirected by filters and grabs, call the function **InputSetTarget()**. The function has the prototype:

```
STATUS EXPORTED InputSetTarget(
    OBJECT target,          // new target object
    U32 flags               // new target flags
);
```

target is the UID of the object that is the new target for input event messages.

flags specifies filter flags for the target object.

Applications do not normally call this function. It is used by the application framework's selection model to redirect input.

Getting the Target 53.3.7

To get the UID of the current Input target, call the function **InputTargetGet()**. The function prototype is:

```
OBJECT EXPORTED InputGetTarget(void);
```

The function has takes no parameters. It returns the object UID of the current target object.

Chapter 54 / Pen Event

The pen and screen act in concert to produce a series of events based on the windows presently displayed on the screen. When the pen is held out of proximity of the screen, no events are generated. A typical sequence of events generated by the pen include:

The input system sends pen events to each window according to the window's input flags, as described in Chapter 53, Input Subsystem API.

1. An in-proximity (**msgPenInProxUp**) event is generated when the pen first comes within the sensing range of the screen.
2. As the pen moves over the window, move events (**msgPenMoveUp**) are sent to the window.
3. When the pen touches down in the window, a pen-down event (**msgPenDown**) is sent to the window.
4. As the pen moves around the window, more move events (**msgPenMoveDown**) are sent to the window.
5. As the pen crosses the window boundary, a pen exit event (**msgPenExitUp** or **msgPenExitDown**) is sent to the exited window, and a pen enter event (**msgPenEnterUp** or **msgPenEnterDown**) message is sent to the entered window.
6. When the pen is lifted from the screen, a pen-up event(**msgPenUp**) is sent to the window.
7. When the pen leaves the sensing range of the screen, a out-proximity (**msgOutProxUp**) event is sent to the window.

Pen Event Data 54.1

This section describes how the fields in the input event data structure are filled in for the pen event types. These definitions are for pen events generated by the standard PenPoint™ pen driver.

The input event data structure for pen events includes the following fields:

devCode a message representing the type of input event.

timestamp the time at which the event entered the input queue, measured in milliseconds from system startup.

xy where on the screen the event occurred, in local window coordinates.

listener not used for pen events.

destination the UID of the window to receive the input event. Normally, this is the frontmost window that does not have **inputTransparent** set.

originator the object that generated the event. For pen events, the originator is always **thePen**.

eventData for pen events, a PEN_DATA structure (defined in PEN.H) containing the location of the pen in hardware digitizer coordinates (**penXY**) and a pointer to any stroke data associated with the event (**pStroke**).

The following sections describe each of the pen input event types and summarize the event data for each type.

msgPenDown 54.1.1

The input subsystem sends **msgPenDown** when the pen tip changes touched the screen. The event data structure contains the following information:

Table 54-1
msgPenDown Event Data

Field	Contents
devCode	msgPenDown
timestamp	the time at which the event entered the input queue, measured in milliseconds from system startup.
xy	where the event occurred, in LWC
listener	not used
destination	frontmost window without inputTransparent
originator	the object that generated the event. For pen events, the originator is always **thePen**.
eventData	
penXY	digitizer location of the pen
pStroke	pNull

msgPenUp 54.1.2

The input subsystem sends **msgPenUp** when the pen tip is lifted from the screen. The event data structure contains the following information:

Table 54-2
msgPenUp Event Data

Field	Contents
devCode	msgPenUp
timestamp	the time at which the event entered the input queue, measured in milliseconds from system startup.
xy	where the event occurred, in LWC
listener	not used
destination	frontmost window without inputTransparent
originator	the object that generated the event. For pen events, the originator is always **thePen**.
eventData	
penXY	digitizer location of the pen
pStroke	pNull

msgPenMoveUp and msgPenMoveDown

54.1.3

The input subsystem sends **msgPenMoveDown** when the pen tip is moved over the surface of the screen. The pen must move at least one pixel to generate these events (see **inputResolution**). Depending on how quickly the pen moves, the reported points will not necessarily be adjacent pixels. The event data structure contains the following information:

Table 54-3
msgPenMoveUp and msgPenMoveDown Event Data

Field	Contents
devCode	msgPenMoveUp or msgPenMoveDown
timestamp	the time at which the event entered the input queue, measured in milliseconds from system startup.
xy	where the event occurred, in LWC
listener	not used
destination	frontmost window without inputTransparent
originator	the object that generated the event. For pen events, the originator is always **thePen.**
eventData	
penXY	digitizer location of the pen
pStroke	pNull

msgPenEnterUp and msgPenEnterDown

54.1.4

The input subsystem sends when **msgPenEnterUp** and **msgPenEnterDown** when the pen tip enters a window diplayed on the screen which has **inputEnabled** and is not **inputTransparent**. The event data structure contains the following information:

Table 54-4
msgPenEnterUp and msgPenEnterDown Event Data

Field	Contents
devCode	msgPenMoveUp or msgPenMoveDown
timestamp	the time at which the event entered the input queue, measured in milliseconds from system startup.
xy	where the event occurred, in LWC
listener	not used
destination	frontmost window without inputTransparent
originator	the object that generated the event. For pen events, the originator is always **thePen.**
eventData	
penXY	digitizer location of the pen
pStroke	pNull

msgPenExitUp and msgPenExitDown 54.1.5

The input subsystem sends **msgPenExitUp** and **msgPenExitDown** to the last window that was entered when the pen tip enters another window. The event data structure contains the following information:

Table 54-5
msgPenExitUp and msgPenExitDown Event Data

Field	Contents
devCode	msgPenExitUp or msgPenExitDown
timestamp	the time at which the event entered the input queue, measured in milliseconds from system startup.
xy	where the event occurred, in LWC
listener	not used
destination	frontmost window without inputTransparent
originator	the object that generated the event. For pen events, the originator is always **thePen.**
eventData	
penXY	digitizer location of the pen
pStroke	pNull

msgPenInProxUp 54.1.6

The input subsystem sends **msgPenInProxUp** when the pen tip moves into the sensing range of the screen. The event data structure contains the following information:

Table 54-6
msgPenInProxUp and msgPenInProxDown Event Data

Field	Contents
devCode	msgPenInProxUp
timestamp	the time at which the event entered the input queue, measured in milliseconds from system startup.
xy	where the event occurred, in LWC
listener	not used
destination	frontmost window without inputTransparent
originator	the object that generated the event. For pen events, the originator is always **thePen.**
eventData	
penXY	digitizer location of the pen
pStroke	pNull

msgPenOutProxUp 54.1.7

The input subsystem sends **msgPenOutProxUp** when the pen leaves the sensing range of the screen. The event data structure contains the following information:

Table 54-7
msgPenOutProxUp Event Data

Field	Contents
devCode	msgPenOutProxUp
timestamp	the time at which the event entered the input queue, measured in milliseconds from system startup.
xy	where the event occurred, in LWC
listener	not used
destination	frontmost window without inputTransparent
originator	the object that generated the event. For pen events, the originator is always **thePen**.
eventData	
penXY	digitizer location of the pen
pStroke	pNull

msgPenStroke 54.1.8

The input subsystem sends **msgPenStroke** between the **msgPenDown** and **msgPenUp** events and passes the collected stroke points (at digitizer resolution). The event data structure contains the following information:

Table 54-8
msgPenStroke Event Data

Field	Contents
devCode	msgPenStroke
timestamp	the time at which the event entered the input queue, measured in milliseconds from system startup.
xy	where the event occurred, in LWC
listener	not used
destination	frontmost window without inputTransparent
originator	the object that generated the event. For pen events, the originator is always **thePen**.
eventData	
penXY	digitizer location of the pen
pStroke	pointer to the stroke data, a PEN_STROKE structure (see PEN.H)

msgPenTap 54.1.9

The input subsystem sends **msgPenTap** when the pen tip goes Down-Up within a fixed amount of time. Multiple taps are counted and the count is passed in a subfield of **eventData**. This event is generated in addition to the normal **msgPenDown/msgPenUp** sequence. The event data structure will have the following information:

Table 54-9
msgPenTap Event Data

Field	Contents
devCode	msgPenTap
timestamp	the time at which the event entered the input queue, measured in milliseconds from system startup.
xy	where the event occurred, in LWC
listener	not used
destination	frontmost window without inputTransparent
originator	the object that generated the event. For pen events, the originator is always **thePen**.
eventData	
penXY	digitizer location of the pen
taps	penTapCount, the number of taps before timeout

Chapter 55 / Keyboard Events

Unlike pen events, keyboard events are not associated with a particular screen location. When keyboard events are routed through the input subsystem, they typically are sent to the input target object maintained by the selection manager.

Keyboard Event Data 55.1

This section describes how the fields in the event data structure are filled in for the keyboard event types. The input event data structure for keyboard events includes the following fields:

devCode a message representing the type of input event.

timestamp the time at which the event entered the input queue, measured in milliseconds from system startup.

xy Keyboard events have no associated screen location. To indicate this, the x and y coordinates of **xy** are both set to **minS32** for keyboard events.

listener not used for keyboard events.

destination the object which is to receive the event. For keyboard events, **destination** is always **null**. The selection manager keeps track of which object is to receive keyboard events.

originator the object which generated the event.

eventData a KEY_DATA structure (defined in KEY.H) containing information about the kyboard event, such as the keycode of the pressed key.

For keyboard events, the **eventData** field of the event data structure is a KEY_DATA structure (defined in KEY.H). The KEY_DATA structure, which is specific to keyboard events, contains the following fields:

KEY.H describes keyboard input event APIs. Do not confuse it with KEYBOARD.H, which provides support for software keyboard emulations.

keyCode the ASCII value associated with the key.

scanCode the scan code that the keyboard associates with the key. This value is specific to the type of keyboard, and therefore any code which relies on it is hardware-dependent.

shiftState the state of the shift, control, alt, and other keyboard modifiers at the time the key was pressed. The various shift states are defined in KEY.H.

repeatCount the number of times this ASCII character character has been repeated. In the case of **msgKeyMulti** events, the number of entries in the **multi** array.

multi an array of KEY_MULTI structures, representing a number of keypresses queued for processing in a single event. A KEY_MULTI structure includes every field that a KEY_DATA structure includes, except for the multi field (see KEY.H for more details).

The following sections describe each of the pen input event types and summarize the event data for each type.

msgKeyDown 55.1.1

The input subsystem sends **msgKeyDown** when a key is depressed. The **msgKeyDown** event data structure contains the following information:

Table 55-1
msgKeyDown Event Data

Field	Contents
devCode	msgKeyDown
timestamp	time the event entered the input queue, in milliseconds since system startup
xy	(minS32, minS32)
listener	not used
destination	null
originator	object which generated the event
eventData	
keyCode	null
scancode	scan code for the key
shiftState	shift state when the key was pressed
repeatCount	1
multi	null

msgKeyUp 55.1.2

The input subsystem sends **msgKeyUp** when a key is released. The **msgKeyUp** event data structure contains the following information:

Table 55-2
msgKeyUp Event Data

Field	Contents
devCode	msgKeyUp
timestamp	time the event entered the input queue, in milliseconds since system startup
xy	(minS32, minS32)
listener	not used
destination	null
originator	object which generated the event
eventData	
keyCode	null
scancode	scan code for the key
shiftState	shift state when the key was pressed
repeatCount	1
multi	null

msgKeyChar 55.1.3

The input subsystem sends **msgKeyChar** after the **msgKeyDown** event; the message yields the translation of the key scan code and the shift state into an ASCII key code. This event is sent whenever a new key is depressed and whenever the processing for the same key has completed. If the ASCII key code is the same as the last one reported, the **repeatCount** value is incremented. The **msgKeyChar** event data structure contains the following information:

Table 55-3
msgKeyChar Event Data

Field	Contents
devCode	msgKeyChar
timestamp	time the event entered the input queue, in milliseconds since system startup
xy	(minS32, minS32)
listener	not used
destination	null
originator	object which generated the event
eventData	
keyCode	ASCII character associated with the key
scancode	scan code for the key
shiftState	shift state when the key was pressed
repeatCount	number of repeats since last msgKeyChar
multi	null

msgKeyMulti 55.1.4

The input subsystem sends **msgKeyMulti** after the **msgKeyChar**; the message is used to group sequences of characters into a single event. This single event summarizes all **msgKeyChar** events since the last time that a **msgKeyMulti** event was sent. Because the **msgKeyMulti** event duplicates the information in the **msgKeyChar** events, process either **msgKeyChar** or **msgKeyMulti** messages, not both. The **msgKeyMulti** event data structure contains the following information:

Table 55-4
msgKeyMulti Event Data

Field	Contents
devCode	msgKeyMulti
timestamp	time the event entered the input queue, in milliseconds since system startup
xy	(minS32, minS32)
listener	not used
destination	null
originator	object which generated the event
eventData	
keyCode	null
scancode	null
shiftState	null
repeatCount	number of KEY_MULTI structures in the multi array
multi	an array of KEY_MULTI structures

Chapter 56 / Using clsIP

clsIP is called to create insertion pads for use as UI components in applications. Insertion pads are windows that accept pen input, accumulating the strokes in a scribble object and handing the accumulated stroke information to a translation object when the user has finished entering input.

Topics covered in this chapter are:

- Creating and destroying insertion pads.
- Inserting an insertion pad into a parent window.
- Deleting an insertion pad.
- Handling the translation data.

clsIP Messages 56.1

clsIP inherits from **clsBorder**. Table 56-1 summarizes the messages **clsIP** defines.

Table 56-1
clsIP Messages

Message	pArgs	Description
		Class Messages
msgNew	IP_NEW	Creates a new insertion pad object.
msgNewDefaults	P_IP_NEW	Initializes the IP_NEW structure to default values.
		Style and Attribute Messages
msgIPGetStyle	P_IP_STYLE	Passes back the style flags for the IP.
msgIPSetStyle	P_IP_STYLE	Changes the style flags for the IP.
msgIPGetTranslator	P_OBJECT	Passes back the translator for the IP.
msgIPSetTranslator	P_OBJECT	Sets the translator for the IP.
msgIPGetClient	P_OBJECT	Passes back the client of the IP.
msgIPSetClient	P_OBJECT	Sets the client of the IP.
msgIPSetString	P_CHAR	Stores a string into the IP.
		Button Messages
msgIPTranslate	BOOLEAN	Forces the translation of scribbles in the IP.
msgIPCancelled	OBJECT	Indicates cancellation of the IP.
msgIPClear	OBJECT	Clears the value in an IP.

continued

Table 56-1 (continued)

Message	pArgs	Description
		Observer/Client Messages
msgIPCopied	OBJECT	Indicates data copied or translated from a delayed state.
msgIPDataAvailable	OBJECT	Indicates availability of data from the IP.
msgIPTransmogrified	OBJECT	Indicates that the displayType style of the IP has been changed.
		Data Retrieval Messages
msgIPGetXlateData	P_IP_XLATE_DATA	Returns the translated data from the insertion pad via an xlist.
msgIPGetXlateString	P_IP_STRING	Used instead of msgIPGetXlateData if a simple string is needed.
		Interesting Inherited Messages
msgFree	P_OBJ_KEY	Defined in CLSMGR.H.
msgSave	P_OBJ_SAVE	Defined in CLSMGR.H.
msgRestore	P_OBJ_RESTORE	Defined in CLSMGR.H.
msgSetOwner	P_OBJ_OWNER	Defined in CLSMGR.H.
msgSPaperXlateCompleted	OBJECT	Defined in SPAPER.H.
msgWinStartPage	nothing	Defined in WIN.H.
msgCstmLayoutGetChildSpec	P_CUSTOM_LAYOUT_CHILD_SPEC	Defined in CLAYOUT.H.
msgGWinForwardedKey	P_INPUT_EVENT	Defined in GWIN.H.
msgInputTargetActivated	OBJECT	Defined in INPUT.H.
msgTrackProvideMetrics	P_TRACK_METRICS	Defined in TRACK.H.
msgTrackUpdate	P_TRACK_METRICS	Defined in TRACK.H.
msgTrackDone	P_TRACK_METRICS	Defined in TRACK.H.

Creating an Insertion Pad

56.2

Like all UI Toolkit classes, **clsIP** inherits from **clsWin**, which means that you can insert them into a tree of windows.

Normally, you create an insertion pad as you build up and initialize the user interface for your application. You send **msgNew** to **clsIP** to get a new insertion pad object, and **msgWinInsert** to insert the insertion pad as a child window of one of the windows in the UI for your application. Typically, you will insert the new insertion pad into a custom layout.

If the insertion pad is created in response to user activity, it will be inserted into the window tree as a child of the window where the activity took place, causing it to "pop up" on the display.

To create a new insertion pad, you must initialize an IP_NEW typed structure variable by sending it along with **msgNewDefaults** to **clsIP**. When the filled-in structure is returned you may modify the fields to get the insertion pad behavior that is appropriate for your application.

The most interesting fields to modify for an insertion pad are the ones that control the style of the insertion pad. Of these, the **ip.style.displayType** field creates the most common visible aspect of the insertion pad. Table 56-2 lists the possible values of the **ip.style.displayType** field.

Table 56-2
Insertion Pad UI Styles

Style Setting	Description
ipsRuledLines	Standard ruled lines.
ipsCharBox	Character boxes.
ipsCharBoxButtons	Same as ipsCharBox.
ipsSignature	Signature pad.
ipsBlank	Same as ipsSignature.

Displaying the Insertion Pad 56.3

After you create the insertion pad, you must insert it into a window tree to make it visible. To insert the IP into a window tree, set its **wm.parent** to the intended parent window and send it **msgWinInsert.** The following code fragment shows how to insert a new insertion pad object into the main window of an application:

```
//
//  Insert the pad into the window.
//
pInst->iPad      = ipNew.object.uid;
wm.parent        = pInst->parentWin;
wm.options       = wsPosTop;
ObjCallRet(msgWinInsert, ipNew.object.uid, &wm, s);
```

When **exprWin** is displayed, the insertion pad will be displayed in front of it (**wsPosTop**). This is how the parent/child window relationship works: the status of the parent window (displayed or not) determines the status of the child window.

Deleting an Insertion Pad 56.4

To extract an insertion pad from the display, send **msgWinExtract** to the IP object. To make the insertion pad appear on the screen again, send **msgWinInsert** to the object. These **clsWin** messages are described in *Part 3: Windows and Graphics.* To destroy the object completely and free the memory used by the instance, send **msgDestroy** to the object. The consequences of destroying an object are discussed in *Part 1: Class Manager.*

Setting the Translator Object 56.5

When you are creating an insertion pad, you should have at hand an already created translation object so that you can pass its UID in the **msgNew** structure for the new insertion pad.

You can also dynamically change the translator object for an insertion pad. For example, you might want to change from alphabetic character translation to numeric translation based on some mode in your form. To do this you must first create the new translator object, and then send its UID in the **pArgs** (which is a simple P_OBJECT structure) for **msgSetTranslator** to the insertion pad Instance.

To avoid memory leaks, always delete the old translation object when you delete the IP or reset its translator.

Handling Xlist Data

56.6

Your application must be ready to handle **msgIPDataAvailable** which is a **clsIP** message. The insertion pad and translation objects are designed to integrate well together, so you don't need to oversee the input control and data handling that occurs between them during a translation. When you create an insertion pad you register the client in the **ip.client** field. Typically, you enter **self** (your application) in this field. This registers the client in a notification list for the insertion pad object when it is created. The insertion pad is in turn registered in the notification list for the translator object that is attched to it. When the translator is done it notifies the insertion pad which in turn notifies the client that the translated input is ready.

The data is returned in the form of a dynamic array called an Xlist. The IP_XLATE_DATA data type is used to handle the specific type of Xlist handed back by an insertion pad.

After being notified the data is ready with **msgIPDataAvailable**, the client must send **msgIPGetXlateData** to the insertion pad. **msgIPGetXlateData** takes an IP_XLATE_DATA structure as its **pArgs**.

Once you have received the data back in the IP_XLATE_DATA structure, Xlist.H defines several functions that you can use to decompose the raw Xlist. Table 56-3 lists the more important functions for extracting Xlist information:

Table 56-3
Some Xlist Functions

Function	Description
XlistTraverse()	Iterate across the list of elements.
XlistGetPtr()	Return a pointer to a specific element.
XlistGet()	Return a copy of a specific element.
Xlist2Gesture()	Extracts the gestures from an Xlist.
Xlist2String()	Extracts the text from an Xlist.

Most Xlist functions are described in Chapter 60, Using Xlists. \PENPOINT\SDK\SAMPLE\ADDER, a sample program included with the PenPoint™ Software Developer's Kit, provides a good example of the use of insertion pads and translators.

Chapter 57 / Using clsSPaper

clsSPaper (scratch paper) is called to create a view object that will both display a user interface window that accepts pen input and manage the collected input in a data object called a scribble. Additionaly, instances of **clsSPaper** have the built-in facility to attach and manage a translator object from the handwriting translation classes.

Topics covered in this chapter are:

- **clsSPaper** messages.
- Subclassing **clsSPaper** in your application.
- Rendering feedback with a drawing context.
- Handling the translation message cycle.

clsSPaper Messages 57.1

clsSPaper inherits from **clsView**. Table 57-1 summarizes the messages defined by **clsSPaper**.

Table 57-1
clsSPaper Messages

Message	Takes	Description
		Class Messages
msgNew	P_SPAPER_NEW	Creates a new clsSPaper object.
msgNewDefaults	P_SPAPER_NEW	Intializes the SPAPER_NEW structure to default values.
		Attribute Messages
msgSPaperGetFlags	P_U16	Passes back the flags.
msgSPaperSetFlags	P_U16	Sets the flags.
msgSPaperGetCellMetrics	P_SPAPER_CELL_METRICS	Passes back the metrics for the internal divisions.
msgSPaperSetCellMetrics	P_SPAPER_CELL_METRICS	Changes the cell metrics and resizes window.
msgSPaperGetSizes	P_SIZE16	Passes back the line height and character width sizes, in points.
msgSPaperSetSizes	P_SIZE16	Sets the line height and character width sizes, in points.
		Stroke Gathering and Translation Messages
msgSPaperGetTranslator	P_OBJECT	Passes back the translator object uid.
msgSPaperSetTranslator	P_OBJECT	Replaces the translation object, passes back the old translator.
msgSPaperGetScribble	P_OBJECT	Passes back the scribble object (may be NULL).

continued

Table 57-1 (continued)

Message	Takes	Description
msgSPaperSetScribble	P_OBJECT	Replaces the SPaper scribble object. Returns the old scribble object through P_OBJECT.
msgSPaperClear	NULL	Clears the stored strokes.
msgSPaperAddStroke	P_INPUT_EVENT	Add a stroke to the spaper and scribble.
msgSPaperLocate	P_SPAPER_LOCATE	Sub-class call to set up for stroke processing.
msgSPaperDeleteStrokes	P_RECT32	Deletes the strokes under the given rectangle.
msgSPaperComplete	nothing	Indicates that stroke entry is done.
msgSPaperAbort	nothing	Indicates that stroke entry is cancelled.
msgSPaperXlateCompleted	OBJECT	Sent when there is data to get out of the translator.
msgSPaperGetXlateData	P_XLATE_DATA	Returns the latest translated data.
msgSPaperGetXlateDataAndStrokes	P_SPAPER_XDATA	Passes back the latest translated data with the stroke data.
		Interesting Inherited Messages
msgFree	P_OBJ_KEY	Defined in CLSMGR.H.
msgSave	P_OBJ_SAVE	Defined in CLSMGR.H.
msgRestore	P_OBJ_RESTORE	Defined in CLSMGR.H.
msgXlateCompleted	nothing	Defined in XLATE.H.
msgWinRepaint	nothing	Defined in WIN.H.
msgWinSized	P_WIN_METRICS	Defined in WIN.H.
msgWinLayoutSelf	P_WIN_METRICS	Defined in WIN.H.
msgInputEvent	P_INPUT_EVENT	Defined in INPUT.H.

clsSPaper Facilities 57.2

clsSPaper provides general facilities for accepting pen input on the screen, handling the collected data, performing a translation on the pen data, and rendering user feedback. Other more specialized classes such as **clsIP** use **clsSPaper**'s general functionality, and then wrap a useful component or toolkit interface around it. With **clsIP** you only need to set a style flag to get various forms of pen input capture and translation. Using these **clsSPaper**-based components makes it easier for you to build advanced input capabilities in the user interface for your application.

clsSPaper maintains a scribble object and a translator object. As a descendent of **clsView**, it displays a window and the data object that it maintains is the scribble. It then orchestrates interaction with the input subsystem so that pen strokes are accumulated in the scribble data object.

clsSPaper manages the window display with options that will display rule lines or character boxes to aid handwriting input. Because **clsSPaper** maintains the scribble data object, you can ask **clsSPaper** to redisplay the user's original digitized input.

Whenever the user terminates input at the screen (different styles of termination are options that are settable) **clsSPaper** passes the accumulated scribble data to a translator object. When the translator object has completed its pass on the data, **clsSPaper** notifies the client that the translation data is available for processing.

Examples

To use **clsSPaper** directly in your application UI, you should create a subclass of **clsSPaper** that adds the particulars necessary for the capture and translation of pen input. Your subclass will need to add:

- Rendering for user feedback in the window.
- **clsSPaper** options for input and translation styles.

This section provides examples showing the steps to do this using the sample program WriterApp. The application source files are part of the PenPoint™ SDK distribution, in the directory \PENPOINT\SDK\SAMPLE\WRITERAP.

Example 57-1

Using a Drawing Context to Render Visual Feedback

Your **clsSPaper**-based window will need to show some sort of feedback as the user writes input in it. This example shows how WriterApp sets up a drawing context (DC) so that it will print text characters in the window after the translation is done.

WriterCompleted() is the message handler for **msgSPaperXLateCompleted**, which clsSPaper self-sends when the user has completed input and the translation object has finished the translation. You will see in a moment how to set up a window as a subclass of **clsSPaper**, so that self (the window object) inherits the capability to self-send **msgSPaperXLateCompleted**.

```
/****************************************************************************
 WriterCompleted
 Called when the translation is complete. Will get xlist from the spaper
 (self), set up a dc to draw the text, and traverse the xlist to draw the
 text.
****************************************************************************/
MsgHandler(WriterCompleted)
{
    XLATE_DATA xData;
    SHOW_DATA show;
    SYSDC_NEW dcNew;
    STATUS s;
    // Get the translated data from the spaper (self)
    xData.heap = osProcessHeapId;
    ObjCallRet(msgSPaperGetXlateData, self, &xData, s);
    // Convert the xlist form bounds/word/bounds/word pairs to
    // bounds/text/bounds/text
    XList2Text(xData.pXList);
    // Create a drawing context to paint the text and initialize
    ObjectCall(msgNewDefaults, clsSysDrwCtx, &dcNew);

    ObjCallRet(msgNew, clsSysDrwCtx, &dcNew, s);
    ObjectCall(msgDcSetWindow, dcNew.object.uid, self);
    ObjectCall(msgDcUnitsDevice, dcNew.object.uid, Nil(P_ARGS));
```

continued

```
        ObjectCall(msgDcSetForegroundRGB, dcNew.object.uid, (P_ARGS)sysDcRGBBlack);
        ObjectCall(msgDcSetBackgroundRGB, dcNew.object.uid, (P_ARGS)sysDcRGBWhite);
        // Set up the font of the drawing context to something reasonable
        SetupFont(SysDcFontId("HE55"), 16, 16, dcNew.object.uid);
        // Begin painting
        ObjCallJmp(msgWinBeginPaint, dcNew.object.uid, Nil(P_ARGS), s, error);
        // Traverse the xlist and display the text
        show.self = self;
        show.dc = dcNew.object.uid;
        XListTraverse(xData.pXList, ShowText, &show);
    error:
        // End the painting, destroy the drawing context, and free the xlist
        ObjectCall(msgWinEndPaint, dcNew.object.uid, Nil(P_ARGS));
        ObjectCall(msgDestroy, dcNew.object.uid, Nil(P_ARGS));
        XListFree(xData.pXList);
        return stsOK;
        MsgHandlerParametersNoWarning;
    }
```

Parsing the Xlist Data 57.3

The first thing that **WriterCompleted()** does is ask for the translated data in the form of an Xlist. Because **clsSPaper** automatically manages a scribble data object and a translator object, you don't need to worry about these. The method simply sends **msgSPaperGetXLate** data to the client object **self**. The message will find its way up to the ancestor **clsSPaper** and be processed correctly. The data is returned and further formatted by being passed through the **Xlist2Text** filter function.

Rendering the Translated Text 57.4

Then **WriterCompleted()** sends a series of messages to **clsSysDrwCtx** to create and initialize a DC. The local **SetUpFont()** function opens and sets the characteristics of the font for the DC. Finally, the DC is activated when the Xlist is traversed with the **XlistTraverse** function. This call contains a pointer to the local **ShowText()** function which actually pulls the characters from the Xlist and plugs them into the DC. The window repaints whenever data is released to the DC, because **msgWinBeginRepaint** was sent to the DC giving it the right to repaint the window with new rendering.

Subclassing clsSPaper 57.5

WriterApp's main window is a view object that incorporates both the inherited functionality from **clsSPaper** as well as the customization in **WriterCompleted()**. To do this requires a subclass of **clsSPaper** with additional behavior. The following example from **WriterApp**'s **WriterInit()** function shows how to create a subclass of **cslSPaper** called **clsWriter**.

Example 57-2
Creating a Subclass of clsSPaper

This example shows how to create a subclass of **clsSPaper**. It starts by sending **msgNewDefaults** to **clsClass**, assigning the CLASS_NEW variable **c** to contain the defaults for all new classes. The following statements set the values specific to the new class, such as its UID (**clsWriter**) and ancestor in the class hierarchy (**clsSPaper**). Finally, it uses this completed CLASS_NEW structure as the argument to **msgNew**, to which **clsClass** responds with the new class.

```
/***************************************************************************
 WriterInit
 Intalls the clsWriter class. This is a subclass of spaper.
 ***************************************************************************/
STATUS GLOBAL WriterInit(void)
{
    CLASS_NEW c;
    ObjectCall(msgNewDefaults, clsClass, &c);
    c.object.uid =      clsWriter;
    c.object.cap |=     objCapCall;
    c.object.key =      (OBJ_KEY)clsWriter;
    c.cls.pMsg =        clsWriterTable;
    c.cls.ancestor =    clsSPaper;
    c.cls.size =        Nil(SIZEOF); // no instance data
    c.cls.newArgsSize = SizeOf(SPAPER_NEW);
    return ObjectCall(msgNew, clsClass, &c);
}
```

Creating an Instance of a clsSPaper Subclass 57.6

Now that you have defined this special view class, you need to build the application shell that will run it. The application provides hooks into the PenPoint application environment—it registers the application as an entry in the stationery menu, provides a frame with a title bar and close corner, and in this example it provides a local menu bar that allows the user to select the type of translation object to use.

Example 57-3
Initializing a clsSPaper-Based Main Window

This code fragment shows how the application initializes its user interface. It creates an instance of **clsWriter** to be used as the main window in the application. It also sets up a menu for selecting translation styles, and creates a first default translator object to be attached to the **clsWriter** instance when the application is opened. **WriterAppInit()** is called whenever the user launches an instance of the application.

```
/***************************************************************************
 WriterAppInit

 Initialize the display for the first time.
***************************************************************************/
MSG_HANDLER WriterAppInit(
    const   MESSAGE         msg,
    const   OBJECT          self,
    const   P_ARGS          pArgs,
    const   CONTEXT         ctx,
```

continued

Example 57-3 (continued)

```
    const   P_IDATA         pData)
{
    APP_METRICS     am;
    FRAME_METRICS   fm;
    WIN_METRICS     wm;
    MENU_NEW        mNew;
    SPAPER_NEW      sNew;
    STATUS          s;
    // Ancestor called in method table
    // Get the main window
    ObjCallRet(msgAppGetMetrics, self, &am, s);
    // Create the client window
    ObjCallRet(msgNewDefaults, clsWriter, &sNew, s);
    sNew.sPaper.flags |= spCapture | spRedisplay | spGrab | spProx;
    ObjCallRet(msgNew, clsWriter, &sNew, s);
    // Create the menu bar
    ObjectCall(msgNewDefaults, clsMenu, &mNew);
    mNew.menu.style.type = msTypeMenuBar;
    mNew.tkTable.pEntries = menuBar;
    mNew.tkTable.client = self;
    ObjCallRet(msgNew, clsMenu, &mNew, s);
    // Set the client window and menu bar in the application frame
    ObjCallRet(msgFrameGetMetrics, am.mainWin, &fm, s);
    fm.clientWin = sNew.object.uid;
    fm.style.menuBar = true;
    fm.menuBar = mNew.object.uid;
    ObjCallRet(msgFrameSetMetrics, am.mainWin, &fm, s);
    // Force a translator (word) to be created
    ObjectCall(msgWriterAppTranslator, self, (P_ARGS)0);
    // Force the applicaiton to lay itself out
    wm.options = wsLayoutResize;
    ObjectCall(msgWinLayout, am.mainWin, &wm);
    return stsOK;
    MsgHandlerParametersNoWarning;
}
```

Setting the clsSPaper Input Flags

57.7

One of the first things **WriterAppInit()** does is send **msgNew** to **clsWriter** to get a new instance of your special view class. As a part of the **pArgs** for this message, the application sets several flags that control the input termination style and pen inking behavior. The flags are defined in SPAPER.H. Table 57-2 lists the **clsSPaper** input flags briefly to show what is available.

Table 57-2
clsSPaper Input Flags

Input Flag	Meaning when set
spCapture	save scribbles between translations
spProx	out of proximity calls msgSPaperComplete
spFixedPos	top left is fixed during resize
spPenCoords	window-relative pen coordinates from Xlist (for xtPolyline and xtSpline only)
spGrab	grab input on penDown, release after msgSPaperAbort or msgSPaperComplete
spScribbleEdit	enable scribble editing
spRedisplay	redraw and display strokes
spSuppressMarks	disable spRuling, spVRuling, spTick and spGrid display
spRuling	enable horizontal ruling
spVRuling	enable vertical ruling
spGrid	enable grid lines (with spRuling)
spBaseLine	make horizontal rules a baseline
spTick	enable tick marks (with spRuling)

After building the application menu (the menu table entries are defined at the top of WRITERAP.C), **WriterAppInit()** plugs all of the UI elements into the frame metrics for the application. The **clsWriter** instance is inserted as the application's main window with the line:

```
fm.clientWin = sNew.object.uid;
```

The metrics are set when the method sends **msgFrameSetMetrics.**

Dynamically Setting the clsSPaper Translator 57.8

The default translator object is set when **WriterAppInit()** sends **msgWriterAppTranslator** to **self.** This invokes a method **WriterAppTranslator()** that dynamically sets the translation object in the **clsWriter** instance.

Example 57-4
Setting the Translator for a clsSPaper Object

This code fragment shows the message handler **WriterAppTranslator().** This method is called whenever the user selects a translation style from WriterApp's Translator menu. It is also called by the initialization method **WriterAppInit()** when the application is opened so that the view object will have a default translator when the UI is presented to the user.

Depending on the selection that the user has made in the Translator menu, this method will create a new **clsXWord** or **clsXText** object and pass the new object's UID to the view object with **msgSPaperSetTranslator.**

Because **clsWriter** is a subclass of **clsSPaper,** and has its **spRedisplay** flag set, the view object automatically keeps the scribble data around between translations. This makes it possible for the user to toggle between translators and retranslate the current input. This is done with the line:

```
ObjectCall(msgSPaperComplete, fm.clientWin, null);
```

continued

Example 57-4 (continued)

This in effect simulates an input termination to the view object which then begins the translation using the old scribble data.

```
/****************************************************************************
 WriterAppTranslator
 Called when the translator is changed from the menu in the application.
 Will create a new translator based on which menu item was chosen and
 and give to the spaper. Will cause translation to re-occur.
 ****************************************************************************/
MsgHandler(WriterAppTranslator)
{
    APP_METRICS am;
    FRAME_METRICS fm;
    XLATE_NEW xNew;
    STATUS s;
    OBJECT oldTranslator;
    ObjCallRet(msgAppGetMetrics, self, &am, s);
    ObjCallRet(msgFrameGetMetrics, am.mainWin, &fm, s);
    switch ((U16)(U32)pArgs) {
        case 0:
            //clsXWord
            ObjectCall(msgNewDefaults, clsXWord, &xNew);
            ObjCallRet(msgNew, clsXWord, &xNew, s);
            break;
        case 1:
            // clsXText with only numbers
            ObjectCall(msgNewDefaults, clsXText, &xNew);
            xNew.xlate.charConstraints = disableUpperCase | disableLowerCase
                                       | disableCommonPunct | disableOtherPunct;
            ObjectCall(msgNew, clsXText, &xNew);
            break;
        case 2:
            // clsXText
            ObjectCall(msgNewDefaults, clsXText, &xNew);
            ObjectCall(msgNew, clsXText, &xNew);
            break;
        default:
            return stsOK;
    }
    // dirty everything for the repaint
    ObjectCall(msgWinDirtyRect, fm.clientWin, Nil(P_ARGS));
    // force the repaint
    ObjectCall(msgWinUpdate, fm.clientWin, Nil(P_ARGS));
    ObjCallRet(msgSPaperGetTranslator, fm.clientWin, &oldTranslator, s);
    ObjCallRet(msgSPaperSetTranslator, fm.clientWin, &xNew.object.uid, s);
    // Free the old translator
    if (oldTranslator != objNull)
        ObjectCall(msgDestroy, oldTranslator, Nil(P_ARGS));
    // force retranslation
    ObjectCall(msgSPaperComplete, fm.clientWin, Nil(P_ARGS));
    return stsOK;
    MsgHandlerParametersNoWarning;
}
```

Chapter 58 / Using the Translation Classes

The translation classes segment the strokes of a scribble object into sets of one or more strokes and translate the sets into computer-readable characters or other meaningful content. Different translation classes focus on various types of expected input such as gestures, letters, numbers, or whole words. The appropriate translator object can be created by the client according to the context of the input session.

A **stroke** is a mark defined by the path of the pen from the point at which the pen tip touches the display to the point at which it comes up from the display. A **scribble** is simply a collection of strokes.

A translation object can accept stroke data from a scribble as the user enters strokes, or it can wait until the user has completed the input and then translate the accumulated stroke data. Translator objects return gesture IDs or ASCII character data to the client in a dynamic array called an **Xlist**.

The client object that manages the input window, scribble data object, and translator object is typically an instance of **clsView** or one of its descendants, such as **clsSPaper**. For example, an input pad manages an input window for the purpose of gathering scribble data from the user. The input pad also manages a translator object, to which it passes the scribble data for translation.

Topics covered in this chapter are:

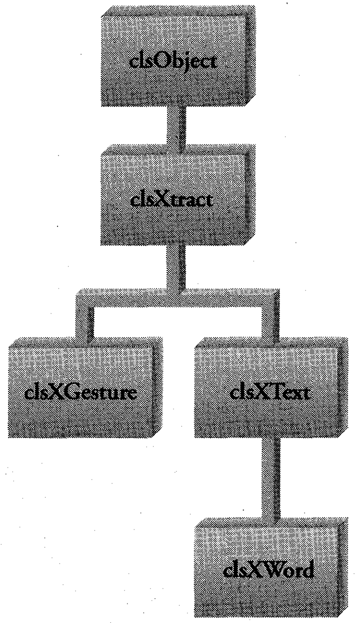
- Translation class hierarchy.
- Translation class data structures.
- Handwriting translation flags.
- Translation templates.
- Translation class messages.

In the current version of PenPoint™, the translation classes are designed for American English input. Future versions of PenPoint with international language support will use an improved approach to handwriting translation.

Hierarchy of the Translation Classes 58.1

The translation classes all descend from **clsXtract**, which contains the functional interface to the feature extraction and recognition engine. Figure 58-1 shows the inheritance hierarchy of the translation classes.

Figure 58-1
Translation Class Hierarchy



For historical reasons, two header files declare the messages and functions to which **clsXtract** can respond. XLATE.H declares most of the messages; XTRACT.H declares the rest. As a result, many of the data structures and messages **clsXtract** uses include the term **xlate** in their names. Keep in mind that **clsXtract** is the real class. There is no **clsXlate**.

Remember to include both XLATE.H and XTRACT.H when you need to use ***clsXtract****.*

Translation Data Structures 58.2

clsXtract defines several data structures that serve as arguments to its messages. Some of the data structures, such as the XLATE_METRICS data structure, are composed of a collection of smaller, lower level data structures. This section describes each of these data structures.

XLATE_METRICS Structure 58.2.1

The XLATE_METRICS structure contains information about the insertion pad to which the translator is attached. The insertion pad sets the values in this structure when the translator is attached with **msgIPSetTranslator**. The XLATE_METRICS structure contains the following fields (the types of each field appear in parentheses following the name):

lineCount (U16) number of lines in the insertion pad. If this value is zero, the number of lines is not fixed.

charCount (U16) number of character columns in the insertion pad. If this value is zero, the number of columns is not fixed.

charBox (SIZE32) height and width of character box.

baselineOffset (S32) baseline offset to bottom of char box (if **charCount** is not zero).

XLATE_CASE_METRICS Structure 58.2.2

Translators can use "smart case" heuristics for handling letter case. If the **smartCaseDisable** flag is not set (see "Handwriting Translation Flags," below), then the translator uses the information in its XLATE_CASE_METRICS structure to determine how to capitalize words.

type (XLATE_CASE_TYPE) whether to translate as a field or sentence. Possible values for **type** include:

xcmNone force everything to lower case.

xcmSentence capitalize the first letter of each sentence. Use the **context.sentence** value to determine letter case heuristics.

xcmField use the **context.field** value to determine letter case heuristics.

writer (XLATE_CASE_WRITER) whether to expect all uppercase or mixed-case text. This normally reflects the user preference set in the Settings notebook. Possible values for **writer** include:

xcmMixedCaseWriter writer uses mixed upper and lower case.

xcmAllCapsWriter writer uses all upper case letters.

context (union of SPELL_CASE_CONTEXT and XLATE_CASE_FIELD) context guidelines for translating text. If **type** is **xcmSentence**, use **context.sentence**, a SPELL_CASE_CONTEXT structure as defined in SPELL.H. If type is **xcmField**, use **context.field**, an XLATE_CASE_FIELD structure with the following possible values:

xcmOneInitialCapField capitalize first letter in the field.

xcmAllInitialCapsField capitalize first letter in each word.

xcmAllCapsField captialize all letters in the field.

XLATE_NEW Structure 58.2.3

The XLATE_NEW structure includes an OBJECT_NEW_ONLY structure called **object**, through which **clsXtract** inherits from **clsObject**. For information specific to **clsXtract**, the XLATE_NEW structure includes an XLATE_NEW_ONLY structure called **xlate**. The following section describes the XLATE_NEW_ONLY structure.

XLATE_NEW_ONLY Structure 58.2.3.1

The XLATE_NEW structure includes an XLATE_NEW_ONLY structure called **xlate**. xlate includes the following fields:

hwxFlags (U32) a set of flags representing translation rules (see **msgXlateFlagsSet**). "Handwriting Translation Flags," below, discusses the flags in more detail.

charConstraints (U16) flags constraining the characters the writer is expected to write. This may improve translation accuracy because the shape matcher will know that it does not need to consider certain characters as possibilities. The possible contraints (which you may combine) include:

xltDisableUpperCase disallow A through Z.

xltDisableLowerCase disallow a through z.

xltDisableNumerals disallow 0 through 9.

xltDisableCommonPunct disallow .,'!?;:%$#+-/*()"=.

xltDisableOtherPunct disallow all other punctuation.

metrics (XLATE_METRICS) information about the insertion pad to which the translator is attached. See "The XLATE_METRICS Structure," above, for details.

pTemplate (P_UNKNOWN) a pointer to a compiled translation template, or **pNull** if none. See "Translation Templates," below, for details.

xlateCaseMetrics (XLATE_CASE_METRICS) case post-processing controls. See "The XLATE_CASE_METRICS Structure," above, for details.

Handwriting Translation Flags 58.3

A translator receives a scribble from an input pad, then segments the scribble into sets of one or more strokes. The translator translates the sets of strokes and associates a **score**, a measure of confidence in the translation, with the translation.

Translators use a number of rules in scoring a translation, giving higher scores to translations that obey the rules. One of the fields in an XLATE_NEW structure is a U32 called **xlate.hwxFlags**, which contains a variety of flags that govern which rules to use in this process. You can think of these rules as falling into three categories:

built-in rules rules involving translation abilities built into the translator.

knowledge-source rules rules involving external sources of information such as a spelling checker or template.

post-processing rules rules involving changes to the text after it is translated.

The following sections discuss each of these types of rules and the **xlate.hwxFlags** flags associated with them.

Built-In Rules 58.3.1

The built-in rule flags direct the translation object use various default language rules to assist recognition. When a flag is turned on, the translator will show a preference for translations which obey the rule associated with that flag. For example if **caseEnable** is on, the translator will show a preference for words that are all lower case, all upper casem, or all lower case except the first letter.

The flags governing the built-in rules include:

xltSegmentVeto disallow translations that yield more than one character per character box.

xltCaseEnable weigh in favor of translations that fit standard rules of capitalization (the first word of each sentence is capitalized, for example).

xltAlphaNumericEnable weigh in favor of translations that fit standard groupings of letters and digits (for example, a word that begins with a digit is a number).

xltPunctuationEnable weigh in favor of translations that fit standard rules of punctuation (for example, a comma does not follow a space).

Knowledge Source Rules 58.3.2

PenPoint supports two knowledge sources which a translator can use to improve its translation accuracy: the spelling dictionary and translation templates. The **spelling dictionary** is a list of correctly spelled words and rules for generating other correct words (by adding word endings, for example). A **translation template** improves translation accuracy by constraining the way in which the translator interprets handwritten input. "Translation Templates," later in this chapter, discusses translation templates in more detail

Certain translation flags direct the translator to use to these knowledge sources as an aid to handwriting recognition. There are three types of flag for each knowledge source:

Enable enables the use of a particular knowledge source, giving preference to translations that conform to the source.

Veto when the knowledge source is enabled, rejects any translation that does not conform to the source.

Propose when the knowledge source is enabled, if the translator can't generate a translation with a high enough score, the knowledge source proposes translations that conform to the source.

Therefore, the valid knowledge-source flags include:

xltSpellingEnable use spelling dictionary and give preference to words in the dictionary.

xltSpellingVeto reject words not in the spelling dictionary.

xltSpellingPropose propose words from the dictionary when the translator doesn't find a best guess.

xltTemplateEnable use the translation template and give preference to words that match the template.

xltTemplateVeto reject words that do not match the template.

xltTemplatePropose propose translations that match the template when the translator doesn't find a best guess.

The Veto and Propose flags may be used individually or combined, but they have no effect unless the corresponding Enable flag is set.

Post-Processing Rules 58.3.3

The translation object can apply postprocessing rules to assist errorchecking and **proofing**, or spelling correction. The only post-processing currently implemented is the **smart case** behavior. This capability calls for the translator to use linguistic rules to correct the capitalization of the translation. The translator applies smart case corrections unless you disable this behavior by setting the **xltSmartCaseDisable** flag.

Translation Templates 58.4

A **translation template** is a data structure that defines constraints on the way a translator interprets handwriting input. For example, using a translation template, you can force the translator to restrict its output to a certain set of words or characters. By limiting the translator output to a smaller set, translation templates can improve translation accuracy.

A translation template is a single, allocated block of memory containing no internal pointers. PenPoint provides a function, **XTemplateCompile()**, that lets you "compile" an XTM_ARGS data structure into a translation template. An XTM_ARGS structure includes the following fields:

The XTEMPLT.H SDK header file describes a variety of utility functions for working with translation templates.

xtmType (XTEMPLATE_TYPE) the type of translation template. Each of the types is discussed further in "Template Types," below.

xtmMode (XTEMPLATE_MODE) the way in which the translator should use the template. Each of the modes is discussed in "Template Modes," below.

pXtmData a pointer to the data set defining the template, according to template **type**. For example, **pXtmData** might point to a list of acceptable characters, or a list of acceptable words.

Template Types 58.4.1

The **xtmType** value specifies how to interpret the data to which **pXtmData** points. Possible values are:

xtmTypeNone The template does not restrict translations in any way. **pXtmData** is ignored.

xtmTypeGesture the template restricts translations to a limited set of gestures. **pXtmData** points to an XTEMPLATE_GESTURE structure, which includes the following fields:

count (U32) the number of gestures in the list of acceptable translations.

pGestures (P_MESSAGE) a pointer to an array of **count** acceptable gestures (32-bit codes defined in XGESTURE.H).

xtmTypeCharList the template restricts translations to a limited set of characters. **pXtmData** is a P_STRING pointing to a null-terminated array of acceptable characters.

xtmTypeWordList the template restricts translations to a limited set of words. **pXtmData** is a PP_STRING pointing to an array of null-terminated strings denoting the acceptable words. To identify the end of the array of acceptable words, the last pointer in the list must be Nil(P_STRING).

xtmTypePicture the template restricts translations to strings matching a specific pattern, or **picture**. **pXtmData** points to a string representing the picture. Certain characters in a picture string have special meanings:

- 9 the corresponding character must be numeric (a digit from 0 to 9).
- a the corresponding character position must be alphabetic.
- A the corresponding character position must be upper-case alphabetic.
- n the corresponding character position must be alphabetic or numeric.
- N the corresponding character posistion must be upper-case alphabetic or numeric.
- x the corresponding character position may be any character.
- [the following characters up to but not including the next right square bracket (]) define a set of characters of which the corresponding character position must match one. The 9, a, A, n, N, and x characters do not have special meanings within square brackets. A hyphen within square brackets indicates a range of characters. For example, [abe] matches a, b, or e, while [ab-e] matches a, b, c, d, or e.
- \ ignore any special meaning for the following character literally. For example, 9 matches any digit, while \9 matches only the digit 9. Similarly, [a-c] matches a, b, or c, while [a\-c] matches a, -, or c.

Template Modes 58.4.2

The **xtmType** values described in the previous section specify how to interpret the template data (for example, as a list of words). The **xtmMode** value specifies how to apply the data set to the translations. Possible values for **xtmMode** include:

xtmModeDefault reject any translation that does not match the template exactly.

xtmModePrefixOK consider translations that match any prefix of the template to match the template.

xtmModeLoopBackOK consider translations that match any number of repetitions of the template to match the template.

xtmModeCoerced coerce the translation to match the template, even if it doesn't match exactly. This is meaningful only for templates of type **xtmTypeWordList**.

Translation Messages

58.5

Do not use private messages.

For historical reasons, the two header files that declare **clsXtract** declare some private messages which you should not use. A future release of PenPoint will correct this problem. For now, just don't use the private messages.

Table 58-1 summarizes the public **clsXtract** messages and functions.

Table 58-1
clsXlate Messages

Message	pArgs	Description
		Class Messages
msgNewDefaults	P_XLATE_NEW	Initializes the XLATE_NEW structure to default values.
msgNew	P_XLATE_NEW	Creates a new translation object.
		Translator Initialization Messages
msgXlateModeSet	HW_MODE	Sets the mode of the translation object.
msgXlateModeGet	P_HW_MODE	Gets the mode of the translation object.
msgXlateMetricsSet	P_XLATE_METRICS	Set the translation object's XLATE_METRICS to communicate UI-based information that may assist in segmenting the incoming strokes into characters.
msgXlateMetricsGet	P_XLATE_METRICS	Reports the translation object's XLATE_METRICS values.
msgXlateStringSet	P_XLATE_STRING	Sets the current textual context for the translation object.
msgXlateSetFlags	U32	Sets the translation flags of the translation object.
msgXlateGetFlags	P_U32	Gets the translation flags of the translation object.
msgXlateFlagsClear	U32	Clears the translation flags of the translation object.
msgXlateCharConstrainsSet	P_U16	Sets the character constraints of the translation object.
msgXlateCharConstrainsGet	P_U16	Gets the character constraints of the translation object.
msgXlateTemplateGet	PP_UNKNOWN	Gets the template for the translation object.
msgXlateTemplateSet	P_UNKNOWN	Sets the template for the translation object.
msgXlateCharMemorySet	P_CHARACTER_MEMORY	Sets the current character memory for character box mode.
msgXlateCharMemoryGet	P_CHARACTER_MEMORY	Gets the current character memory for character box mode.
msgXlateSetXlateCaseMetrics	P_XLATE_CASE_METRICS	Sets the "smart case" metrics.
msgXlateGetXlateCaseMetrics	P_XLATE_CASE_METRICS	Gets the "smart case" metrics.
msgXlateSetHistoryTemplate	P_UNKNOWN	Subclass hook for implementing a translation history for the translator.
msgXlateGetHistoryTemplate	PP_UNKNOWN	Gets the current alternate translation template, if the subclass implements such behavior.
msgXtractGetScribble	P_OBJECT	Reports the UID of the scribble object to which the translator is attached.

continued

Table 58-1 (continued)

Message	pArgs	Description
		Translation Control Messages
msgScrAddedStroke	P_SCR_ADDED_STROKE	The scribble object sends this message to the translator when it gets a new stroke.
msgScrRemovedStroke	P_SCR_REMOVED_STROKE	The scribble object sends this message to the translator when an existing stroke is deleted.
msgScrCompleted	pNull	When the scribble knows there will be no more strokes added, it sends this message to the translator. This causes the translator to self-send msgXtractComplete.
msgXtractComplete	pNull	Self-sent in response to msgScrCompleted. Provides hook for subclasses to complete translation of scribble.
		Notification Messages
msgXlateData	P_XLATE_DATA	Reports translated data from a translation object.
msgXlateCompleted	pNull	Notifies client that translation is complete. Client normally will respond by sending msgXlateData to discover the translation result.

Creating a Translator 58.5.1

You create instances of subclasses of **clsXtract**, not of **clsXtract** itself.

You create a translator in the usual way. Send **msgNewDefaults**, with a P_XLATE_NEW as its argument, to a **clsXtract** subclass (**clsXText**, **clsXWord**, or **clsXGesture**). **clsXtract** sets the referenced XLATE_NEW structure to default values. You then send **msgNew** to the class, with the same P_XLATE_NEW as its argument. This creates a new instance of the class, and the class sets the **uid** field of the referenced XLATE_NEW to the UID of the new instance.

If you think you need to change any of the default values, you can do so after sending **msgNewDefaults**, by directly assigning fields of the XLATE_NEW structure, or after creating the translator object with **msgNew**. After creating the object, you can change these values by sending **msgXlateMetricsSet**, **msgXlateStringSet**, and **msgXlateSetFlags**.

Initialization Messages 58.5.2

Translator initialization messages are messages sent before the translator interprets the user's input. For example, **msgXlateSetFlags** sets the translator flags described in "Handwriting Translation Flags," above. Another initialization message, **msgAdded**, establishes the translator as an observer of a particular scribble object. After the translator is attached to a scribble in this way, the scribble object will send messages to the translator to notify it of changes in the state of the scribble.

Control Messages 58.5.3

Control messages are messages that control how the translator gathers stroke data from the scribble it is observing. The scribble sends **msgScrAddedStroke** to the translator every time the user adds a stroke to the input, and **msgScrRemovedStroke** every time the user removes a stroke. The translator can use these notifications to implement dynamic translation.

When the scribble determines that the user input is complete (for example, when the user presses the OK buttton on the input pad), it sends **msgScrCompleted** to the translator. The translator object responds to **msgScrCompleted** by self-sending **msgXtractComplete. clsXtract** subclasses should respond to **msgXtractComplete** by translating the stroke data that the clsXtract object has gathered.

Notification Messages 58.5.4

The translator object sends **msgXlateCompleted** to its client (usually an input pad) to notify the client that the translation is complete.

The client sends **msgXlateData** to get the result of the translation. The translation result is an **Xlist** whose specific type depends on the specific subclass of **clsXtract.** See Chapter 60, Using Xlists, for more information on Xlists. The client can send **msgXlateData** only once, after which the translator frees all resources related to the translated data.

Chapter 59 / Using Scribbles

A **stroke** is a mark defined by the path of the pen from the point at which the pen tip touches the display to the point at which it comes up from the display. A **scribble** is simply a collection of strokes. **clsScribble**, which inherits directly from **clsObject**, provides a storage mechanism for scribbles, enables scribbles to render themselves, and establishes a protocol for communicating with translators (subclasses of **clsXtract**).

Scribble Concepts 59.1

This section describes some of the basic concepts of scribbles.

Stroke Indexing 59.1.1

A scribble object maintains a collection of strokes in an indexed, internal list. The strokes are numbered from zero, and the index increases for each added stroke. Strokes may be removed from a scribble, as well, but this does not affect the indexing. When a stroke is removed, it is simply marked as removed; its structure remains intact.

Scribble Base and Bounds 59.1.2

Each scribble has a **base**, a point in digitizer coordinates that specifies the scribble's offset from the origin of the window in which it exists. The coordinates of strokes in the scribble are stored relative to the scribble base.

A current optimization requires all of the strokes in a single scribble must be within 32767 digitizer points of one another to allow the use of 16-bit values in the handwriting translation system.

This arrangement—the strokes relative to the scribble base, the scribble base relative to the window origin—lets you position the scribble as a unit within the window. An input pad, for example, resets its scribble's base when the user changes the window origin by resizing the input pad. By changing the scribble base, the input pad keeps the scribble a constant distance from the top of the input pad even though the base is specified relative to the window origin.

A scribble's **bounding rectangle**, or simply **bounds**, is the smallest rectangle that encloses all of the scribble's strokes (except those strokes marked as removed).

Rendering 59.1.3

If you provide a drawing context, a scribble can render itself. Input pads take advantage of this behavior whenever the input pad window becomes dirty. See *Part 3: Windows and Graphics* for more information about windows and drawing contexts.

Translator Notification 59.1.4

A scribble implements part of the handwriting translation protocol by defining messages to send to a translator observing the scribble. A scribble notifies its observing translator when the scribble adds or removes a stroke, and when the scribble determines that the user is not going to add more strokes.

clsScribble Messages 59.2

Table 59-1 summarizes the messages **clsScribble** defines. The following sections discuss these messages in more detail.

Table 59-1
clsScribble Messages

Message	pArgs	Description
		Class Messages
msgNewDefaults	P_SCR_NEW	Sets the default values for the msgNew arguments.
msgNew	P_SCR_NEW	Creates and initializes a new scribble object.
		Attribute Messages
msgScrSetBase	P_XY32	Sets the stroke coordinate base for the scribble.
msgScrGetBase	P_XY32	Passes back the scribble base.
msgScrGetBounds	P_RECT32	Passes back the scribble bounds.
msgScrCount	P_U16	Passes back the total number of strokes in the scribble, including strokes marked as removed.
		Stroke Messages
msgScrAddStroke	P_SCR_ADD_STROKE	Adds a stroke to the scribble.
msgScrCat	SCRIBBLE	Concatenates the strokes from another scribble.
msgScrDeleteStroke	U16	Deletes (marks as removed) the stroke associated with a specified index.
msgScrDeleteStrokeArea	P_SCR_DELETE_STROKE_AREA	Deletes all the strokes that touch the specified area.
msgScrClear	void	Deletes and frees all of the scribble's stroke data.
msgScrHit	P_SCR_HIT	Searches for the next stroke which intersects the specified rectangle.
msgScrRender	P_SCR_RENDER	Given a drawing context, renders the scribble in a window.
msgScrStrokePtr	P_SCR_STROKE_PTR	Passes back a pointer to a specific stroke.
		Notification Messages
msgScrComplete	void	Clients send this messsage to the scribble to notify the scribble that stroke entry is complete.
msgScrCompleted	NULL	Sent to observers to indicate that the stroke entry is completed.
msgScrAddedStroke	P_SCR_ADDED_STROKE	Sent to observers to notify them of the addition of a stroke to the scribble.
msgScrRemovedStroke	P_SCR_REMOVED_STROKE	Sent to observers to notify them of the removal of a stroke from the scribble.

Creating a New Scribble Object 59.3

You create a scribble in the usual way, by sending **msgNewDefaults** to **clsScribble** to set a SCRIBBLE_NEW structure to default values, then **msgNew** to create the scribble object. The only value in the scribble part of a SCRIBBLE_NEW is **scribble.base**, an XY32 giving the scribble base offset from the lower left corner of the window.

Scribble Attribute Messages 59.4

A scribble object has a base offset which determines where it will begin to render itself in the window. The scribble base represents digitizer coordinates relative to the lower left corner of the window. You can change the scribble base with **msgScrSetBase**, and learn its current value with **msgScrGetBase**.

A scribble maintains a bounding rectangle, which is the smallest rectangle that contains all of its strokes. You can determine the origin and size of the bounding rectangle, relative to the scribble base, by sending **msgScrGetBounds** to a scribble object.

You can determine the number of strokes a scribble object has recorded by sending **msgScrCount** to the scribble. The number passed back is the total number of strokes, including strokes marked as removed. You normally use **msgScrCount** to set an index for a loop that iterates over every stroke in the scribble.

Stroke Messages 59.5

The primary purpose of a scribble object is to maintain a collection of stroke objects, so it is not surprising that most of the messages **clsScribble** defines are related to the management and manipulation of the strokes.

You can add a stroke to the end of a scribble's list of strokes by sending **msgScrAddStroke** to the scribble, passing the stroke as an argument. You can also copy all of the strokes from one scribble object to another by sending **msgScrCat** to the destination scribble object, passing the source scribble as an argument.

Deleting a stroke does not destroy or free the stroke data, but simply marks the stroke as removed by setting a bit in the stroke data structure. You send **msgScrDeleteStroke** to a scribble object to delete a stroke whose index you specify. You can also delete all strokes within a specified rectangle by sending **msgScrDeleteStrokeArea** to the scribble object. **msgScrDeleteStrokeArea** interprets the rectangle origin and size relative to the scribble base, and marks as removed any stroke whose bounding rectangle intersects the area rectangle.

You can send **msgScrClear** to delete all strokes in the scribble. Unlike **msgScrDelete** and **msgScrDeleteArea**, **msgScrClear** does not simply mark the strokes as removed, but destroys the stroke data and frees the memory space they used.

You can find strokes that fall within a specified rectangle by sending **msgScrHit** to a scribble, passing a pointer to a SCR_HIT structure as an argument. You pass in a rectangle (relative to the scribble base) and stroke index in the SCR_HIT structure. The scribble passes back the index of the first stroke whose bounding rectangle intersects the rectangle you passed in.

You can instruct a scribble to render all of its scribble by sending **msgScrRender** to the scribble, passing a pointer to a SCR_RENDER data structure as an argument. The SCR_RENDER structure specifies a drawing context, a rectangle, and a range of stroke indices. **msgScrRender** renders the strokes in the window to which the drawing context is attached, rendering only those strokes which fall within the specified rectangle (interpreted in LWC) and stroke range. It does not render strokes marked as removed.

If you wish to manipulate an individual stroke, you can send **msgScrStrokePtr** to a scribble, passing a pointer to a SCR_STROKE_PTR structure as an argument. You pass in a stroke index in the SCR_STROKE_PTR argument. The scribble passes back a pointer to the stroke whose index you passed in. Be careful when you use this **messageScrStrokePtr**, as it generates a pointer to the stroke data, not a copy of the stroke.

Notification Messages 59.6

Clients of scribble objects typically establish a protocol for interacting with scribbles, so clsScribble defines a few notification messages to facilitate such protocols. For example, clients can send **msgScrComplete** to a scribble object to inform it that there are no more strokes to process.

Scribble objects send three notification messages to objects that observe the scribble. A scribble sends **msgScrAddedStroke** to observers when the scribble adds a stroke to its stroke list. A scribble sends **msgScrRemovedStroke** to its observers when the scribble marks a stroke as removed. Finally, a scribble sends **msgScrCompleted** to observers when the scribble receives **msgScrComplete**.

Chapter 60 / Using Xlists

An Xlist is a dynamic array of elements, stored in a heap you associate with the Xlist when you create it. Xlists of various types are used throughout the system. The primary purpose of Xlists is to pass translated information between translator objects and their clients (such as input pads), but it is possible to use Xlists for other purposes.

Xlist.H defines functions that you use to:

- Create, modify, and destroy Xlists.
- Traverse lists, access, and set list element.
- Filter data from Xlists.

An Xlist filter converts an Xlist into an Xlist of a different format (see XLFILTER.H for an example).

Concepts 60.1

An **Xlist** is a data structure that contains of a list of pointers to Xlist elements, a set of Xlist flags, and other internal data. The actual organization of an Xlist is private; you use the Xlist functions to create and modify Xlists.

When a client creates an Xlist, the list and its elements are allocated from a heap specified by the client. A client can use this heap to allocate space for the list elements (with **XlistAlloc**; the element flag must be **xfHeapAlloc**). The data allocated from the heap is deallocated when the client frees the Xlist or calls **XlistFreeData.** Clients can allocate other data from the Xlist heap, but it is not recommended (it is the client's responsibiltity to free this data).

Xlist Flags 60.1.1

Each Xlist has a 32-bit value used for flags. These flags store data about the Xlist. Do not confuse these Xlist flags with the element flags that are stored in each Xlist element.

The flag values **flag0** through **flag15** are used by PenPoint™ (and are described below). The flag values **flag16** through **flag31** can be used by clients.

The only flag defined by PenPoint is **xflXlist2Text**, which indicates that the Xlist has already been processed through the function **Xlist2Text.**

Xlist Elements 60.1.2

Each Xlist element is defined by the structure Xlist_ELEMENT. The structure contains the following fields:

flags (U16) element flags.
type (XTYPE) the type of the data in **pData.**

pData (P_UNKNOWN) a pointer to element data.

These Xlist element values are explained in detail below.

Xlist Element Flags 60.1.3

Each Xlist has a set of flags that specifies how the element's data should be treated when the list is freed or duplicated. The flags are:

xfHeapAlloc the element's data was allocated from the Xlist heap.

xfObject the **pData** is the UID for an object. Do not duplicate this element.

xfXlist the element's data is a pointer to another Xlist.

xfExtracted the element's data is used somewhere else and should not be freed when freeing the Xlist. If you set this flag, it is your responsibility to free the data.

The first three flags (**xfHeapAlloc**, **xfObject**, and **xfXlist**) are mutually exclusive. Setting more than one of these flags will have unpredictable results.

Xlist Element Data 60.1.4

Each Xlist element contains a pointer to data (**pData**). The type of data is specified in the **type** indicator. Table 60-1 lists the Xlist element types and the corresponding **pData** interpretations.

Table 60-1
Xlist Element Data Types

Type	pData	pData refers to
xtNull	pNull	Null element. Used for placeholders and dummy elements.
xtBounds	P_BDATA	Bounds data used by clsXGesture and clsXText.
xtGesture	P_GDATA	Gesture data used by clsXGesture.
xtText	P_STRING	Text data used by clsXText and the function Xlist2Text().
xtObject	OBJECT	Object data.
xtBoundsX	P_BDATA	Screen relative bounds data.
xtCharAttrs	P_Xlist_CHAR_ATTRS	Character attributes data used by clsText (TXTXlist.H).
xtParaAttrs	P_Xlist_PARA_ATTRS	Paragraph attributes data used by clsText (TXTXlist.H).
xtTabs	P_Xlist_TABS	Tabs data used by clsText (TXTXlist.H).
xtCharPos	TEXT_INDEX	Character position data.
xtTextList	P_WORD_LIST	Word list data used by handwriting translation.
xtTextListEnd	NULL	End of word list indicator used by clsSPaper.
xtTextWord	P_XTEXT_WORD	Text data used by clsXtext and clsSPaper.
xtStroke16	P_SPAPER_STROKE_DATA	Stroke data used by clsSPaper.
xtTeachData	P_XTEACH_DATA	Teaching data used by clsXteach.
xtUID	UID of a gesture object	A gesture object.
xtEmbedObject	P_TEXT_EMBED_OBJECT	Embedded text object data used by clsText.
xtExtended	UID of data object	Extended data.

Xlist Functions 60.2

Table 60-2 lists the Xlist functions and provides a brief description for each one.

Table 60-2
Xlist Functions

Function	Description
XlistNew()	Creates a new Xlist.
XlistFree()	Frees an Xlist and all its data.
XlistGetFlags()	Passes back the Xlist flags for the Xlist.
XlistSetFlags()	Sets the Xlist Flags.
XlistMetrics()	Passes back the number of entries and heap Id.
XlistInsert()	Create a new element at the index'th location.
XlistDelete()	Delete the element at the index'th location.
XlistTraverse()	Iterates across the list of elements.
XlistIndex()	Passes back the current traversal index.
XlistSet()	Stores the copy of the index'th element.
XlistGet()	Passes back a copy of the index'th element.
XlistGetPtr()	Passes back a pointer to the index'th element.
XlistAlloc()	Allocates some memory from the Xlist heap.
XlistFreeData()	Releases the data with the given entry.
XlistDup()	Duplicates the contents of one Xlist into another.
XlistDupElement()	Duplicates the source element, append to the destination.
Xlist2Gesture()	Extracts the gestural information from an Xlist.
Xlist2StringLength()	Passes back the length of the string that Xlist2String will need.
Xlist2String()	Extracts the text information from an Xlist.
XlistDump()	Debugging interface for displaying an Xlist in the debug log.
XlistDumpSetup()	Sets the Xlist debug log display routine by type.

Using the Xlist Functions 60.3

Typical clients create Xlists with **XlistNew()**, add and delete elements with **XlistInsert()** and **XlistDelete()**, access the value of elements through filters or with **XlistGet()**, traverse the elements with **XlistTraverse()**, and destroy and free all the elements with **XlistFree()**.

The other functions, while useful in certain circumstances, are rarely used. These functions are described in the *PenPoint API Reference* and in the file Xlist.H.

Creating a New Xlist 60.3.1

To create a new Xlist, call the function **XlistNew()**. The function has two parameters:

heap (OS_HEAP_ID) the heap from which to allocate the Xlist and its elements.

ppXlist (P_Xlist) a pointer to the Xlist the function creates.

Inserting an Xlist Element 60.3.2

To insert an element in an Xlist, call **XlistInsert()**. The function has three parameters:

pXlist (P_Xlist) a pointer to the Xlist in which to insert the element.

Index (U16) an index to the location where the new element is to be inserted.

pElem (P_Xlist_ELEMENT) a pointer to the Xlist_ELEMENT to insert.

If the index is greater than the current number of entries, the element is added to the end of the Xlist.

Deleting an Xlist Element 60.3.3

To delete an Xlist element, call **XlistDelete()**. The function has two parameters:

pXlist (P_Xlist) a pointer to the Xlist from which to delete the element.

index (U16) the index of the element to delete.

XlistDelete() calls **XlistFreeData()** to free the memory of the Xlist element structure as well as of the data to which the element points.

Freeing All Elements of an Xlist 60.3.4

To destroy all of an Xlist's elements and free their memory, call **XlistFree()**. The message has only one parameter: a P_Xlist pointing to the Xlist whose elements it is to free.

This function traverses the Xlist, frees the data for each element (unless the element has **xfExtracted** set) and frees the elements data structures themselves.

Traversing an Xlist 60.3.5

The function **XlistTraverse()** allows you to iterate across the elements in an Xlist. For each element in the Xlist, **XlistTraverse()** calls a callback function which you provide. If the callback routine returns anything but **stsOK**, **XlistTraverse()** terminates and returns the same status that the callback funtion returns. You can use **XlistTraverse()** to perform nested traversals.

The **XlistTraverse** takes three parameters:

pXlist (P_Xlist) a pointer to the Xlist to traverse.

pProc (P_XPROC) a pointer to the callback function.

pUserData (P_UNKNOWN) a pointer to user data that will be passed to the callback function.

The prototype for the the callback function is:

```
STATUS (PASCAL *P_XPROC)(P_Xlist pXlist, P_Xlist_ELEMENT pElem, P_UNKNOWN pUserData);
```

The parameters are:

pXlist a pointer to the Xlist being traversed

pElem a pointer to the current element in the list

pUserData a pointer to the user data passed to **XlistTraverse()**.

Getting and Setting Xlist Elements 60.3.6

To get an element from an Xlist, call **XlistGet()**; to set an element in an Xlist, call **XlistSet()**.

Both messages take three parameters:

pXlist (P_Xlist) a pointer to the Xlist whose element the function should get or set.

index (U16) the index of the element to get or set.

pPtr (P_Xlist_ELEMENT) a pointer to an Xlist_ELEMENT structure.

XlistGet() copies the element from the Xlist to to pPtr, while **XlistSet()** copies pPtr to the Xlist. Remember that an Xlist element is a pointer to some data. **XlistGet()** and **XlistSet()** copy pointers to data, but they do not make copies of the data itself.

If the index is greater than the number of elements in the list, **XlistGet()** will get the last element in the list and **XlistSet()** will store the last element in the list.

XlistSet() replaces the existing element specified by the index. If you want to add a new element, use **XlistInsert()**.

Chapter 61 / Using Gesture Windows

Introduction 61.1

clsGWin (Gesture Window) inherits from **clsWin**. **clsGWin** adds some special functionality to the standard window input handling capabilities described in Chapter 53 (Input Subsystem API). The various **clsGWin** subclasses use this functionality to interpret pen input as gestures. Many of the PenPoint™ Windows and Graphics and UI Toolkit classes inherit from **clsGWin**.

You will very rarely need to use a **clsGWin** instance directly, or subclass it. In most cases where you want to capture gestural input from the screen, you can use a standard UI Toolkit class.

clsGWin also implements the Quick Help interface. This interface lets you specify a resource ID for each of the UI Toolkit components the user interface for your application. Whenever the Quick Help gesture ? is drawn over an element that inherits from **clsGWin**, the Quick Help manager uses the resource ID that is stored in the **clsGWin** object's **helpID** field to locate the help text resource to display.

A **clsGWin** object is able to receive pen input, test to see if it is a gesture, and if a gesture is recognized send **msgGWinGesture** to clients. **msgGWinGesture** has a **pArgs** data structure GWIN_GESTURE that describes what gesture has been entered by the user, as well as some state information about the size (bounds) of the glyph that the user has made, and the x-y coordinate of the gesture **hotspot**. The frontmost window containing the hotspot is typically the target of the gesture.

A **clsGWin** object automtically creates a **clsScribble** object whenever it receives pen input.

clsGWin implements a lightweight window that automatically interprets input as gestures. When it receives input, a **clsGWin** object collects the strokes in a scribble. When the input event is terminated, the gesture window creates an **clsXGesture** translator and passes the scribble data to it. The gesture window then reports the translator results to the relevent client code.

Gesture Window Messages 61.2

Table 61-1 summarizes the messages **clsGWin** defines.

Table 61-1
clsGWin Messages

Message	pArgs	Description
Class Messages		
msgNewDefaults	P_GWIN_NEW	Initializes the GWIN_NEW structure to default values.
msgNew	P_GWIN_NEW	Creates and initializes a new instance.
Attribute Messages		
msgGWinGetStyle	P_GWIN_STYLE	Returns the current style.
msgGWinSetStyle	P_GWIN_STYLE	Sets the style settings.
msgGWinSetHelpId	U32	Sets the gesture window's helpId for quick help.
msgGWinGetHelpId	P_U32	Returns the gesture window's helpId.
msgGWinGetTranslator	P_OBJECT	Returns the gesture window's translator object.
msgGWinSetTranslator	P_OBJECT	Sets the translator object and returns the previous one.
Gesture Messages		
msgGWinTransformGesture	P_GWIN_GESTURE	Transforms gesture information into local window coordinates.
msgGWinTransformXList	P_XLIST	Transforms xlist information to local window coordinates.
msgGWinAbort	pNull	Stop processing a gesture.
msgGWinBadGesture	P_GWIN_GESTURE	Displays feedback for unrecognized and unknown gestures.
msgGWinHelp	pNull	Displays quick help for the gesture window.
msgGWinForwardGesture	P_GWIN_GESTURE	Instructs the gesture window to forward a gesture to parent windows.
msgGWinForwardedGesture	P_GWIN_GESTURE	Gesture window sends this message to parent window in response to msgGWinForwardGesture.
msgGWinForwardKey	P_INPUT_EVENT	Instructs the gesture window to forward a keyboard event to parent windows.
msgGWinForwardedKey	P_INPUT_EVENT	Gesture window sends this message to parent window in response to msgGWinForwardKey.
msgGWinIsComplete	P_GWIN_GESTURE	Determine whether there are more gestures to process.
msgGWinGestureDone	P_GWIN_GESTURE	Sent to indicate the end of a gesture.
msgGWinStroke	P_INPUT_EVENT	Self-sent to process a pen stroke received from the input system.
msgGWinTranslator	P_OBJECT	Self-sent to retrieve the translator used to gather and translate strokes.
msgGWinComplete	pNull	Self-sent to process a gesture, typically in response to msgGWinForwardedGesture.
msgGWinXList	P_XLIST	Self-sent to process an xlist.
msgGWinGesture	P_GWIN_GESTURE	Self-sent to process a gesture.
msgGWinKey	P_INPUT_EVENT	Self-sent to process a key input event, typically in response to msgGWinForwardedKey.
msgGWinBadKey	P_INPUT_EVENT	Self-sent to allow a subclass to handle bad keys.

INDEX

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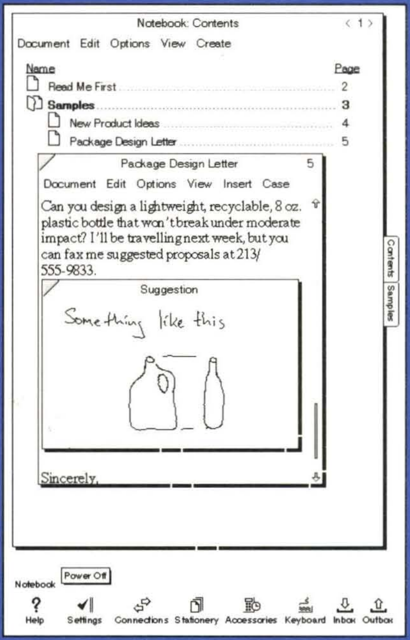
PenPoint™ Architectural Reference, Volume I

PenPoint Architectural Reference, Volume I, together with Volume II, provides a comprehensive description of the Application Programmatic Interface (API) for the PenPoint operating system. This volume describes the functions and messages that you use to manipulate classes, and the fundamental classes used by almost all PenPoint applications. The topics discussed in this volume include the:

PenPoint class manager
PenPoint Application Framework™
ImagePoint™ graphics imaging model
PenPoint user interface toolkit
PenPoint input subsystem and handwriting translation.



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