IBM Data Processing Techniques

IBM Study Organization Plan

The Method Phase III

This manual discusses how to conduct the third phase of a system study, "Designing the New System". Design alternatives are formulated initially around design concepts for the activity. Other activities are checks for possible consolidation. Equipment configurations are analyzed for each alternative and refined into a system solution. Implementation costs are compiled, added to projected operating costs and compared to systems benefits to determine economic impact on the business. Design data is organized into a final report entitled "New System Plan".

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CHAPTER 1 — DESIGNING A NEW SYSTEM

This manual is a working guide for conducting business system studies through the third and final phase of the Study Organization Plan: designing and describing a new system.

PHASE III OBJECTIVES

New system design is concerned with the development, evaluation and description of a business information system that best fulfills the requirements established in the Phase II Systems Requirements Specification (SRS). During Phase III, various design approaches are considered. For each alternative, a broad class of equipment is specified and evaluated against the SRS. The most promising solutions are further defined in terms of specific equipment configuration; finally, the best solution is recommended to management.

STUDY TASKS

Several major tasks are performed in the design of a new system:

- Develop a basic system design.
- Analyze the interaction of multiple activities.
- Specify the equipment configuration.
- Prepare a preliminary plan for system implementation.
- Determine the impact of the design on profitability of the business.
- Document the new system design.

Phase III starts from the Systems Requirements Specification and terminates with the preparation of a New System Plan.

The Phase II Systems Requirements Specification (SRS) is a significant input to Phase III, because design alternatives are accepted or rejected on their ability to satisfy specific requirements appearing in the SRS. The statement of business goals in the SRS shows what the new system is expected to accomplish. The statement of activity scope and boundary define size and content of each activity for design purposes. Input/Output, Required Operations, and Resource Sheets amplify requirements such as (1) the number of characters and fields in inputs and outputs, (2) the rate at which information is moving into and out of the system, (3) a summary of processes in each operation and frequency of their execution, and (4) file characteristics and content. As designs evolve, measurement factors appearing in the SRS can be used to evaluate design alternatives.

In system design, attention is first centered on the single predominant activity of the business according to its size, potential savings, or special characteristics. Initially, various input, output, processing and file possibilities are hypothesized. The possibilities are then merged into alternative system designs, using different design approaches. Several alternatives are formulated and, through evaluation and selection of the most reasonable, are successively reduced to a manageable two or three. Finally, system solutions are developed at a generic equipment level where types of equipment are chosen (binary, decimal, random access, tape, etc.). Systems integration is the analysis of activity interaction and the recognition of opportunities for consolidating activities.

The final major task in actual design is the selection and refinement of an equipment configuration from generic alternatives. Specific equipment solutions (actual machines such as 729 IV, 1311, 1301, 1401, 1410, 7090, 7010, etc.) are postulated for each design alternative retained up to this point, and these equipment possibilities are evaluated by performing a rough timing and costing analysis. The best solution for each design alternative is then compared with the others in order to arrive at a final solution and designation of a complete equipment configuration. Finally, detail run timing and cost figures on this solution are reviewed to ensure validity of the decision.

While system implementation itself is outside the scope of SOP, it is necessary to know and show the numbers and types of people required to put the system into operation, when they will be needed, and how long it will take to complete the transition from design to full system operation. Major "get-ready" costs involved in system implementation and time schedules are prepared for management's information. These costs include:

- Detailed system design
- Programming and program testing
- Installation (physical)
- Conversion and test
- Personnel selection and training

As the system evolved, measurement factors from the SRS were used to evaluate performance of alternatives. Now, the system is appraised on the basis of its total worth to the business. Business profits, operating expenses, return on investment, and cash flow (projected over the estimated life of the new system) are typical factors used in this analysis.

At the completion of these several tasks, the new system design is organized and documented in a final report entitled New System Plan.

NEW SYSTEM PLAN

The Phase III report (Figure 1) is a concise and complete description of the new system with an objective judgment of the system's immediate and future value to the business. The report contains a Preface and five major sections:

- Management Abstract
- New System in Operation
- Implementation Planning
- Appraisal of System Value
- Appendix

Each of the report sections is directed at a particular audience. The Management Abstract section outlines key recommendations of the study and summarizes the system design for top management. The New System in Operation section conveys to operating management the special features of the system as it will function after installation. The Implementation Planning section shows the costs and time required to put the system into operation, and the Appraisal of System Value section reveals the cost and profit impact of the system to financial personnel. Finally, the Appendix contains data useful for implementation and operation by methods and programming personnel.

VARIABILITY OF APPLICATION

The Study Organization Plan is designed for application to many industries, to enterprises of different sizes, and to studies with widely divergent objectives. Many of the topics discussed in this manual will not fully apply to every study. For instance, the New System Plan as presented in Chapter 6 is only one way for a study team to present its recommendations to management, for many businesses have their own traditional and time-proven methods of presenting capital investment recommendations.

One particularly difficult phenomenon to depict is the complex iterative process by which a study team arrives at a system solution for a given set of conditions. The exact nature of this procedure can only be described briefly, at best; truly creative system design is an art, not a science.

The main benefit of the Study Organization Plan will be derived from its value as a guide, and in this respect its point of view and suggestions will never become a substitute for imaginative, resourceful, and industrious system design on the part of the study team.

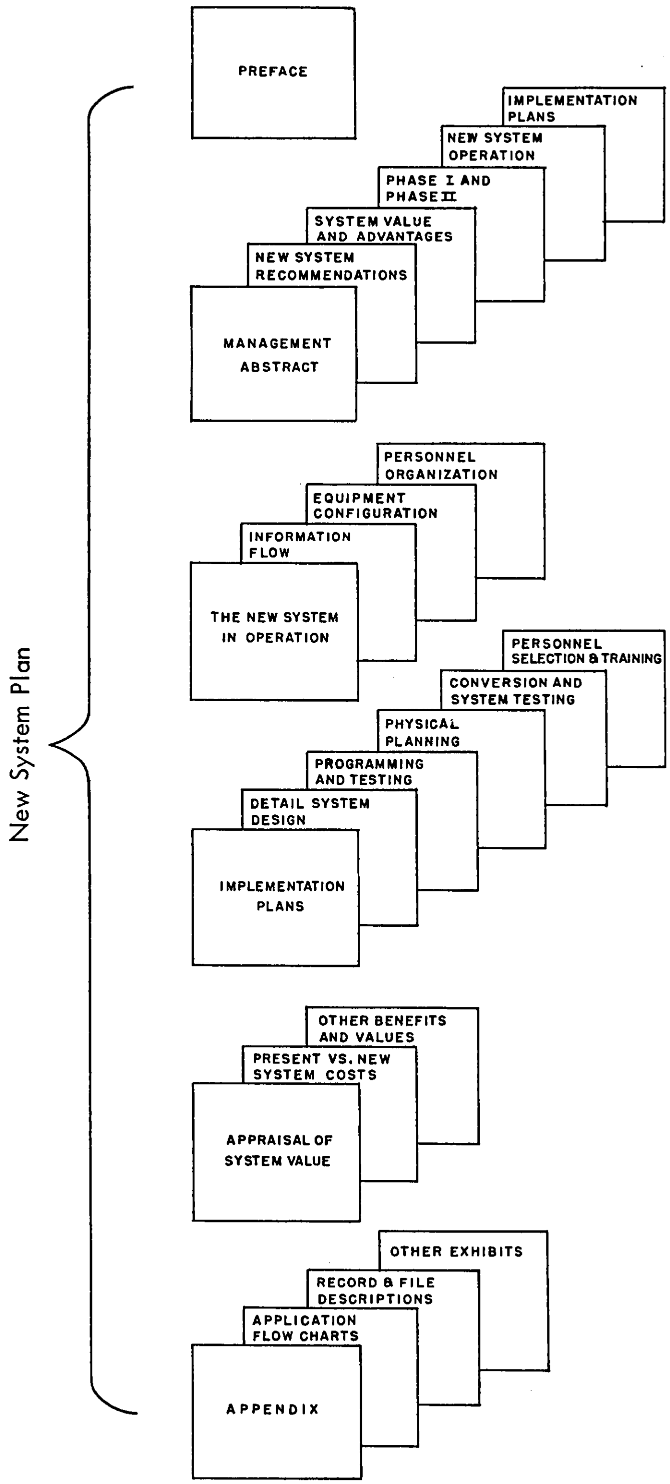


Figure 1. New System Plan

CHAPTER 2 — BASIC SYSTEM DESIGN

In basic system design, a study team lays out a master plan for a new system, first concentrating on the single most important activity of the business. Possibilities for inputs, outputs, operations and files are first identified. The best possibilities among these elements are fused into a few specific design alternatives, using various design concepts. Each alternative is described at a generic system level on an Activity Sheet, with appropriate supporting narrative description.

Basic system design involves five major steps:

1. Activity selection. — The dominant activity is selected for initial design.
2. System element analysis. — Various element possibilities (different inputs, outputs, processing operations and files) are identified and evaluated for this activity.
3. Design alternative formulation. — Design alternatives are synthesized and evaluated; the best two or three are accepted for further analysis.
4. Generic system description. — The selected design alternatives are documented with a generic system description on an Activity Sheet.
5. Multiactivity integration. — Other activities undergo a similar process. Relationships among design alternatives for the activities are then analyzed, and appropriate compromises and consolidations are made. A few realistic design alternatives are carried forward for selection of specific equipment.

System design requires a high level of creativity, but it is more fruitful if it is a disciplined effort. Thinking in terms of design concepts — independently of specific equipment configurations — is a major key. Imagination in the application of design concepts can lead to the major improvements a study team seeks.

Building designs around concepts or ideas can best be illustrated by example. The National Bank of Commerce, of Syracuse, New York,* like other banks, offered its customers a complete range of banking services (checking accounts, Christmas club, etc.), yet it processed the information for each one in separate, specialized routines. One design concept considered was the use of an integrated banking information service, producing one monthly statement for each customer covering the entire range of bank services used. Discussion and analysis showed that a consolidated monthly statement of transactions and balances was feasible. The "one customer, one statement" concept led to important changes in element requirements. Since much similarity existed in file requirements among the several activities, a central file was postulated to handle all data. Similarity of input data requirements for checking and savings accounts led to the use of a check-like document issued by the bank (or written by the customer) rather than the conventional deposit and withdrawal slips. Review of pending legislation requiring a savings passbook showed that there was a good chance that the practice of returning these documents to the customer could be discontinued. This would mean that the bank could mail out a monthly or quarterly statement of customer balance and interim transactions. Furthermore, with the central file concept, up-to-the-minute statistics by teller, by branch, or for the entire bank could be made available to direct inquiry from remote locations.

Developing a system design in terms of a concept (in the above case, the central file concept), and independently of equipment, applies to all types of studies. Design quality depends on applying sound technical and business judgment based on broad knowledge of equipment characteristics and capabilities, an awareness of outstanding design concepts developed in previous studies, a thorough grounding in programming principles, and solid experience in the use of management science and other technical tools.

ACTIVITY SELECTION

The initial activity for basic design is selected on the basis of one or more of the following features:

- Dominant performance criteria. — A single performance requirement (response time to customer inquiries and orders, for example) makes the activity so important that it overrides other activities.
- High affectable dollars. — A potentially large savings is involved.
- Large size. — The activity is large either in input/output volume or in computing complexity.
- Inefficiency. — The activity has the most inefficient area of performance in the present system.
- Management preference. — Management may have its own special reasons for selecting the activity.

SYSTEM ELEMENT ANALYSIS

After an activity is selected, possibilities for its elements (inputs, outputs, processing operations, and files) are individually examined. The SRS operations section is particularly helpful in identifying and evaluating possibilities. Penetrating and specific questions must be asked about each. If punched card

*Names and locations for this and other actual studies mentioned in the text have been disguised.

input is under consideration, the volume of information, the handling of this information, the time it would involve on representative equipment, and accuracy or verification requirements must be examined before concluding that punched cards are the best input. Each possibility must be realistic — in terms of money available, the implementation time planned for, and the originality or newness of the approach. If the use of magnetic ink coded input, for instance, departed from established industry practices, prior acceptance by governmental agencies of industry associations might be required. Many specific possibilities are usually rejected at this point: known equipment capabilities may not permit economical use of the proposed input or output form, may not provide the access frequency required for the file, or may not have the computation speed demanded for the proposed method of processing.

Input/Output Characteristics

Throughout the analysis of design possibilities, the study team constantly considers the dominant characteristics of the activity; frequently, input and output volumes and characteristics provide such dominance.

Inputs usually have to be accepted in the form in which they are received from the outside (or from another activity); thus, many times design is really the task of conversion to machine-usable form. For outputs, design frequently involves producing a form acceptable to the environment (or to another activity). This may require several intermediate steps, as in an activity using a communications network. In such an activity inputs may be received originally in oral or handwritten form, converted to punched paper tape, transmitted over a circuit to a data processing center which again produces punched paper tape, converted from paper tape to cards, and finally edited and processed on a small computer to produce magnetic tape for further large computer operations.

Typical considerations in analyzing input possibilities are:

1. Does each input have to be handled on an as-received (usually a unit) basis, or can inputs be processed in batches?
2. Should inputs received in nonprocessable form be converted, edited and machine-entered, or should they be manually entered?
3. Can inputs be processed randomly as received, or should they be sequenced by designated control fields?
4. What is the significance of input volume variation on system performance criteria, particularly during peak periods?
5. Is interruption to be allowed or not? How does this affect reliability requirements?

Output possibilities are similarly examined:

1. Are reports to be printed or punched, or is the output to be in some form of audio or direct display (such as voice answerback or direct display of blueprints)?
2. How much of output content is to be summarized? detailed? listed by exception?
3. Which reports must be generated on schedule? on demand? on exception?
4. What are the general requirements on format, readability, number of copies, etc.?
5. Are standard forms required, or may non-standard forms be used?
6. Can output printing be offline?
7. Will output data be reused?
8. Will output go to another activity as a signal, tape record, or other machine-usable form?

After these possibilities have been explored and the inappropriate, unlikely and unacceptable ones set aside, possible inputs and outputs can be stated as "punched cards", "magnetic tape", "machine-sensible" for optical scanning (or magnetic ink character recognition)" and the like. This selection of reasonable possibilities takes into account such factors as time restrictions or equipment capabilities, while not explicitly specifying input/output equipment.

Processing Characteristics

Possibilities for processing are next evaluated. Primary concern in processing is the magnitude and complexity of operations and what this entails in basic system design. Such points as the following are analyzed:

1. Should processing be random or sequential?
2. How frequently are operations executed?
3. What are the predominant characteristics in operations — arithmetic? logical? relational? edit? lookup?
4. If high in mathematical processes, is floating point arithmetic necessary?
5. How complex is operations logic (in terms of computing time)?
6. Can processing include main-line operations only, or must it include all exceptions? some exceptions?
7. Will operations require significant restart and monitor routines?

Manual or human considerations also must be examined:

1. How automatic (man-independent) is the system to be? Is manual override necessary, or can the system operate automatically without intervention?
2. What kind of audit trail should be provided?

3. Must error corrections be made immediately, or can errors be recycled for later processing?

The conclusion of this analysis is a statement of possible processing characteristics which could solve the problem (speed in operations per second, minimum memory size, special instruction capabilities, and so on).

File Characteristics

In analyzing files, as in other activity elements, dominant activity characteristics are isolated and evaluated:

1. To what extent do separate files contain the same data? Can they be consolidated?
2. How frequently is a file referenced for inquiry?
3. What is the frequency of file change or updating?
4. How many ways is a file referenced? If it is in one order, will there be necessity for resorting to other sequences?
5. What is the growth rate of the file?

The result of the analysis is a description of file alternatives in terms of file size, average access time, maximum access time, etc.

FORMULATING DESIGN ALTERNATIVES

A design alternative is a specifically stated combination of various input, output, processing and file element possibilities. Each design alternative is built around a design concept: the way in which the information processing will be carried out. A design concept is the glue that holds together the separate elements in a design alternative; a design alternative describes how the concept is applied using the elements. In most cases, design alternatives are built upon a concept or approach which has proved successful in previous installations in the type of business under study. Where pioneering is required, greater design time is usually needed. Many possible design alternatives will be discarded because of timing imbalances or obvious cost constraints; with a solid knowledge of equipment capabilities, design alternatives can be intelligently judged without the time or expense of detailed system design and run timing. Measurement factors outlined in the SRS are used to evaluate alternatives; the most feasible two or three are selected as basic system designs. Application of an appropriate design concept determines to a great extent how the individual possibilities are combined into a system. Four of the many varieties of design concepts are illustrated here.

1. Regeneration

Instead of retaining a large number of answers in memory, it is often possible to store the decision logic necessary to compute or generate answers. When the regeneration (rather than the file reference) principle is used extensively, files are reduced, searches eliminated, and access speeds increased.

2. Transaction-File Reversal

Transaction-file reversal shows how good solutions evolve by considering extremes or opposites. In a manufacturing business, for example, gross parts and materials requirements are often established by successive explosion of bills of material through several levels of the product structure. Product requirements are considered the transactions, and the bills of material are the files. This approach is often cumbersome and time-consuming. However, by completely reversing the procedure and by considering where-used bill of material records as the transactions to be passed against the product requirements (as the file), it may be possible to accomplish the same result in a single pass through the computer at significantly lower cost.

3. Unified Services

In multiservice or multiple location operations, a decision must be made whether to design several independent systems or to consolidate data processing operations into a single system. In a company with a widespread network of warehouses, for example, the system can be warehouse-oriented or total-network-oriented. Such a decision depends on many different factors: type of products stocked in each warehouse, nature of the market, characteristics of the distribution system, etc. The unified services concept would consider the entire span of requirements for each warehouse in a single system.

4. Real-Time Response

Entire systems can be built around real-time response to each transaction received; the system becomes the "sum of the transactions". Real-time systems typically involve communications networks and are highly equipment-dependent; for example, systems recently designed for airlines and brokerage firms would not have been possible without TELE-PROCESSING® equipment and random access files.

In many industries there are particular concepts that are suitable and around which design alternatives can be formulated. Online processing, daily cycling, periodic status review, exception reporting, and centralized data processing are a few examples of frameworks upon which design alternatives have been built. If a standard application program pertains directly to an activity, the concept behind that program can certainly be considered as one of the principal options.

At the outset of basic design, a study team deals with pieces and parts (inputs, operations, etc.). Now, in formulating design alternatives, the team approaches design from an integrated and unified standpoint; a design, instead of being an aggregation of parts, is an entity. Creative effort has been applied to build the system around a design concept. A large number of design alternatives may result from this process; typically, some are fairly similar, others quite different. Alternatives for the activity are compared with each other, and similar ones are combined until the best two or three basically different alternatives remain.

GENERIC SYSTEM DESCRIPTION

At this point, sufficient information has been accumulated to prepare a generic system description, which is essentially a statement of the major inputs, outputs, processing operations and files needed. No detailed run design is formulated and no attempt is made to state how many card readers, tape units or printers are desired, or what size memory is desired. The purpose of the generic system description is to show the logical flow of information and the logical operations necessary to carry out the particular design alternative. Figure 2 is a generic system description for a multiple warehouse inventory control system. The Activity Sheet is convenient for this documentation, since it shows a system flowchart along with information on volumes, time relationships, and specific functions or requirements.

The following narrative indicates the kind and level of information that should be available at the end of basic system design.

Warehouse Inventory Control Activity

This activity is concerned with an inventory control system for a finished goods warehouse. There are many relatively small items stocked in the central warehouse with which the information processing system is associated. Five other auxiliary warehouses, from 100 to 500 miles away, place orders on the central warehouse and may require rapid delivery of critical items. There are four major groups of operations within the system: updating stock status, based on actual transactions; response to inquiries from auxiliary warehouses and central warehouse; reorder analysis, including purchase order preparation; and weekly analytic reports to show slow-moving items, major changes in usage rates, behind-schedule reports, economic lot sizes, etc.

A. Update Stock Status

1. As material is received, the enclosed paperwork is marked to indicate the quantity received and quality acceptance. The bill of lading or packing slip is then passed against the receiving order file to withdraw the appropriate receiving record (a prepunched card) for each item. Actual quantity received, date received, and quality acceptance code are keypunched, and the card information is then transmitted to the data processing center.
2. After each customer order is filled, a card is keypunched for each item on the marked-up order, showing actual quantity delivered, customer number, item number, date, quantity, etc. These withdrawals are transmitted to the data processing center.
3. A variety of miscellaneous transactions are initiated by the warehouse, the receiving area, and purchasing: returns, rejects of incoming material, recounts, back orders, substitution, scrap items, etc. A card is prepared for each such transaction with the appropriate code for the transaction; item identification and quantity information are then inserted in the card. These cards are also transmitted to the data processing center.
4. Transactions are received throughout the day at the data processing center. As each transaction is received, it is processed against the master stock file (on a random access device) to update the status of each item. Validation checks are made during this operation to ensure that the item number is correct and that the quantity of the transaction is within reasonable limits. Invalid transactions are printed as typewriter output.

B. Remote Orders and Stock Status Inquiry

5. The order-filling area (in the central warehouse) and the auxiliary warehouse have direct keyboard input to the data processing center by which online inquiries can be made. Availability (or planned availability) for all items can be obtained on an online basis by keying the item information, quantity desired, and nature of the request.
6. The data processing center interrupts its other processing on receipt of an inquiry to determine stock status and to answer the information request. This is then transmitted back to the proper station. If a reservation or a request to ship is made, appropriate paperwork is prepared and the master stock file modified to show the reservation or withdrawal.

C. Reorder Analysis and Purchase Order Preparation

7. Each night, after all transactions have been posted, the entire master stock file is reviewed. Each item's current balance and planned available balance are analyzed against expected day-by-day requirements and desired protective stock levels. Where appropriate, reorder quantity is calculated and reorders are made. Planned due date is set, based on normal delivery cycles. If normal reorder quantity does not give adequate coverage, a specific indication is made.
8. All orders are then sorted by commodity code. Total dollar volume is summarized by commodity.
9. For each commodity code the approved vendor list is reviewed and individual orders are assigned to vendors on the basis of planned participation rates on specific items being ordered, dates required, and current quality-and-date performance by the vendor. Purchase orders are then prepared, and items ordered from the same vendor are grouped together by commodity

code. Individual receiving cards are prepared for each item, sent to receiving, and placed in the receiving file. The vendor file is updated to note volume or orders placed and items ordered.

10. The purchase orders are reviewed by the purchasing agent or buyer on the following day, and each is approved and signed. Where changes are required or special decisions needed, the purchasing agent can request detailed information from the master stock file.

D. Stock Status Analysis

11. Weekly, the master stock file is reviewed to determine whether actual usage rates have changed significantly from expected usage rates and to carefully compare current stock status with revised usage. This identifies excessive stocks, overdue orders, and other specific relationships that require management attention. An item-by-item stock status report is issued with an exception report indicating usage and status of each item whose balance or open order is outside planned control limits.

MULTIPLE ACTIVITY INTEGRATION

Where system design encompasses several activities, alternatives are formulated for the others in the same manner as described above. The resulting best design alternatives for each are then compared with the major activity for resolution of conflicts or incompatibilities. Activities are also reviewed as a group to determine the potential for consolidation among inputs, outputs, operations and files.

Basic Design Compatibility

Characteristics of the dominant activity may be so overriding that other considerations are subordinated and alternatives for the remaining activities tailored to fit the basic design. TELE-PROCESSING systems for investment houses and airlines are examples of this; the system is designed around the real-time activity (order and inquiry processing), and other activities are accommodated offline as equipment capacity and available processing time permit (though additional features and components may well be added to the system).

Developing an efficient solution for activities with diverse profiles can significantly increase equipment requirements. One activity, for example, might call for a very large random storage device; another might need a central processing unit with complex, high-speed logical and arithmetic commands. Properly designed, a system using a large-scale computer with both tape and random access files might handle both activities efficiently; conversely, separate smaller machines with specialized files might prove to be a more economic solution.

Sometimes a "balancing" activity is added to take advantage of the higher price-performance ratio of larger equipment. An activity requiring extensive computation and limited input/output can be combined with another activity having high input/output volumes and relatively little computation. Later, when equipment is selected, these two activities together could represent a better total equipment utilization than would be possible for either one alone; hence, the installation is more profitable to the user.

Even the proposed implementation schedule can influence multiple activity decisions. Complexity of installation and lack of trained programmers and analysts often make an extended implementation period necessary. When this occurs, effort is first directed to the dominant activity schedules for initial implementation, with only a compatibility check made in regard to the others.

Consolidation Opportunities

To this point, activities have been treated as relatively independent entities; there may be further opportunities for consolidation, especially in regard to common usage of files.

Files having common characteristics, content, and application should be consolidated wherever feasible. Consolidation possibilities were shown by several files in Butodale Electronics Company. Engineering maintained a large parts file containing data on manufactured and purchased parts, costs, and commodity codes for compiling quotations on requests to bid; three manufacturing sections (standard products, custom-designed products, and spare parts) each supported cost files for preparing product costs; and accounting used another cost file for pricing purposes. This last file was sequenced by part and assembly number, and it showed both part cost and part selling price. A good possibility for file consolidation existed among these three files, as long as each activity had proper access to the data.

Other consolidation possibilities exist among inputs, outputs and operations. One activity may use the same or similar inputs, or it may produce outputs similar to those of another activity, as demonstrated in the "one customer, one statement" approach of the National Bank of Commerce (page 3). Output from one activity is often input to another. Inputs and outputs of the several activities, therefore, are examined for consolidation (or even for combining two sequential activities by eliminating the input/output junction); care must be taken to resolve incompatibilities of form, content, timing or accuracy of data between activities.

Activity Name INVENTORY CONTROL

UPDATE STOCK STATUS

Freq: As transactions received

Inputs: 2000, 2010, 2020

Key	Time	Note
1-4	2 HR	1000
2-4	2 HR	1000
3-4	4 HR	1000

RESPONSE TO INQUIRY

Freq: As received

Inputs: 2030

Key	Time	Note
5-6	1 MIN	1000

REORDER ANALYSIS

Freq: Daily

Inputs: 4010

Key	Time	Note
7-8	6 HR	1000
8-10	2 HR	1000

REPORTING

Freq: Weekly

Inputs: 4010

Key	Time	Note
11-12	8 HR	1000

INPUTS

Key	Name	Volume
2000	Receipts	500/Day
2010	Withdrawals	10,000/Day
2020	Misc Trans	1,000/Day
2030	Inq's & Ord's	2,000/Day

OUTPUTS

Key	Name	Volume
3000	Stk Status	1,750/Day
3010	Invalid Trans	-
3020	Ship Instr	500/Day
3030	Recv'g Cards	500/Day
3040	Purch Ord	100/Day
3050	Exceptions	1,000 Items/Day
3060	Stock Status	20,000 Lines/wk

FILES

Key	Name	Size	Access Rqmts	Note
4000	Recv'g File	20,000 Records	Randm-5 Min	
4010	Master Stock	20,000 Records	Randm- 10 Sec	
4020	Commodity	200 Records	Seq - Daily	1050
4030	Vendor	1,000 Records	Randm-3 Min	1050

IBM **Activity Sheet**

NOTES

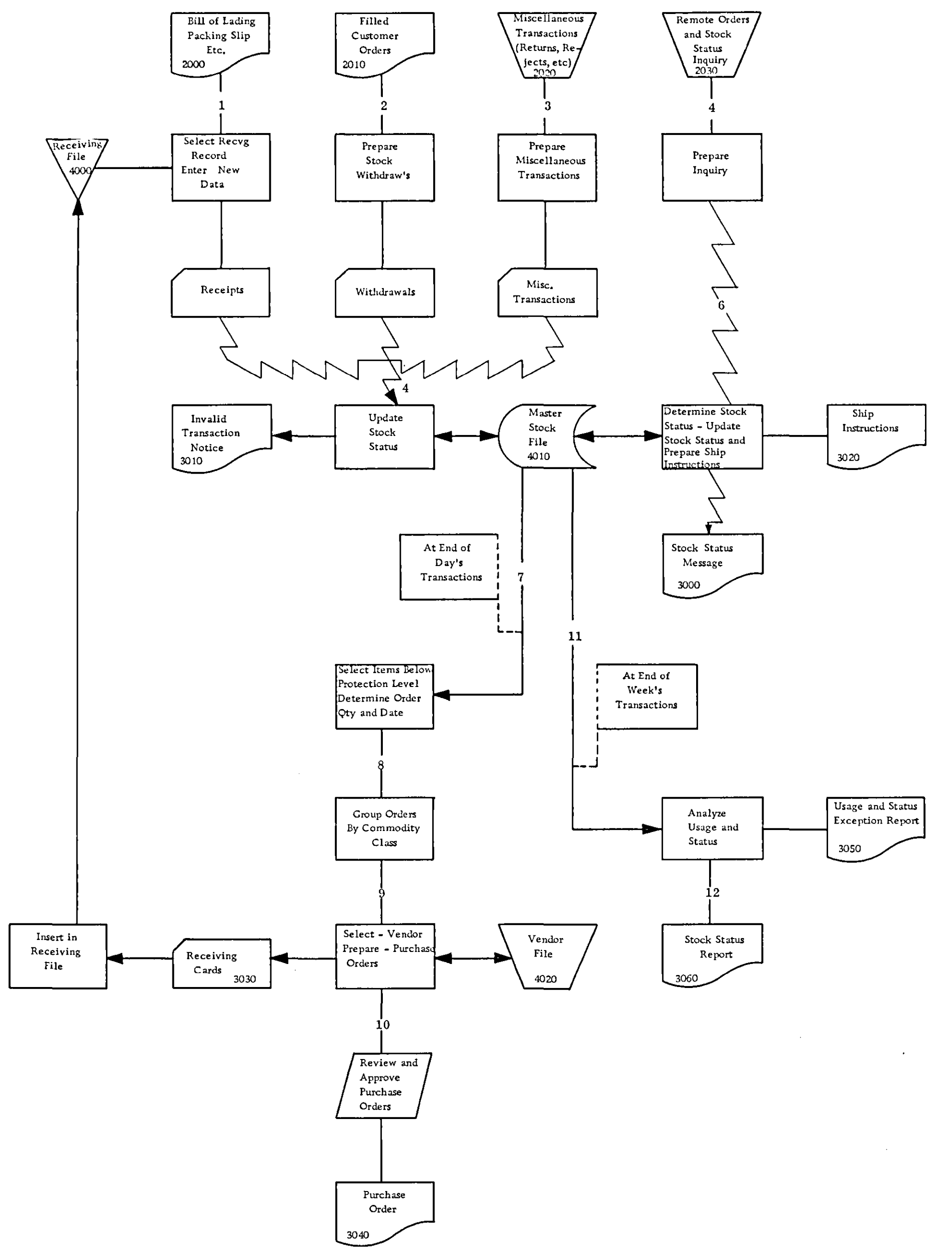
1000 - Maximum allowable under SRS

NOTES

1050 - Commodity file is section of vendor file

Figure 2. A generic system description

FLOW DIAGRAM



NOTES

M08-4608-2

LEGEND BOX

ORGANIZATIONAL COMPONENTS

KEY NUMBERS

1 - 999	Between Operations
1000 - 1999	Notes
2000 - 2999	Inputs
3000 - 3999	Outputs
4000 - 4999	File Usage

IBM Activity Sheet

Analyst G. F. Fry

Date

Study Atlantic Distributors

Activity Name

INVENTORY CONTROL

Figure 2. continued

Operations are normally less susceptible to consolidation than inputs, outputs or files. Nevertheless, they should be checked for possible multiprogramming when there is a dissimilarity of basic design concepts (one activity with low-volume real-time operations, the other a high-volume batch activity, both processed simultaneously with a real-time interrupt; one activity with high input/output and low computation, the other with high computation, both processed simultaneously by interspersing transactions, etc.). Note that one consolidation often opens up other consolidation possibilities. The use of a common transaction document for inputs at National Bank of Commerce made possible the combining of operations among the affected activities by taking advantage of the differences in operation volume and frequency of execution.

After reviewing the various possibilities, two or three integrated design alternatives are put together on Activity Sheets. Both these "total" design alternatives and the earlier individual activity alternatives are the basis for system selection.

SUMMARY

The process of basic system design leads to the definition of alternative systems at a generic level. These alternatives are the base on which specific system selection takes place. Experience, of course, is required to find out where basic design should be stopped in order to avoid getting involved in implementation details.

Some systems engineers will find it more convenient to go through systems selection for a single design alternative before formulating additional alternatives. This is perfectly reasonable and does not at all "conflict" with the guide to design of systems outlined in these Study Organization Plan manuals.

When creative basic system design has been carried out, the opportunity exists for efficient system selection from reasonable alternatives which will meet business goals and objectives.

CHAPTER 3 — SYSTEM SELECTION

System selection is the process of developing an efficient equipment configuration for a design alternative. This is an iterative, trial-and-error process. Evaluation of equipment solutions will suggest further changes in the configuration or features and even in the design alternative structure. Equipment selection affects and is affected by run design. Modification of one directly influences the other and may, in turn, influence alignment of equipment with design alternatives.

THE PROCESS OF SELECTION

The design alternatives plus other system requirements provide the framework within which system selection is performed. These requirements may be quite explicit and may significantly limit equipment choice — for example, the system:

- Must provide magnetic ink character recognition for input of transactions.
- Must create a magnetic tape output which is compatible with file requirements on a 7094.
- Must provide for immediate inquiry for master file records.

Each of these requirements implies either that certain components must be included in the final system, or that certain components may not be included — which actually simplifies system selection.

There may also be qualitative boundaries within which the system must operate to be acceptable:

- Operating time must not exceed two shifts per day, five days per week.
- Operating cost must be less than a certain limit. There also may be the implication that the new system should not exceed the operating cost of the old system.
- A particular report must be available to management at a given time.
- Cycle or turn-around time must be within a specified limit; transactions received by a certain time must be processed the same day.
- Availability requirements must be satisfied.

A dollar value is often associated with bringing a factor further inside the boundary limit: for example, decreased cycle time may result in a decrease in open accounts receivable. Choice between equipment configurations meeting all restrictions may be based on the degree to which boundary limits are bettered. Boundary restrictions often limit equipment. Cost may eliminate certain large systems; availability may require the duplexing of some components.

Initial evaluation of both the requirements and the boundaries defines the framework within which equipment can be selected. This does not mean that the requirements have become inviolate. Realities of system selection may show that some requirements are so expensive to satisfy that they should be relaxed. A stipulation, for example, that a report be available by 4:00 p.m. one day, rather than 8:00 a.m. the next day, may be the only factor which forces the selection of a 1410 operating one shift per day, rather than a 1401 operating two shifts per day. Such a requirement must be examined in light of the additional expense directly attributable to it. Since the requirements have already been reviewed and approved, any such change must be cleared before it is adopted.

System selection, then, is essentially a serial, iterative process aimed at satisfying design requirements and boundaries. These restrictions are sequenced in order of importance or difficulty, so that there is a basis for choosing to improve upon one of the factors rather than another.

System selection involves iteration through the following steps:

1. Specify equipment to satisfy a design alternative.
2. Define runs using the specified equipment.
3. Time the configuration for each run, beginning with the longest run, until a requirement is violated or until all runs have been timed.
4. Iterate, modifying the equipment configuration (or the system design), to remove the violation or improve relationship to boundary factors. More components will reduce running time and extra shift rental; fewer components will increase running time but decrease prime shift rental and extra shift hourly rate.
5. When the best joint solution for equipment and runs has been found, specify a new equipment solution for that design alternative.
6. After two or three feasible equipment and run solutions have been timed, go to the next design alternative.
7. When all design alternatives have been evaluated, select the best equipment/design combination based on requirements, running time, cost impact upon the business, and implementation and operating costs of the proposed systems.

EQUIPMENT SPECIFICATION

Postulation of successive equipment alternatives includes consideration of peripheral characteristics of the equipment and its support: modularity, programming languages, and IBM application programs.

Modularity

Modularity allows the addition of more components (or the substitution of faster components) for a significant increase in throughput with little or no program modification. If a large activity is gradually cut over to a computer system, modularity allows initial installation of a less expensive, slower system with faster components added as volume warrants. Modularity is also significant if volume is expected to grow substantially with little or no change in system objectives.

The substitution of faster components for slower ones with no programming change is the most important consideration; examples are the substitution of a 7010 processing unit for a 1410 processing unit or the substitution of 729 VI tape units. Nearly as useful is modularity which only requires program recompilation, such as substitution of 7340 tape units for 729 tape units. Recompilation is necessary for proper IOCS commands, but the program otherwise remains unchanged. Less valuable is the ability to add components (more tape units or more core storage), for in most circumstances, taking full advantage of such modularity requires reprogramming of at least the longest runs if the additional components are to affect running time. In such a case it may even be preferable to go to an entirely different computer rather than add more components to the present system.

Programming Languages

Although programming does not take place until the system is actually implemented in Stage 2, selection of a programming language affects the equipment choice. The equipment configuration, for example, must be sufficient to compile the programming language chosen.

The most widely used languages are FORTRAN, COBOL, Autocoder, Symbolic Programming System and Report Program Generator. Several factors should be assessed in reaching a decision on a language:

1. Will the workload consist of many one-shot jobs, resulting in a heavy load of programming and compilation — or will relatively few, repetitive programs utilize the system? High-level languages tend to reduce programming costs but increase compilation costs and may produce somewhat less efficient (space or time) programs.

2. If the system is input/output-dominated, an efficient input/output control system is vital.

3. Will programming be done by many people scattered throughout the organization (open shop) or by a centralized group of programming specialists (closed shop)? FORTRAN, for example, is easier to teach to many novice programmers, but more efficient programs may be written by a group of professional specialists using a more machine-oriented language.

IBM Application Programs

Use of IBM standard application programs can represent a substantial saving over design and implementation of a tailor-made set of programs. Most application programs are written for specific minimum configurations, such as the lens design program for the 1620. Even when modification is necessary to meet business requirements, the detailed system design information (record layout, system runs, file organization, indexing schemes, general and detailed flowcharts, etc.) can save much effort.

RUN DEFINITION

The effectiveness of an equipment configuration is shown by analysis of run timing and cost. A first step, therefore, is organization of the system into a series of computer runs which break the job down into manageable portions.

Most systems have natural segmentation points for initial run timing. In a serial system, for example, natural segments are:

- Input conversion and data validation
- Sorting
- Master file updating
- Output editing and conversion

For a real-time system, the points differ somewhat:

- Input
- Transactions (batch, single)
- Inquiries
- Control functions
- Outputs
- Reports

Runs are generally defined in descending order of their impact on total running time. As runs are defined, other aspects arise:

- On smaller systems, both the maximum possible configuration and the minimum configuration are restrictions. Even on large-scale systems, where the theoretical maximum configuration of input/output devices may exceed the realistic requirements of any one activity, a maximum core storage restriction exists.
- Where multiple input/output devices are attached to a single control unit, the maximum

number that a control unit can handle acts as a ceiling on the configuration. This ceiling may be exceeded, but only at the cost of an additional control unit.
- Volume must be analyzed when converting from source media to magnetic tape (and from magnetic tape to punched card or printed output) to determine whether to convert online or through a supporting system. Special requirements such as optical scanning, MICR reading of input documents, or production of special-media outputs also affect this decision.

After runs are defined, a system flowchart (or run organization chart) showing the flow of information through the system and the relationship of runs to files will illustrate magnitude and scope of the computer runs.

After run definition, the study team selects the number and models of random access units, tape drives, printers, readers, punches, etc. Equipment features are identified completely, including, among others:

- Process Overlap
- Advanced Programming
- Compressed Tape
- Interrupt
- Tape Intermix
- Tape Switching
- Multiply-Divide
- Print Storage
- Direct Seek (1311)
- Cylinder Mode (1301)
- High-Low-Equal Compare

RUN TIMING AND COSTING

Each equipment configuration is evaluated for performance and cost with a detailed run timing and cost analysis. This requires identification of equipment features, a more detailed description of file organization, and a review of noncomputer-oriented factors.

File definitions are expanded to show:

- Restrictions on file format, such as block size limitations and compatibility requirements.
- Record formats, recognizing:
  a. core storage characteristics (word size and extra control characters).
  b. Magnetic tape unit characteristics (suppression of leading blanks and zeros and extra control characters).
- Average record length of each file (in characters or digits for tape, in words for core storage).
- IOCS requirements.

Approximate tape-passing time and the number of reels required can be calculated for each file on the basis of volume, tape density, and a tentative record-blocking factor. Tape drives are assigned to achieve a balanced channel condition, and provision is made for error and exception routines. (Checkpoint and restart procedures are needed for long runs.)

Utility runs, such as sorts and merges, are timed from published formulas. For other types of runs, timing is based on tape-passing time and internal processing time (considering core storage and tape-interference time). If the system is unbuffered, run time is the sum of tape-passing time and internal processing time; if the system is buffered, run time is the greater of internal processing time or tape-passing time on the channel with the heaviest load.

Runs are reviewed for improvement in order of total running time. It may be possible to reduce the number of tape drives, combine short runs, or split long runs for greater efficiency.

The best equipment configuration for a design alternative is determined from run time results and from a careful review of other system costs.

System cost is constructed from unit costs for system components, special features, operating supplies and personnel requirements. By definition, a system comprises people, procedures and equipment. System selection to this point has been concentrated on equipment. Associated procedures also must be examined to take advantage of file organization and compaction techniques, better concepts of information storage and retrieval, new transmission equipment, and the like.

There must also be an estimate of the cost of personnel to operate the system after it is fully installed. Salaries and clerical support costs are developed from actual payroll data (or industry averages, for new jobs) projected over the useful life of the operating system. Combined with timing and cost data for the equipment, this produces a total operating cost for the new system.

FINAL SYSTEM SELECTION

The process just described for equipment specification, run definition, and timing and cost analysis is repeated for two or three equipment solutions (where practical) for a given design alternative. The best solution for that design alternative is then selected. The process is executed for each design alternative until a final choice can be made among the best solutions for each alternative.

In the final selection process several additional business factors must be reviewed:

- Growth of the business
- Need for system flexibility

- Other applications and activities
- Ease of implementation
- Need for common languages
- Selection and training of personnel

One particularly important consideration in system selection is evaluation of the several prospective solutions as they impact on implementation costs and on the general operations of the business. This is necessary in order to comprehend the complete system cost and thus avoid the error of making the ultimate decision solely on the basis of equipment rental. When these topics have been examined in conjunction with the special advantages of each system configuration, the final system decision should be the one that is best for the total business, both now and in future years.

With the designation of a system solution, run description and timing data are reviewed once more to ensure that the best possible run design exists prior to final documentation.

Separate Activity Sheets may be filled out for each system run or they may be combined on one system flowchart. Volumes, time relationships, frequency, and other significant data are noted in the tabular area; the system flowchart is drawn on the right side of the form, showing inputs, outputs, operations, terminations, etc.

Message, File, and Operation Sheets may be used where appropriate. Selected detail is the keynote to documentation; critical areas may require some detailing, but most areas can be treated on a general level.

A summary Activity Sheet is usually desirable to display the system as an entity, with separate descriptions of equipment configuration and personnel requirements.

SYSTEM SELECTION EXAMPLE

Since the process of system selection involves a certain amount of recycling and iteration, it is illustrated further in the following example of a finished stock control and warehousing activity from a multiplant manufacturing concern. In order to demonstrate system selection, reference is made occasionally to decisions arrived at during basic design and system integration.

General Data

The company maintains 20 finished-stock warehouses and distribution centers at widely dispersed points throughout the country, each one differing in size and type of items stocked. The study team formulated two basic design alternatives: one for a decentralized, local control system, and another for a completely centralized system. Orders presently are received at the several warehouses by telephone, in the mail, or on handwritten forms.

Decentralized Concept

Under the decentralized design alternative, manual documents would be converted to punched cards and processed in a computer four times a day at each warehouse. A random access file would be maintained for inventory item balances and pricing data. Output would be in two forms: a printed listing of transactions and updated balances, and a card for order picking. Reorder point analysis was scheduled for once-a-day review.

Three general equipment configurations were postulated for this alternative:

1. 1440-1311 card-to-card system with an online printer.
2. 1401-1311 card-to-card system with an online printer.
3. 1620-1311 system. The acceptance of this configuration would depend largely on the volume of complex calculations.

A fourth possibility was the use of unit record equipment in conjunction with tub files. Because the study team had to contend with different volumes at different warehouses, there was a chance that any one of these configurations might be appropriate in individual situations.

Starting with the knowledge that the design concept is decentralized and with the fact that several generic equipments have been specified, what implications can be made in regard to each system? In the 1440-1311 system, for example:

- Can enough 1311s be provided to allow real-time response?

  -or-
- Does the inflow of work have to be considered in batches?

In regard to files:
- What files are needed?
- How many transactions occur per day, distributed in time?
- How many characters are there in each transaction?
- Can name and address be coded or does it come direct?
- How big is the inventory file?
- Can it be combined with the pricing file, or name and address file?
- Is discount data a separate file, or can this be put alongside each item?

In regard to batching:
- Is inventory reorder point data separate or combined with another file?

- Are orders separated by geographical location to take advantage of full carloads?
- Are orders filled by breaking packs, or only to full-unit packs?
- How are modifications handled?
- What kind of sales records are submitted and maintained?
- Is accounts payable part of this routine or is it separate?
- Does credit have to be authorized on each order?

All these questions are directed at determining the number and size of files. Having defined the files and decided on batch processing, the next step involved an identification of runs, as follows:

1. Sort transactions by item or customer number.
2. Review credit by customer name or number.
3. Sort by geographic location code.
4. Group items into carload lots.
5. Sort carloads by item number.
6. Pass item numbers against the inventory file to produce picking tickets.
7. Sort picking tickets into sequence by location for carload accumulations.
8. Price the items from price charts.
9. Resort by customer.
10. Perform a discount analysis.
11. Produce an invoice and accumulate to accounts receivable.

This first pass run designation was then reanalyzed to improve its overall efficiency, and the amount of processing was defined to some extent for each run.

Next, the equipment configuration was expanded in detail. For example:

- Is advanced programming needed?
- Is multiply-divide operation required?
- How many disk drives and packs?
- What speed card reader is needed?
- What line speed is required for the printer?
- How many characters are being punched on each run?

Finally, a run timing and costing analysis was prepared for each run, which led to further run modifications. This entire process was repeated for the other two proposed equipments: 1401-1311 and 1620-1311. On the basis of the run timing and costing results of each equipment configuration, a decision was made on the most feasible one for the decentralized design alternative: one 1440-1311 system for each finished-stock warehouse and distribution center, and one central 1620 system for invoicing.

Centralized Concept

The same general approach was applied to the design alternative built around centralized control.

Equipment networks were postulated to answer such questions as:

- What kind of terminals would be needed? What kind of lines?
- How many miles of lines?
- What would line rates be?
- Would lines be simplex, duplex or half-duplex?
- Would there be punched card or tape input terminals, or job-oriented terminals?
- Centrally, would a 7750 be used as a message exchange, or would some other type of equipment be used?
- Are reliability requirements such that equipment must be duplexed, or is there an adequate fallback procedure, or is degraded service acceptable?

With files, the 1301 instead of the 1311 was the minimum consideration because of total data storage requirements. Additional questions might be:

- How many logical files are there?
- How are files organized?
- How are files addressed? That is, are files controlled by warehouse or by part number for all warehouses?

These and similar questions were reviewed until a detailed specification of inputs, outputs and files had been completed.

The run designation was quite different from the decentralized alternative, since the system would operate on a real-time basis. Eight or nine major operations were specified for processing transactions and for any batch or clean-up runs associated with them. A system simulation was considered necessary to evaluate the complexities of interactions, queuing, and overlap seeks (the IBM General Purpose Systems Simulator proved to be effective here).

Once all these considerations had been weighed, equipment configurations were postulated:

- Back-to-back 1410s
- Single 7080 with 1401 for I/O
- 1401 system for inputs and outputs; 7010 to handle complex calculations

The configuration was then detailed to show:

- Features of the equipment
- Numbers and speeds of tapes
- Numbers and sizes of disk files
- Number of channels between the input/output device and the computer; between files and the computer.

Run timing was considerably more complicated for these alternatives and again required the use of the General Purpose Systems Simulator. On the basis of run time and cost comparisons, the study team decided on a 7040-1401 combination as the ideal solution, even though this particular configuration had not been specified originally. This solution illustrates how equipment alternatives become modified and blended through successive iterations. The 7040-1401 provided the best compromise in calculating capability, in conjunction with the high input/output capability of the 1401, which could handle the scientific computations of an engineering activity. The remainder of the equipment specification included six tapes, four terminals at each location, and half-duplex lines.

System Selection

The centralized equipment solution was compared with the solution under the decentralized concept. The evaluation between the two included examination of many factors examined in system requirements:

- Future business growth
- System flexibility
- Ease of implementation
- Training of personnel
- Common language
- Effect of other applications
- Cost

When these factors were fully examined and some of the alternatives reorganized and rearranged, a final decision was made, as follows:

- Three high-volume warehouses were assigned separate 1440s, although invoicing was to be performed centrally.
- The other 17 warehouses were unified under a central 7040-1401 system with a one-hour lag and limited batching to compensate for queues in the system.

The complete design solution was documented as a final step to show detail on the equipment, individual run descriptions, files, inputs and outputs.

CHAPTER 4 — IMPLEMENTATION PLANNING

A substantial investment in time and money is required to transform a drawing-board solution into a fully operating system. Investment in implementation is as much a part of the total cost of a new system as the rental or purchase price of equipment. Therefore, it is necessary to prepare an accurate estimate of these costs for management review as part of system recommendations.

IMPLEMENTATION SCHEDULES

In many studies the estimate should reflect the fact that complete systems are rarely installed simultaneously. For instance, an implementation schedule for replacing a 7070 tape system with a complex computer network of TELE-PROCESSING equipment and the 7074, may call for a four-step program extending over a period of two to three years:

- Step 1. The present system's programs and tables are converted to the logic of the new 7074 and stored in one of the new system's disk files. Transactions are still batched on tape and processed against tape master records.
- Step 2. All master records now on magnetic tape are converted to disk master records; additional disk file units are installed at this point. Transactions would enter the system from tape in random sequence and be processed against disk file master records.
- Step 3. "In-house" or home office inquiry stations and the transmission control unit are installed. The control program, under design since the first phase, must be operational at this point. Operating programs are now put into final form. Checkpoint and restart procedures are tested.
- Step 4. Terminal units are installed in field offices (starting with offices that transmit the greatest diversity of transaction types in order to fully check out system logic).

Checkpoints

There is no complete check list that will apply to every implementation program. There are certain checkpoints, however, that are encountered in most schedules. These are useful when incorporated into a specific preinstallation plan.

SYSTEM PREINSTALLATION

- Establishment of an organization
- Initial education program
- General system design
- Physical installation plans
- Detailed system design
- Completion of first test
- Establishment of conversion procedures
- Commitment on system delivery
- Machine-room layout and cable order
- Selection and training of operating personnel
- Conversion, testing and pilot runs

Two special planning tools or techniques, PERT (Program Evaluation and Review Technique) and LESS (Least Cost Estimating and Scheduling), both based on the critical path method of analysis, have been used in planning preinstallation schedules. If either PERT or LESS is employed, its use at this point should be confined to an overall description of implementation plans; later, when implementation has actually begun, a more detailed network may be developed.

COST PLANNING

Implementation itself takes place after the New System Plan is approved. Initial planning for implementation, however, must begin before recommendations are submitted — in order to consider the implementation schedule and cost. Implementation cost planning consists of five major tasks:

- Detailed system design
- Programming and program testing
- Physical planning
- Conversion and system testing
- Personnel selection and training (performed concurrently with other tasks)

For each of the tasks an estimate must be prepared showing how long it will take, how many trained personnel are needed, how much training each person will require, and how much it will cost.

Detailed System Design

The new system must be described at a procedural level (during detailed system design) before programming can begin. When developing the implementation plan, the concern is not with the techniques of detailed design, but with the time and cost implications of performing this task: How long will it take? How many trained specialists will it require? How much will it cost in total? etc. These considerations are answered by compiling individual estimates for separate assignments within detailed system design: flowcharting, detailed run design and run book preparation, forms design and layout, report content and layout, detailed file design, manual procedures, supplies ordering (punched cards, magnetic tapes, printed forms), etc.

Estimates are prepared by sampling representative routines, applying experience from comparable prior designs, using appropriate standards, or conducting small-scale desk tests. After individual estimates have been completed for all assignments, they are reviewed for possible lap-phasing or parallel execution (to the extent that personnel will be available to handle a compressed schedule). An overall plan is then prepared.

One method of displaying this data in compact form is illustrated in Figure 3 *. The upper bar graph shows total dollar expenditures in a particular time period; the linear graph (connecting the triangles) shows cumulative total dollars as of that time period. The lower horizontal bar graph portrays the period of time over which the assignment is to be performed and the dollars required for the assignment.

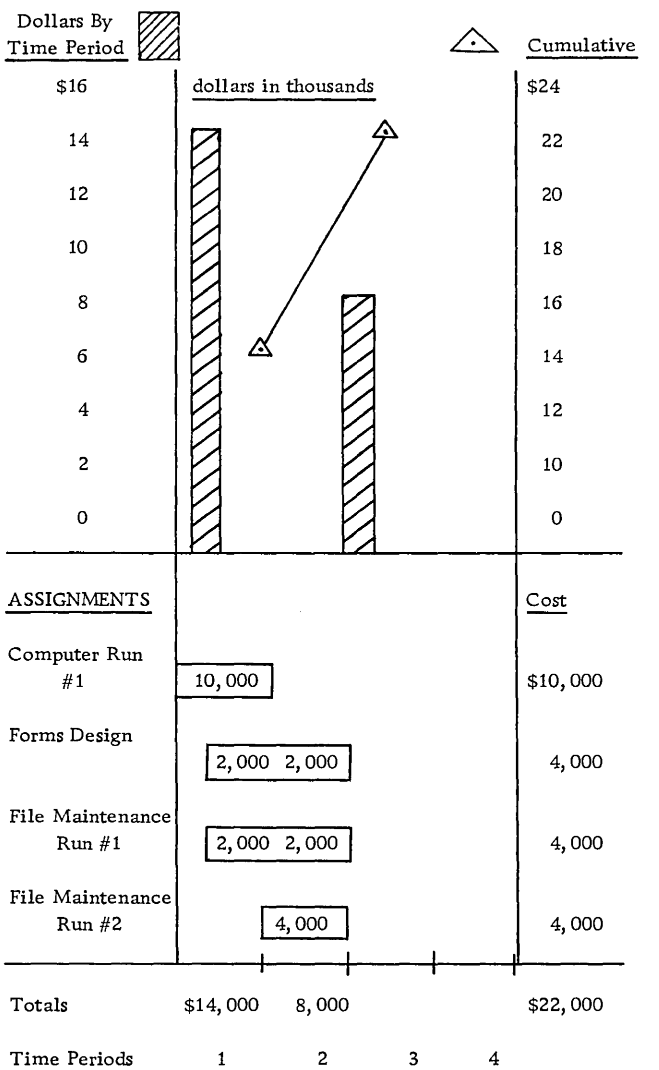


Figure 3 Implementation time and cost plan - - detailed system design

*This exhibit and others which follow are intended solely as illustrations of how to depict implementation costs. They are not intended to illustrate the costs of any particular installation or equipment.

Programming and Program Testing

As segments of the detailed system design are completed, programming will be initiated: program flowcharting, coding, creating test data, desk checking, testing and debugging. Time and cost are estimated for the implementation plan.

After basic logic and flow have been defined, a programmer will normally analyze and rearrange operations to take maximum advantage of computer (and peripheral equipment) characteristics. This reorganization involves evaluation of a number of computer-oriented design considerations which have an important effect on system performance and efficiency: tape blocking, channel assignment, memory overlay, use of subroutines, reference tables, multiple printers, work areas, overlapping and sequence of seeks, etc. Introduction of these will undoubtedly cause some changes in the detailed design. An appropriate cost allowance for this work should be included in the programming estimate; magnitude of the cost will depend largely on the quality of the design that will be turned over to the programmer by the analyst.

Time and cost estimates must also be developed for creating test data and for desk-checking the program coding prior to machine testing. In machine testing and debugging, automatic testing packages improve machine utilization and enable more programs to be tested in a given length of time. Waiting time should be allowed for during debugging, since a computer may not always be immediately available.

After individual segments (routines or runs) are debugged, they must be linked with other segments. An adequate safety factor is necessary here: debugging of individual segments can be predicted with a fair degree of accuracy, but when several programs are pulled together, their interaction may be very high — and the higher the interaction, the more sharply debugging time increases.

Total programming time can be reduced by using IBM programming systems: generalized programs, utility programs, and program testing aids. IBM application programs likewise can materially reduce programming time — whether the package is used intact, is modified, or is used as detail support (system runs, file organization, indexing schemes, record layout, etc.).

Actual costs from installed systems and suggested time allowances can be studied for guidance in calculating programming estimates, in addition to drawing on the experience of programmers. Time and cost data can be displayed in a format similar to that of Figure 3.

Physical Planning

Various aspects of physical planning (site selection and construction, air conditioning, equipment and office layout, electrical and cable requirements, etc.) have been thoroughly discussed in other literature; detailed guides are available on both the general subject and individual systems. For example:

- "Physical Planning", general information manual (F24-1052)
- "1401 Installation Manual, Physical Planning", reference manual (C24-1404)
- "Physical Planning, IBM Input-Output Components, 7000 Series and 1410 Systems", installation manual (C22-6681)

The main concern in establishing a physical installation time and cost plan is to provide an adequate time schedule and sufficient construction funds for the work.

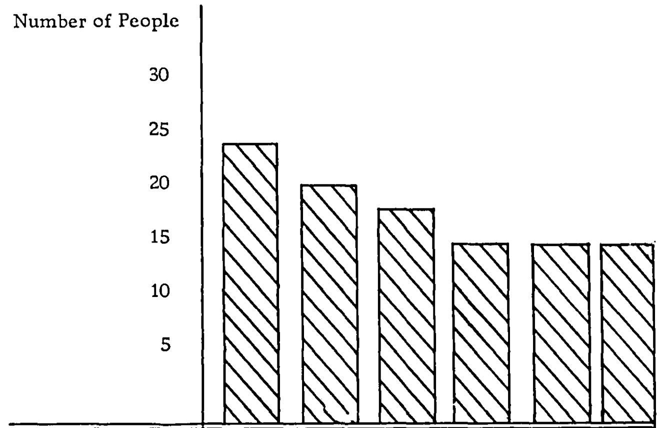
The installation estimate can be reported in a form similar to that shown in Figure 3, from data supplied by designated subcontractors or an internal facilities group.

Conversion and System Testing

The size of the conversion task depends on how large a part of the total system is included in the initial cutover, and how much is consigned to later sequential or progressive implementation. A variety of assignments are reflected in the time and cost estimate for conversion:

- Preparing and editing files for completeness, accuracy and format.
- Establishing file maintenance procedures.
- Providing training in system operation for using departments and for source-data departments.
- Compiling cutover schedules.
- Planning for pilot or parallel operation. (In parallel operation, the old and new systems are operated simultaneously for a time on current data; in pilot operation, the new system is checked out extensively, using data from a prior period, before it takes over processing current operations.)
- Coordinating the conversion.

A realistic schedule is based on the amount and type of work to be done and on the availability of personnel to handle it with dispatch. Appropriate time and costs can be summarized in a form similar to that of Figure 3.



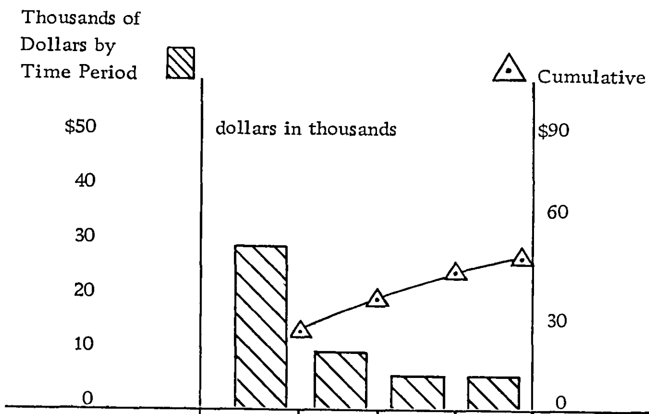
Time Periods	1	2	3	4	5	6
	IMPLEMENTATION				OPERATION	
Coordinator E	+1 1	0 1	0 1	0 1	0 1	0 1
Systems Analysts E	+4 E 4	-2 2	-1 1	-1 0	0 0	0 0
Programmers 1/2 E 1/2 T	+10 +10	-4 6	-3 3	-2 1	0 1	0 1
Coders T	+2 2	0 2	0 2	-2 0	0 0	0 0
Machine Operators 1/2 E 1/2 T	+4 4	+2 6	+2 8	+1 9	0 9	0 9
Maintenance E	+2 2	0 2	0 2	0 2	0 2	0 2
Time Periods	1	2	3	4	5	6

E — Experienced
T — Trainee

Figure 4. Implementation Time and Cost Plan - - Personnel

Personnel Selection and Training

Each of the foregoing tasks included some personnel cost for doing the work. Since salaries and associated overhead constitute a large part of implementation expense, it is often helpful to show the personnel buildup (by job categories) for all tasks in a separate summary. Figure 4 shows requirements for each position, broken down by experienced personnel (E) and trainees (T). The upper numeral in a box indicates the number of persons to be added or released during a stated time period, while the lower numeral reveals the cumulative number in that position at any one time.



	1	2	3	4	Cost
Travel & Living	$ 3,000	$1,000			$ 4,000
Supplies	1,000	500	$ 500	$ 500	2,500
Personnel					
Coordinator	1,000				1,000
Systems Analysts	4,000				4,000
Programmers	12,000	3,000			15,000
Coders	4,000	1,000			5,000
Operators	4,000	4,000	4,000	4,000	16,000
Total	$29,000	$9,500	$4,500	$4,500	$47,500
Time Periods	1	2	3	4	

Figure 5. Implementation Time and Cost Plan - - Personnel Training

An expense other than the salaries of implementation personnel is that of testing and selecting these individuals, then training them in the classroom and on the job. Time must also be allowed for interviewing, testing, rating and selecting these personnel.

Extensive educational programs are offered on specific data processing systems for those who will perform systems analysis, programming, and machine operations jobs, as well as for systems installation and operation supervisors. Job training for tape librarians, console operators and auxiliary machine operators is also required. Availability of this training is an important factor in accomplishing a smooth transition to routine systems operation while meeting tight schedules.

Identifying, scheduling and summarizing personnel selection, and training time and cost is the final step in implementation planning. Figure 5 illustrates one way of displaying these costs and their time relationships.

SUMMARY

An implementation plan thoroughly documents the expected investment in systems installation as an important element of total systems cost. Estimated time and cost to execute the plan are of primary relevance here — rather than the substance and detail of Stage 2 implementation work.

System implementation planning has a parallel in physical system planning. Before a commitment is made to proceed with the building of a new plant, management must know what costs are entailed, how long the construction will take, and what the cost of the product will be when produced by the new facility. Only then can a reasonable comparison be made between required investment and the benefits to be derived from making this investment.

In the next chapter, benefits and operating costs are appraised for the new system, using implementation planning data. When this appraisal is accomplished, the study team has the necessary facts to present to management what the system is and what it will do (Chapter 3), what investment is required to place it in operation (Chapter 4), and what economic benefits will accrue from its use in the business (Chapter 5). On the strength of this knowledge, management can make a decision on installing the new system.

CHAPTER 5 — APPRAISAL OF SYSTEM VALUE

In the final analysis, the essential value of a new system to a business is determined by management. Management appraises system value by how well it measures up to selected decision-making yardsticks, asking: How will the system affect profits and markets for the next few years? Are there sufficient funds to support initial installation, or does money have to be borrowed? If so, for how long? What is the economic worth of the system besides higher operating efficiency and greater flexibility? To answer questions like these, a study team puts a set of calipers on the proposed system to find out what its ultimate payoff will be in terms other than cost.

NATURE OF VALUE

An appraisal of system value must have multiple dimensions to satisfy management: in addition to cost, there should be comparable appraisals for time, flexibility, volume, and accuracy values. It is often difficult to assign values to less tangible measures, yet these must be evaluated on an economic basis to provide management with explicit information for making sound judgments.

Most of the measurement factors were outlined in the Phase II SRS, and they have already served individually as guideposts for system design. Now the problem is one of establishing the system's total economic effect on the business. This approach can be illustrated by the study involving the National Bank of Commerce of Syracuse. The real value of a unified banking system is not just that "the depositor is better served and more satisfied". A substantive statement of this value would say:

- System accuracy, flexibility and expandability accommodate planned increases (4% annually) in the number and amount of deposits. These extra funds will then be available for reinvestment in income-producing endeavors.
- The system encourages depositors to combine their other banking requirements with this institution. This will lead to increases from profit-generating services.

These advantages can be further refined with forecasts of change in assets and revenue due solely to the new system.

To prepare a comprehensive appraisal of system value, four types of data are needed:

1. New system operating costs, projected over the estimated useful life of the system.
2. Present system operating costs, projected over the same period.
3. Investment required to bring the new system into full operation (implementation costs).
4. Basic values the new system offers to a business, expressed in economic terms.

Costs are then related to values to show total system impact. Comparisons are made to a consistent base at all times; this base is the projection of present system costs. The approach is especially helpful if two or more recommended designs (for example, an online and an offline system) are analyzed in terms of system value. In this situation, the study team makes an evaluation of each possible system against the common denominator of the present system — instead of the less conclusive evaluation of one new system against another.

NEW SYSTEM OPERATING COSTS

One documentary output from system selection (Chapter 3) is a description and summary of operating costs for the proposed system. Costs were compiled for the equipment, material and personnel required. If these figures were not then projected into the future, an estimate of direct operating expense is now developed to cover the useful life of the system — recognizing factors such as anticipated growth and planned expansion.

Cost Projection

Estimated equipment, personnel and other costs are influenced by the potential growth of the business and by the decisions on implementing the system progressively over some period of time. A sales forecast and the implementation schedule are necessary resources for preparing a cost summary. Marketing forecasts of sales or service levels as developed for other business planning applications are used. If desired, the potential variation in forecast accuracy can be accounted for by stating future expected sales on a probability basis (Figure 6).

The implementation schedule, although emphasizing only the initial installation, should also contain plans for implementing other activities. The cost estimate is prepared with due recognition to equipment and personnel buildup required to support the additional workload.

Equipment costs have to reflect the decision to rent or to purchase. With rental, monthly charges are carried as expense; with purchase, a schedule is set up for monthly depreciation charges and related costs (such as the interest on money borrowed to finance the purchase). If no decision has yet been reached, parallel descriptions are prepared to show the dual cost impact during a system's life.

1962-63		1964-65		1966-67		1968-69		1970-71	
Prob.	Am't*	Prob.	Am't*	Prob.	Am't*	Prob.	Am't*	Prob.	Am't*
.1	125	.1	165	.1	200	.1	250	.1	300
.4	135	.4	175	.4	215	.4	265	.4	315
.5	150	.5	180	.5	225	.5	280	.5	325
	141.5**		176.5**		218.5**		271.0**		318.5**

* millions of dollars
** weighted average

Figure 6. Projected revenue -- proposed system

Figure 7 is a new system operating cost summary. Where the time span exceeds five to eight years, the figures can be aggregated in two-year sums.

	1964-5	1966-7	1968-9	1970-1	1972-3
Data Processing Equipment	215	240	260	295	295
Personnel	85	85	95	95	105
Materials	120	65	35	35	40
All Other	90	85	90	95	120
Totals (in thousands of dollars)	510	475	480	520	560

Figure 7. New systems costs - projected

Logical Analysis

As cost data is compiled, a study team often finds that special analytical techniques are needed to derive valid data.

Logical analysis techniques are appropriate for constructing operating costs in some areas of the system (number of operators required to run TELE-PROCESSING terminals, for example). For collecting samples of performance, statistical methods are useful. Finally, techniques of experimentation and observation can be applied.

Experimentation involves the manipulation of situations under controlled conditions so that results closely approximate those found in the real world. Experimentation, however, is expensive and should be confined to a limited number of special problems. Simulation, one form of experimentation, may have been employed earlier (especially in design of real-time systems); and if a simulator is already constructed, it can be reused to provide information that will be of assistance in projecting costs.

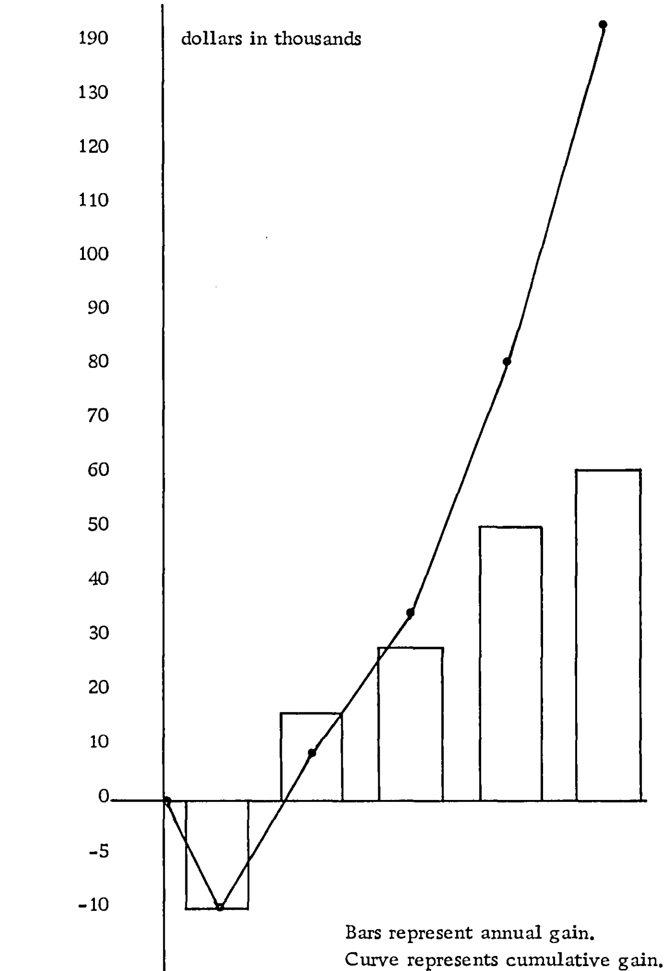
Direct observation (the extrapolation of results from known data) is an informal variation of experimentation. It consists of setting up a test situation to evaluate the length of time a series of operations takes, or to determine what the displaceable costs amount to for certain current operations.

PRESENT SYSTEM OPERATING COSTS PROJECTED

A third category of costs necessary for the value appraisal is an estimate of how much the present system would cost to operate if maintained over the expected life of the new system and with the same level of volume. Included costs are the present personnel, equipment, and other related costs that would be superseded by each new activity. The compilation would cut across conventional organizational boundaries and would reflect the progressive implementation of activities in the business. This makes the costing process complex, but only in this way can costs be compared on a common base.

Balance sheets of financial operations, income and expense statements, and Resource Usage Sheets from the Phase I description of the present business are sources for the needed data. Expenses are projected from current operations to determine how much personnel and equipment costs would be when extended to the higher anticipated volume of future years. Allowances must be made for wage increases, changes in material costs, and trends in cost reduction.

Costs are summarized and then plotted on a graph such as Figure 8 to show the difference between projections in present and proposed system operating expense.



	62-63	64-65	66-67	68-69	70-71
New System	510,000	535,000	575,000	620,000	660,000
Present System	500,000	550,000	590,000	670,000	720,000
Difference	-10,000	+15,000	+25,000	+50,000	+ 60,000
Cumulative Difference	-10,000	+ 5,000	+30,000	+80,000	+140,000

Figure 8. Cost analysis - new system vs. present system

IMPLEMENTATION INVESTMENT

After determining the new system operating costs (Chapter 3), an estimate was established for implementation planning and implementation costs (Chapter 4). Although implementation is a cost in the accounting sense, it also is an investment. Management must weigh its value in the same manner as new plant construction costs or other projects competing for investment funds. For this reason, implementation costs are regarded as an element of investment during system appraisal.

ECONOMIC VALUE OF THE NEW SYSTEM

Aside from costs, a study team should consider some of the less tangible ways a new system affects the business. What is it worth, for example, to achieve 99% accuracy in certain operations rather than 93% accuracy? A general explanation is not enough; to effectively demonstrate the real value of such an improvement, accuracy must be discussed in economic terms. One approach is to look at business lost because of invoice or statement errors. If a company loses 3% of its customers annually because of statement errors, and if the new system prevents such errors, this 3% can be saved; the effect is a 3% annual gain in customers for the company. The analyst, using additional sales statistics, could then translate this 3% gain into actual dollars of gross sales.

This type of analysis is applied to each of the factors outlined in the SRS (and to any other factors added since publication). The results explain how the new system will perform in regard to each factor, and what economic value is assigned to this performance. Some factors to consider are:

- Decrease in the length of a product or service processing cycle
- Improvement in product or service quality
- Shortened response time to inquiries from prospective customers
- Effect on other classes of investment and resources (for example, accounts receivable, utilized floor space, inventories, etc.)
- Increased employment stability
- Better delivery promises to customers kept
- Greater stock availability to service a variable demand
- Effect of cost reduction, elimination of spoilage and waste, and obsolete materials

RELATING COSTS TO VALUE

In a final step, the several analyses of cost and value are drawn together to present a complete and integrated appraisal for the new system. This is accomplished through displays meaningful to management: profit and loss, return on investment, and cash flow statements.

Profit and Loss Statement

The cost-value relationship can be portrayed in financial report style with a summary-of-operations statement for the entire business or for some

(4-year average - $ in 000)	Present	Proposed	Difference
Net Sales Billed	$8710	$8830	+$120
Cost of Sales	7560	6950	- 610
Direct Material	3280	3040	- 240
Data Processing Equipment	30	110	+ 80
Other Indirect Costs	430	350	- 80
Non-Qualifying Costs*	1930	1930	-
Gross Income	1150	1880	+ 730
Federal Income Tax	600	980	+ 380
Net Income	550	900	+ 350
% to Sales	6.3	10.2	+ 3.9

*Expenses not affected by new system; detail attached

Figure 9. Summary of operations

selected part of it (Figure 9). This method requires projection of data to develop additional information.

Estimates of future conditions and events must be conservative, reasonable and believable. The sales forecast is a case in point. If, for example, one benefit from the proposed system is reduced cycle time or faster response to customer inquiries, what direct effect will this have on future markets? material costs? selling price? Unless the impact of this benefit can be predicted with assurance by the marketing department, the conservative approach is to use the same sales forecast for both present and proposed systems.

In the compilation of cost data, projection can be simplified by separating nonaffectable costs from computations. Within affectable cost areas, such factors as personnel changes, cost reduction improvements, waste and spoilage reductions, quality improvements, and differences in fixed and variable costs are priced out. One study team conducted a broad analysis of this type by interviewing each department head. Supervisors were asked to pinpoint how their costs would change with the new system — down to individual job classifications and related-expense areas. Nonaffected costs were set aside and the supervisors' estimates were adjusted for the greater volumes anticipated over the next few years. Results were then organized in an operations statement similar to Figure 9.

Time Periods		1	2	3	4	Total
Present System	(1) Operating Costs	300,000	330,000	370,000	450,000	1,450,000
	(2) Inventory Level	2,000,000	2,200,000	2,400,000	2,800,000	9,400,000
New System	(3) Operating Costs	350,000	300,000	300,000	350,000	1,300,000
	(4) Inventory Level	1,200,000	1,200,000	1,300,000	1,500,000	5,200,000
	(5) Operating Costs Difference (1) - (3)	-50,000	+30,000	+70,000	+100,000	150,000
	(6) Inventory Level Difference (2) - (4)	800,000	1,000,000	1,100,000	1,300,000	4,200,000
	(7) Value of Inventory Reduction 25% of (6)	200,000	250,000	275,000	325,000	1,050,000
	(8) Net Operational Improvement (5) + (7)	150,000	280,000	345,000	425,000	1,200,000
	(9) Implementation plus Equipment Costs	1,200,000				
	(10) Return on Investment	25% per year				

Figure 10. Return on investment analysis

Return on Investment

Another form of value appraisal is the computation of return on investment. This graphically demonstrates the value of a proposed investment in terms of earnings by measuring present system cost, new system cost, and investment differences.

Figure 10 shows the result of such an analysis. Year-by-year system operating costs were projected over four time periods, along with the level of inventory required to support the forecasted sales. (Inventory can be projected by simulations — for example, by applying significant ratios such as turnover by inventory class, number of weeks of inventory on hand, etc. — or by calculating balances remaining from estimated shipment schedules.) Comparable data was developed for the proposed system; the differences are shown in lines 5 and 6.

Dollar value of the inventory reduction was determined on the basis of estimated savings from reduced obsolescence and deterioration, space savings, opportunity costs, etc. In this case it amounted to 25%, and is shown on line 7. The net operational improvement (line 8) was developed by adding the operating cost difference (line 5) to the dollar value of the inventory reduction (line 7) for each forecast period. Implementation costs and equipment purchase costs were totaled to show investment (line 9). Return on this investment (line 10) was found by dividing average yearly improvement by the implementation and equipment costs (line 9). Line 8 totals, $1,200,000, was divided by number of time periods, 4, to produce $300,000 average yearly improvement.

Cash Flow

Display of expected impact of the proposed system on the cash position of the business will enable management to have sufficient funds available to meet commitments as they arise.

A cash flow analysis is illustrated in Figure 11. Total implementation investment was calculated for the period prior to operation, and net operational improvements (same as line 8, Figure 10) were inserted for each following time period. An incremental inventory level difference was computed by subtracting each period's inventory level difference from that of the prior period (line 6 of Figure 10). Equipment purchase costs were included on line 4 to reflect three equal annual payments; this capital charge was depreciated for a five-year life beginning in the second period. Net cash flow is net operational improvement plus inventory level incremental difference plus equipment depreciation minus implementation investment minus equipment purchase price. Cumulative cash flow is the total of the previous year's cumulative cash flow and the current year's net cash flow.

Cash flow can be graphed as in Figure 12. The chart shows that $800,000 additional cash is required to place the system in operation, but that funds will be generated fast enough to permit repayment at the very end of the first period of operation.

Time Periods	0	1	2	3	4
(1) Total Implementation Investment	600,000				
(2) Net Operational Improvement		150,000	280,000	345,000	425,000
(3) Inventory Level Incremental Difference		800,000	200,000	100,000	200,000
(4) Purchase of Equipment	200,000	200,000	200,000		
(5) Depreciation of Equipment		80,000	120,000	120,000	120,000
(6) Net Cash Flow (2)+(3)+(5)-(1)-(4)	-800,000	+830,000	+400,000	+565,000	+745,000
(7) Cumulative Cash Flow	-800,000	+30,000	+430,000	+995,000	+1,740,000

Figure 11. Cash flow analysis

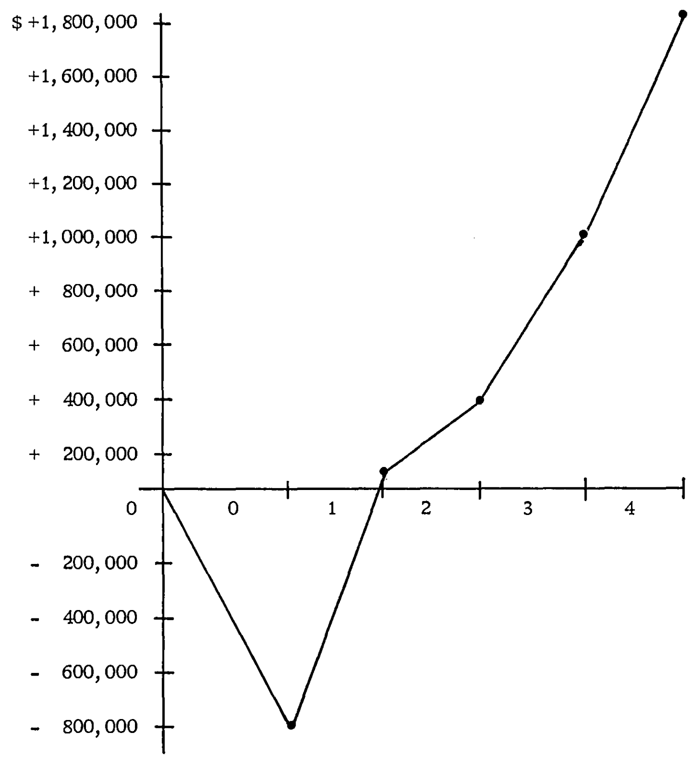


Figure 12. Cash flow graph

DATA AMPLIFICATION AND INTERPRETATION

Much of the information contained in the value review depends on the proper interpretation of future events, so it is advisable to explain how the key cost-value comparisons are developed and to amplify their significance on business operations. Major results of the appraisal should be emphasized, particularly with regard to the time the system is expected to pay back initial investment, and with regard to what the magnitude of the savings will be once the system is in operation for a given time.

CHAPTER 6 — NEW SYSTEM PLAN

The final (Phase III) report of a study proposes a course of action for management. It has two major objectives:

- Provide management with an understanding of the new system, stressing economic value to the business.
- Furnish support data for objective evaluation by technical and functional specialists within the business.

Because of its dual purpose, the report must put the message across succinctly, with awareness of reader interest and point of view. In other words, it must communicate.

Liberal use should be made of charts, graphs, pictures, etc., to illustrate such things as complex points difficult to describe in the text, statistical data, equipment layout, work flow and personnel organization.

SECTIONS OF THE NEW SYSTEM PLAN

The New System Plan* has six sections:

- Preface — containing (1) a letter of transmittal from the study team to management, with recognition of study participants and contributors, (2) a general introduction and (3) a table of contents.
- Management Abstract — a concise, executive-level summary of key system recommendations and study results, aimed at the principal managers of the business.
- New System in Operation — describing how the job will be done, and directed toward operating management.
- Implementation Plans — showing time and cost in system implementation, and directed toward managers responsible for financial operations and planning.
- Appraisal of System Value — portraying economic impact and value of the new system, and aimed at financial and operating management.
- Appendix — displaying selected background data on detailed procedures for methods and programming personnel.

Preface

The transmittal letter to management notes the formal conclusion of Phase III. The original scope and objectives of the study are reviewed along with any major changes in either. Composition of the study team is described and mention is made of special assistance supplied by other persons or groups.

An introduction is written for the report, and a table of contents is included for the material.

Management Abstract

The nucleus of the New System Plan is the Management Abstract. It is written so that an executive can gain insight and understanding into the proposed new system quickly, without the burden of excessive detail. It describes the system at an overview level and serves as an extended table of contents for the balance of the report.

Within this critical section, management expects to see precise facts about the investment potential of the new system. Its content, then, must include a basic appraisal of essential values and advantages to the business. Subject matter must be thorough but selective, and must cover only significant facts (much like a lawyer's brief). Principal points should be stated in an orderly and logical manner and should evoke sharp images.

However brief, an Abstract covers:

- Recommended course of action with regard to new system
- Objective appraisal of system advantages, benefits and savings
- Review of Phase I and Phase II results
- New system operating costs
- Review of investment required during implementation

New System Recommendations

The system solution proposed to management is the concluding recommendation of the study team. The new system is defined and described in broad outline; general advantages are cited for its acceptance and introduction into the business. This is illustrated by an excerpt from the Collins and McCabe report:

*In studies where IBM representatives are requested to prepare a formal proposal for data processing equipment and services, the IBM proposal will cover much of the subject matter discussed in this chapter. There is no intention to suggest that the planner duplicate their efforts by preparing a separate New System Plan. In these studies, the New System Plan as presented here may instead serve as an outline for an oral presentation to management. At this presentation, the IBM proposal could be submitted, along with the planner's recommendations for equipment and services not covered by the IBM proposal (additional common-carrier services, physical site construction bids and estimates, accessories, etc.). If, however, a formal IBM proposal is not required, the New System Plan as discussed here may be used as the basis of a formal document submitted to management.

Following a thorough examination of the present business at Collins and McCabe, and specification of systems requirements, we recommend the installation of an IBM TELE-PROCESSING® system consisting of two IBM 1410 processors, an IBM 7750 Programmed Transmission Control unit, and two IBM 1301 Disk Storage units. This solid-state data processing system will provide complete brokerage service for Collins and McCabe through integration of communications and accounting operations.

The computer-based communications network will bring remotely located data to a central processing area, forward it for action, and return processed data to originating locations for prompt satisfaction of customer requirements and efficient recording and reporting of information.

A complete range of brokerage operations will be handled electronically, with minimum manual intervention. The real-time nature of the system is made possible by computer control of transmission facilities. Random access disk storage units will accept many different types of entries for processing against customer and security files.

System Value and Advantages

Since information and conclusions are presented in order of their interest to management, economic value of the proposed system is discussed next. Management naturally looks first for direct dollar savings, then for intangible improvements. Value must be demonstrated by how the new system will produce added profits, and how the capital structure of the business is affected over the estimated useful life of the system.

To portray value objectively, selected exhibits described in Chapter 5 are used along with a narrative explanation. Figure 13 shows how expected savings were graphically illustrated in the Collins and McCabe report.

Exhibits can be further supported with statements of savings and benefits in specialized areas. In so doing, each factor must be described in terms of direct economic value to the business. Faster, more accurate reports are an advantage, to be sure, but an attempt should be made to translate such intangible benefits into economic value. In the Collins and McCabe report, values were shown for:

- Improved customer service through specific reductions in elapsed time.

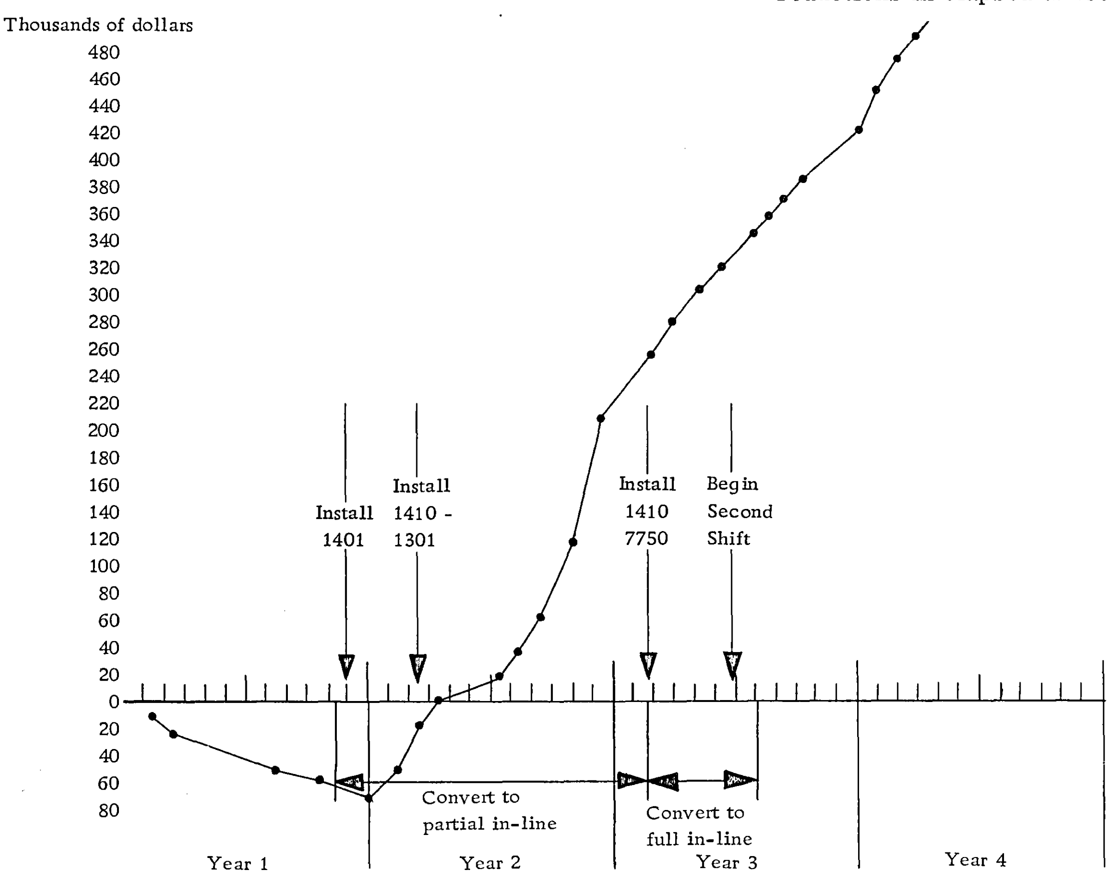


Figure 13. Cumulative Expected Savings

- Greater computation accuracy through error-checking procedures.
- Capacity for growth in transaction volume — without significant increases in clerical cost.
- Reductions in after-hours operation by application of random access storage techniques for transaction and record posting.

The actual value of these and other benefits was shown to demonstrate advantages beyond savings in operating costs.

Present Business Description and Systems Requirements Specification

One or two paragraphs are inserted in the report to review distinctive features from the Present Business Description. Brief facts on products or services, markets, present sales volumes, rate of growth, organization structure, and the like are combined into a comprehensive statement similar to the following:

> Topeka National Bank of Commerce is located in the center of the nation's richest agriculture country. It is organized by the primary services it supplies: correspondence, service, deposits, loans and trusts. The bank has grown at the rate of $2.5 million in deposits per year, for the last 30 years, to the present level of $250,000,000. About 75% of the outstanding shares in the company are owned locally. Of the 210 personnel, 65 are administrative officers and 145 are operational personnel.

Activity requirements for the future system are also outlined here in one or two pages. Goals and scope for each activity are specified in narrative form, as in the following example for an insurance company:

> This activity handles details of new business for Custodian Life Insurance Company, from receipt of an application at the home office to completion of the policy and related records for transmission to the customer. In the last three years, applications processed have increased from 8,565 to 9,811. Volume is expected to increase gradually over the next few years (no sudden increase, however, is expected).
>
> New business applications are vital to the prosperity of Custodian. Quick and efficient processing of applications will assist greatly in stimulating even more new business and in keeping costs down.

Or, the goals and scope could be specified in a two-part list:

> <u>The new activity performs these functions:</u>
>
> Review application and related forms.
> Request medical and policyholder history.
> Underwrite applications.
> Assemble application data.
> Calculate premiums.
>
> <u>The new activity does not perform these functions:</u>
>
> Determine outside underwriting services.
> Determine underwriting standards.
> Set limits on policy size.
> Determine medical standards.
> Determine premium rate schedule.

Cost limitations, policy constraints, or any other considerations affecting the activity are noted at this point.

New System Operation

This part of the Abstract describes how the new system will appear in full operation. Managerial <u>uses</u> of data are emphasized, rather than the mechanics of processing data. Discussion of operating highlights and characteristics should employ terminology used by the management audience.

The content may be organized around a summary system flowchart as prepared in Chapter 3, or around a modified flowchart as in Figure 14 from Collins and McCabe. Description is focused on major inputs, operations and outputs, the main-line events and salient features. Thus management can acquire an understanding of the system in operation without becoming involved in detailed procedures.

Conciseness applies equally well to the equipment description. Frequently, the explanation can be blended with the system operations discussion, as in the following report:

> The data processing center is the heart of the system. Communication lines form the main arteries over which vital reservations data is transferred between agents and the center.
>
> The design of the data processing center is based on two major subsystems: the IBM 7090 Data Processing System and 1301 Disk Storage unit.
>
> The central processing unit performs all logical and decision-making functions required in the reservation process. An integral part of the system is the magnetic core storage unit. The instructions required to process common reservation transactions are stored here, as are transactions actually in process.

The data channel is similar to a subsidiary computer and uses a semi-independent stored program to control the flow of data between the computer memory and a group of input and output devices. Several data channels may operate concurrently in a 7090 system.

Data from communication lines enters the processing center through the IBM 7750 Programmed Transmission Control unit. Among other functions, this device assembles message characters arriving on the communication lines into groups, checks these groups for errors, and moves them into the main computer storage unit.

Large-capacity disks store the reservation records. These disks contain records of seat inventory, availability, current passenger reservations, current flight information, fares, and infrequently used programs. Reading and recording mechanisms, operating automatically under control of the central processing unit and the associated data channels, locate records to be read or recorded at high speed.

The profile of new system operation is completed with a short summary of new positions and specialized job skills required. Personnel requirements can be illustrated graphically by means of an organization chart that shows how the new system differs from the present in positions and in alignment of duties.

Implementation Plans

The timetable and the costs associated with implementation form the final section of the Abstract. A composite exhibit is prepared from the five separate task schedules prepared in Chapter 4, as shown in Figure 15. Beginning with an estimated start date, costs and time are projected for each implementation task; detailed system design, programming, installation, conversion, and personnel selection and training. A one-paragraph description of each task is included with the exhibit, similar to the following explanation on personnel selection and training:

This task involves the selection and education of personnel capable of effectively performing functions such as systems analysis, programming conversion, documentation and console operation. The selection procedures will include aptitude tests, educational qualifications, and past experience reviews. Training will involve both classroom and on-the-job training.

New System in Operation

New system operation from the Abstract is expanded to provide further information for operating managers and other personnel of the business. Principal sources for this second major report section are the individual Activity Sheets. Data is condensed and summarized under three headings:

- Information Flow
- Equipment Configuration
- Personnel Organization

Information Flow

The broad system description and pictorial diagram in the Management Abstract is reoriented to convey more detail on information flow for operating personnel. General terms are replaced by specialized nomenclature associated with equipment descriptions and flowcharting techniques.

Explanation, as before, is highly visual. Description may be maintained at a single level of detail, or it may work down progressively from a total system flowchart, through activity flowcharts, to operation flowcharts, as illustrated in Figure 16 for a state tax agency study. Data for this part of the report is extracted from Activity Sheets prepared earlier in Phase III.

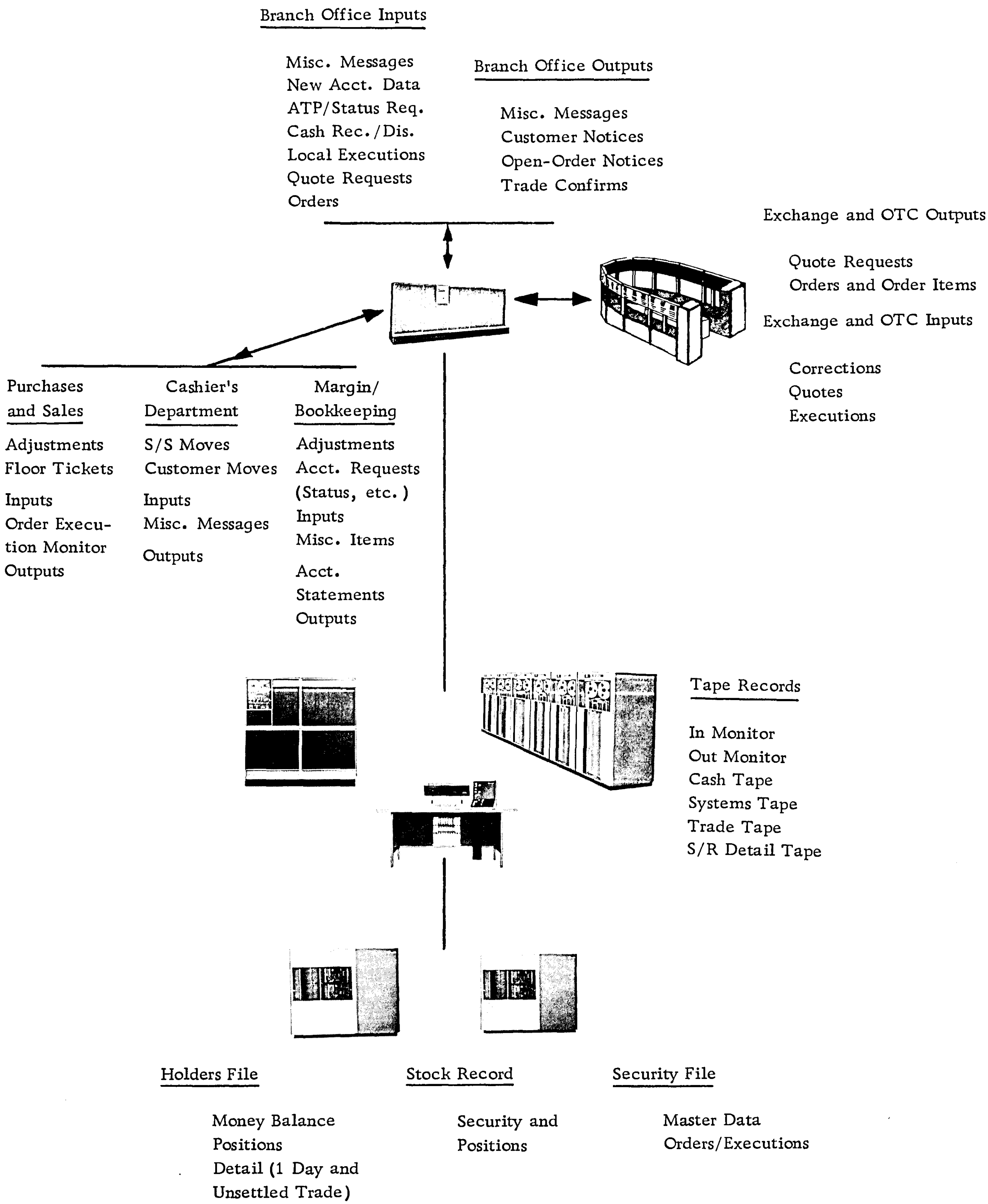


Figure 14. Real-Time Traffic Flow

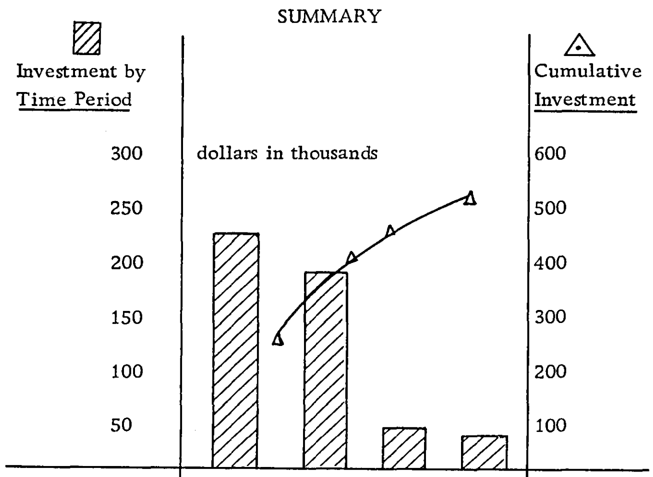
Narrative explanations are appended to the flowcharts, or are integrated into a running system description. A statement for the operation "correction of edit-found errors" in Figure 16 reads:

> Input to the taxpayer error correction routine consists of error cards. Cards are given to clerks, who interpret them and write corrections directly on the cards (those cards that cannot be corrected are destroyed, and corrections are made at the computing center). Cards that can be corrected are of two kinds: those that can be handled locally and those that require information from the master file located at the computing center. In either case, after referring to the source document file or to the appropriate master file at the computer center, the clerks write correct data on the cards. The cards are keypunched, verified, and sorted by document number. They are now ready to be used in correcting the taxpayer error tapes, which are then sent to the computing center.

Equipment Configuration

Each unit of the proposed equipment configuration is identified by name and number and related to the other equipment on a single display, unless photographs have already been used in the general system diagram. Physical characteristics and functions of units are discussed in a paragraph, as in the following description of an IBM 1402 Card Read Punch:

> The 1402 Card Read Punch is a device particularly suited to applications requiring high-speed reading and punching of cards at reasonable cost. It is capable of reading cards at a rate of 800 per minute and of punching cards at a rate of 250 per minute. For maximum utility in the 1401 system, several features are incorporated in the card read punch. High reading speed is complemented by a file-feed device that allows an entire tray of 3,000 cards to be loaded at one time. Cards entered into the machine on either the read side or punch side are directed to radial stackers, each with a 1,000-card capacity. Each can be unloaded without interruption to other operations. For example, forms are converted from card to tape at the rate of 300,000 per eight-hour shift by the use of the exceptional reading ability of the 1402. To ensure accuracy of input information, a comparison check is made at two reading stations. This further reduces the possibility of error. The high punching speed of the 1402 complements its reading speed by punching any cards detected in error during the editing process as exception cards without delaying the conversion process of the main file. The 1402 combines extremely high speed with convenience and self-checking ability to provide low-cost input/output for the card-to-tape and tape-to-punch operations.



Time Period	1	2	3	4	Cost
Detail System Design	14,000	8,000			$ 22,000
Programming	120,000	100,000	10,000		230,000
Installation	48,000	51,000	11,000	10,000	120,000
Conversion and Test			8,000	20,000	28,000
Personnel Selection and Training	38,500	20,000	14,000	7,500	80,000
Totals	$220,500	179,000	43,000	37,000	$480,000
Time Period	1	2	3	4	

Figure 15. Implementation Costs

Personnel Organization

A proposed personnel organization chart has already been included in the Abstract; the specific duties of each new position are outlined here. Delegations of responsibility and authority are also specified, since they apply to the data processing group and that group's relationship with external organization components.

There are generally three categories of full-time systems personnel:

1. Systems analysts — responsible primarily for designing the system and acting as advisors to the programmers in systems problems; they may also serve as programmers.

TOTAL SYSTEM DIAGRAM

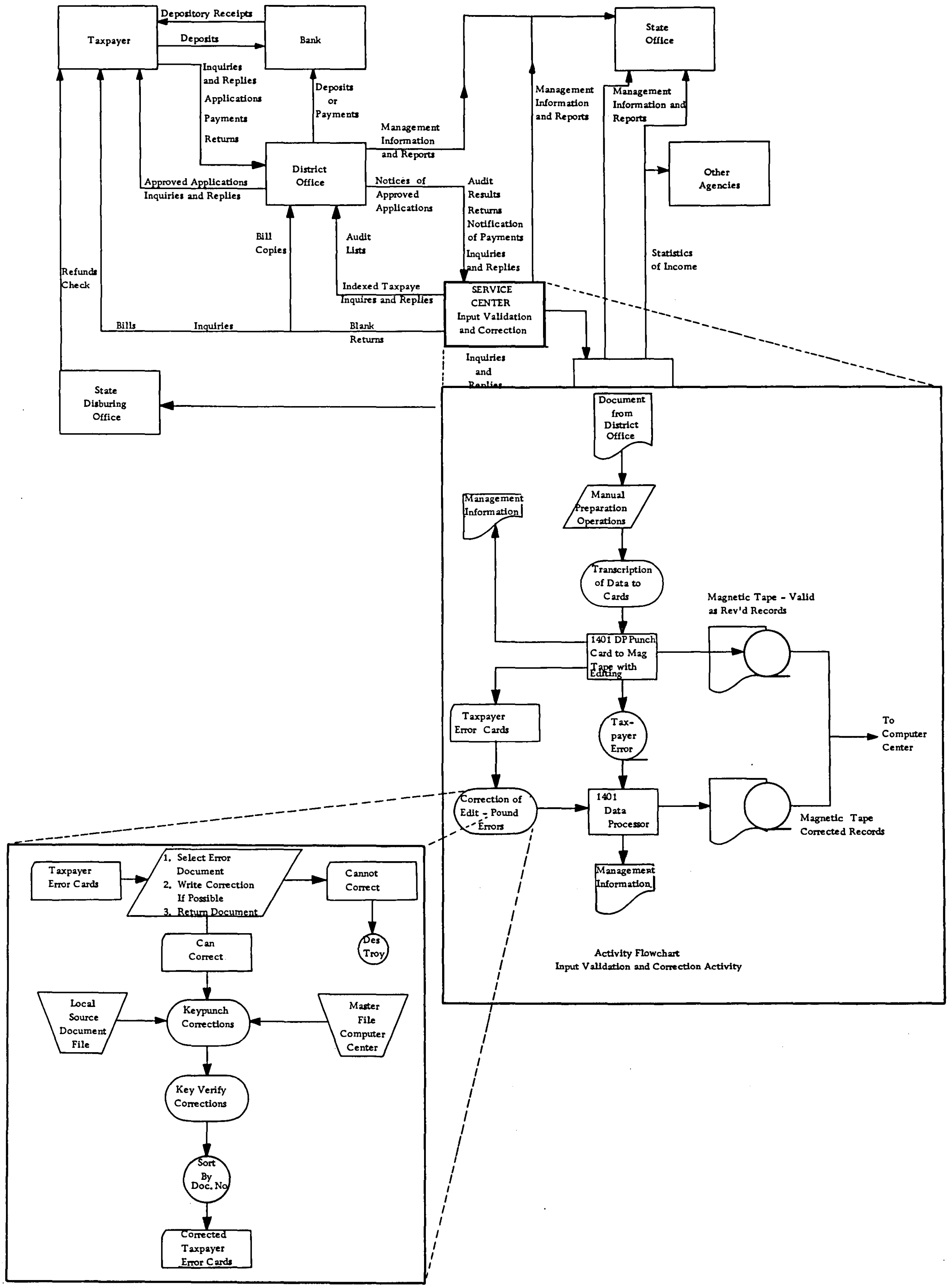


Figure 16.

2. Programmers — who translate the program from flowcharts to machine-acceptable language. This work includes the preparation of detail block diagrams, machine coding and program testing.

3. Operators

a. Console operators, in charge of operations in the machine room during actual running of the equipment.

b. Tape librarians, responsible for the receipt, storage and issuance of taped records.

c. Machine operators, who operate the card and tape equipment of the data processing system.

d. Data control clerks, who log and establish controls on all incoming and outgoing jobs, and who set up and maintain job schedules.

Implementation Plans

Various implementation task schedules discussed in Chapter 4 are placed in this report section to expand the implementation summary of the Abstract. These exhibits, along with backup narrative, provide a sufficient amount of implementation detail, although some study teams have used PERT network diagrams to further illustrate time and cost relationships. The Collins and McCabe report, for example, contained brief narrative accounts on each of the five tasks; major cost and service events were then itemized, showing when equipment and procedures would be installed, and the cost associated with each event.

Figure 17 from Collins and McCabe uses a somewhat different technique of displaying personnel buildup during implementation as compared with the bar graphs in Chapter 4.

Appraisal of System Value

The Abstract emphasized economic values of the system in terms of profits, cash flow, and return on investment. In this appraisal section, system advantages are examined as they pertain to other operating personnel in accounting, facilities, and property departments. Two kinds of information are generally included:

- Cost comparisons between the present system projected and the proposed new system over its useful life
- Detailed descriptions of other system benefits and values

Personnel, materials, data processing rental or depreciation, and related expenses are drawn from the cost summaries prepared in Chapter 5. These are supplemented with narrative to indicate break-even points, trends and other important features.

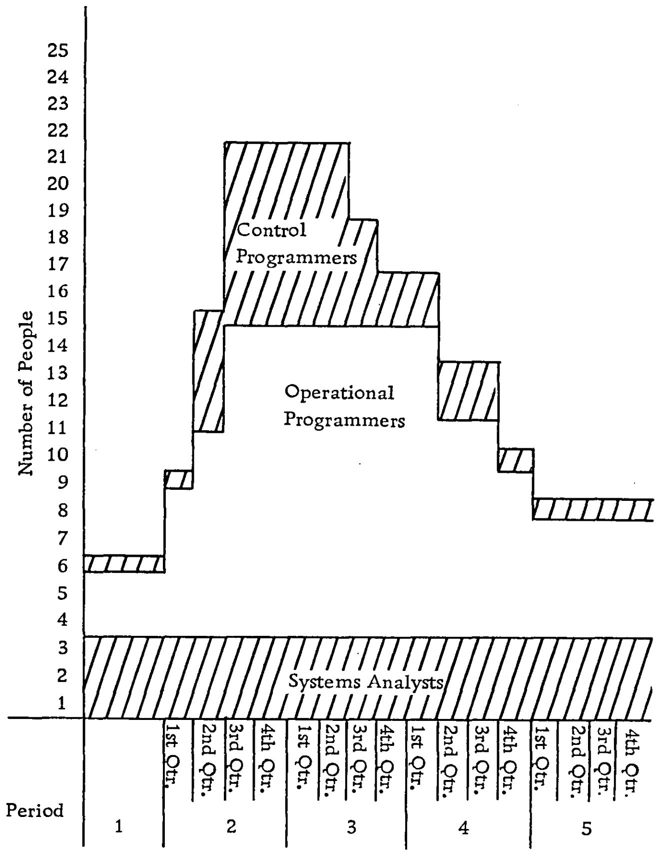


Figure 17. Programming and systems personnel

Specific reasons for rejecting alternate proposals can also be noted here. At Collins and McCabe, alternate solutions for pure message switching, for message switching and order matching, and common-carrier reperforator service were evaluated and reasons listed for the rejection of each one.

A discussion of this nature leads to an evaluation of other system advantages and benefits, including such intangible values as flexibility, efficiency, improved service, reliability, etc. Where assumptions were made in costing these factors, the basis for arriving at value should be carefully explained. Any values developed in Chapter 5 and not covered in the Abstract should be discussed here.

Appendix

The Appendix is fundamentally a technical validation section and contains information useful primarily to methods and programming personnel. This is not a dumping spot for study detail that does not fit elsewhere. Emphasis is directed in particular to critical and to advanced elements of the study.

The Appendix includes such subjects as:

- Simulation data on message flow, volumes, equipment utilization, networks, etc.

- Record, file and message descriptions
- Sample (and demonstration) programs
- Application flowcharts
- Physical planning detail
- Detailed equipment characteristics
- Disk and tape requirement calculations
- Derivation of formulas and calculations
- Training course descriptions
- Programming systems support

The basic five SOP documentation forms (Resource Usage, Activity, Operation, Message and File Sheets) are used as necessary, since they permit description at a very general level, or in considerable depth. Certain types of data, though, require other media for description (panel wiring charts, manual procedures, network diagrams, etc.).

SUMMARY

The new System Plan is both a description of the study team's solution to a major business problem, and a formal presentation to management for decision and action. It is the culmination of a systems study — providing management with the penetrating, thorough, and validated information to make sound systems decisions that will promote the short- and long-term growth of the business. The next step is management's directive to proceed with Stages 2 and 3, Systems Implementation and Operation.

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International Business Machines Corporation
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