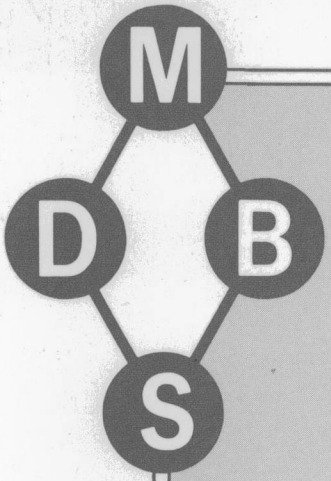

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USER'S MANUAL

HDBS·DMS

HDBS·DDL

Supplement to

MDBS·DMS MDBS·DDL

USER'S MANUAL

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HDBS - An Extended Hierarchical Data Base System

Version 1.04

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PREFACE

This manual is concerned with data base management and its use as a tool in software development. Many experts have predicted that two innovations will dominate the computing scene in the 1980's. The first innovation is in the area of computer hardware with the development of the micro-computers (computer on a chip). The second, a software advance, is the use of highly sophisticated data base management techniques to control complex data structures. These two innovations are combined together in the Micro Data Base Systems' Data Management System. We believe that data base management systems (DBMS) with their capability of supporting selective retrieval to "what if" type inquiries and their ability to support restructuring as the nature of the demands change, will be the focal software in micro's as they are already in mini- and maxi-computers. The micro-computer, with its fantastic computer power on a per-dollar basis, combined with a powerful data base management system, will be a formidable tool for managing enterprises of all types.

The purpose of this manual is to serve as a supplement to the MDBS User's Manual. First we discuss the use of hierarchical (tree) structured data representations. Second, we point out the differences between the HDBS and the MDBS systems. It should be noted that the MDBS system is fully upwards compatible with the HDBS system and that the full MDBS system provides several powerful capabilities not provided by the HDBS system.

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Finally, we request comments from our readers as to how successful, in their view, we have been in achieving these goals. Have you been able to follow our description of how HDBS.DDL and HDBS.DMS should be used and actually have you achieved the expected results? Or have there been points where the steps were unclear or ambiguious? We plan to incorporate these suggestions in future versions to finally achieve a manual that is a fit companion to what we feel is a remarkable and truly innovative software product in the micro-computer area.

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NEW RELEASES, VERSIONS, AND A WARNING

Any programming endeavor of the magnitude of the HDBS systems is bound to continue to evolve over time. Realizing this, Micro Data Base Systems vows to provide its users with updates to their version for a nominal handling fee. When errors are discovered, HDBS users will be informed by a letter and asked to send a copy of their package (on a diskette) to Micro Data Base Systems for the new release.

New versions of HDBS software will be considered as separate products. However, owners of previous versions will be entitled to a preferential rate structure.

Finally, each copy of HDBS products is personalized with the licensee's name. There are several levels of this personalization, some of which involve encryption methods guaranteed to be combinatorally hard to decypher. HDBS products were produced with a sizable investment of capital and labor to say nothing of the years of prior involvement in the data base management area by principals of HDBS. Accordingly, we are seriously concerned about any unauthorized copying of our products and will take any and all available legal action against illegal copying or distribution of our products.

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I. INTRODUCTION

The Micro Data Base Systems' Data Management System (HDBS.DDL and HDBS.DMS) has many components devoted to the defining of storage structures and the storing and retrieving of data. The ideas used in this system were extended from the CODASYL Data Base Task Group, April 71 Report.

For each application system a logical structure of the data base must initially be defined; that is, a formal definition is made in which the relationships between the data elements is presented. Initially a user may list the various data items (field names) that will be involved in a particular application. The process of defining a logical data structure consists of grouping data items into record types (or, in conventional data processing terminology, into logical files) and indicating appropriate relationships between record types. These relationships are only conceptual and do not imply any physical storage allocation. Nowhere in the use of the data management system does a user refer to an actual data storage location, but rather, he refers to the conceptual structure as initially defined. This defining of the data structure is done via the DDL (Data Definition Language) and processed by the program named HDBS.DDL.

After the structure has been defined the application programs will, of course, need to access data from or place new data into the data base. The application program does not, however, read (or write) the desired data directly from (or to) the data base. Instead, it requests the data management routines (HDBS.DMS) to perform the

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necessary operations. This requires the writer of the application programs to know only the conceptual structure of the data base; the DMS is responsible for maintaining the physical structure. The requests to the DMS are made via subroutine calls which make up a collection of commands comprising the DML (Data Manipulation Language).

The HDBS system is designed to process hierarchical (tree) data structures. Such a structure occurs when a class of "record-types"[1] (data records) is allowed to be the "owner" (parent) of zero or more other record types, but may be the "member" (child) of zero, one or more set types. Figure I.1.A illustrates a simple tree structure for a manufacturing organization. The box labelled "DEPT" represents the record type corresponding to departments within the organization. There may be many different departments within the organization, each of which would be represented by an occurence of the DEPT record type. Each department has associated with it both foremen and equipment, represented by the FOREMAN and EQIPMENT record types, respectively. Presumably, the FOREMAN record type would store information about each foreman and the EQIPMENT record type would contain information on each piece of equipment in the department. Finally, each foreman has zero or more employees which she supervises. The record-type EMPLOYEE contains information on the employees. A sample Data Definition Language description of this data base is shown in Figure I.1.B.

[1]Section II.D of the MDBS User's Manual describes these concepts and terminology in greater detail

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The linkage between, say, each employee and the employee's foreman is maintained by the "set-type" S3. A set is the means by which two record-types are linked. In the HDBS system, all sets are "one-to-many" sets, which means that each owner record-type (FOREMAN) may "own" (supervise) many member record occurences (EMPLOYEEs), but that each member (EMPLOYEE) may have at most one owner (FOREMAN). Note that the employees associated with each foreman may be ordered if desired. In the example, each foreman's employees are maintained in sorted order by the employee number ("data-item" NUMBER).

The HDBS systems is actually an Extended Hierarchical Data Base System because it provides direct access to records at any level of the hierarchy without the need to access records at a level higher in the data structure. For example, a purely hierarchical data base system would require a program to access an employee's data record by accessing, in turn, the appropriate department record and FOREMAN record. In the HDBS extended hierarchical data base system, the records of all employess may be accessed directly by use of a special record type known as the SYSTEM record. The SYSTEM record may be defined as the owner of any number of "set-types" and any record type in the data base may be used as a member of these sets. For our example data structure, this means that we may define sets (such as sets S4 and S5) in which all employees are members and may be accessed sequentially (in a sorted manner) or directly (via the FMSK command). Note also that set S4 is sorted on the employee number while S5 is sorted on the employee name. The use of such system sets is a powerful adjunct to the other features of the HDBS system.

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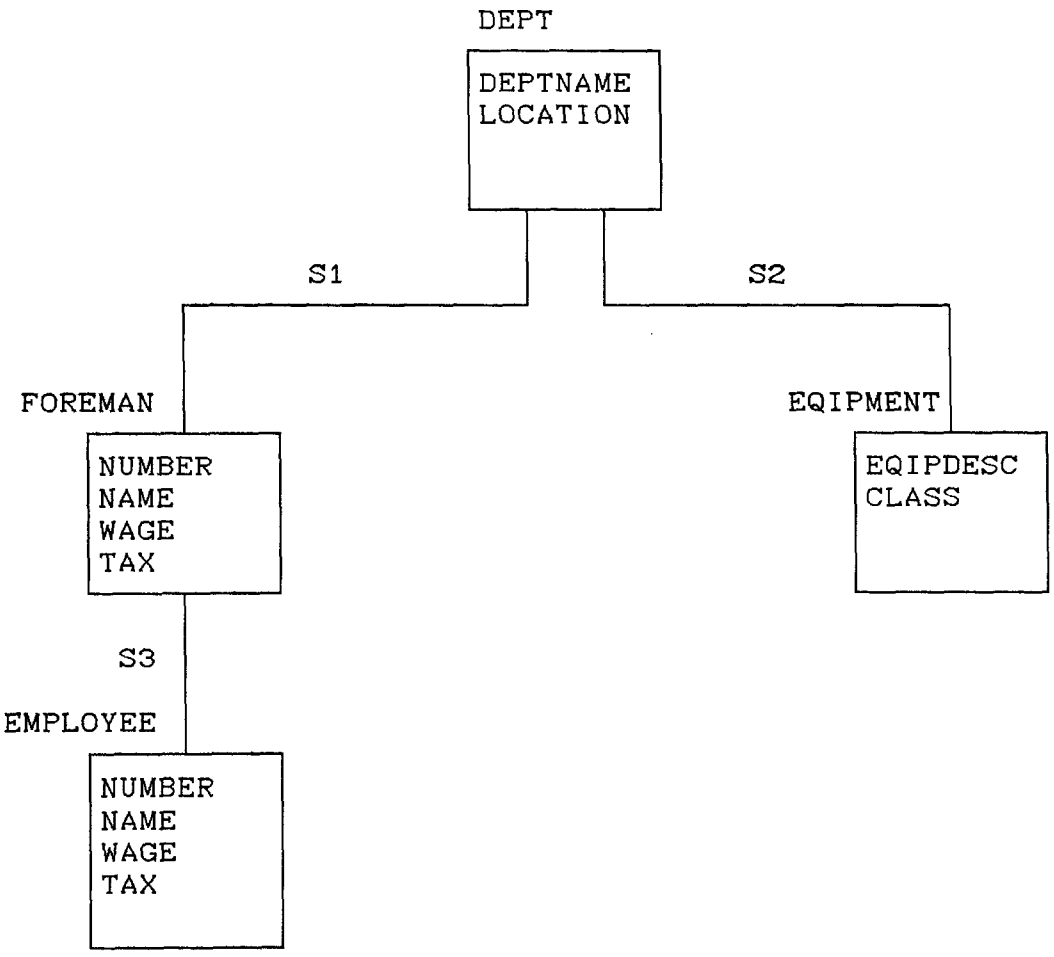

FIGURE I.1.A - TREE DATA STRUCTURE

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```
RECORD DEPT
ITEM   DEPTNAME CHAR 30
ITEM   LOCATION CHAR 20

RECORD FOREMAN
ITEM   NUMBER   INT   5
ITEM   NAME     CHAR 20
ITEM   WAGE     REAL  5
ITEM   TAX      REAL  5

RECORD EQIPMENT
ITEM   EQIPDESC CHAR 30
ITEM   CLASS    CHAR  2

RECORD EMPLOYEE
ITEM   NUMBER   INT   5
ITEM   NAME     CHAR 20
ITEM   WAGE     REAL  5
ITEM   TAX      REAL  5

SET    S1       MAN  1:N
                          SORTED   NUMBER
OWNER  DEPT
MEMBER FOREMAN

SET    S2       MAN  1:N
                          SORTED   EQIPDESC
OWNER  DEPT
MEMBER EQIPMENT

SET    S3       MAN  1:N
                          SORTED   NUMBER
OWNER  FOREMAN
MEMBER EMPLOYEE

SET    S4       AUTO 1:N
                          SORTED   NUMBER
OWNER  SYSTEM
MEMBER EMPLOYEE

SET    S5       AUTO 1:N
                          SORTED   NAME
OWNER  SYSTEM
MEMBER EMPLOYEE

SET    S6       AUTO 1:N
                          SORTED   DEPTNAME
OWNER  SYSTEM
MEMBER DEPT
```

FIGURE I.1.B - DDL DECLARATIONS

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II. MDBS / HDBS DIFFERENCES

The MDBS Data Management System supports several data structures and command features not supported in the HDBS system. Among these are User Access Levels, Variable Length Records, non-1:N set relationships and network data structures. Still, for many users the HDBS system provides the capabilities needed to efficiently handle many common data representation problems.

The following DML (Data Management Language) commands are supported by the MDBS system but are not available in the HDBS package:

CCT - Check Current of run unit Type
CMT - Check current Member Type
COT - Check current Owner Type
CR - Create Record
DRO - Delete Record based on current Owner
FFO - Find First Owner
FINDO - FIND Owner
FLO - Find Last Owner
FNO - Find Next Owner
FOSK - Find Owner based on Sort Key
FPO - Find Previous Owner
GETO - GET data from current Owner
GFO - Get Field from current Owner
GOC - Get Owner Count
GTC - Get record-Type of Current of run unit
GTM - Get record-Type of current Member
GTO - Get record-Type of current Owner
PUTO - PUT data into current Owner
SCO - Set Current of run unit based on Owner
SFO - Set Field in current Owner
SMC - Set Member based on Current of run unit
SMM - Set Member based on current Member
SMO - Set Member based on current Owner
SMR - Set Member based on current Record
SOC - Set Owner based on Current of run unit
SOO - Set Owner based on current Owner
SOR - Set Owner based on current Record
SRO - Set current Record based on Owner

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DIFFERENCES BETWEEN THE MDBS MANUAL AND THE HDBS SYSTEM

Section II.D.3 and II.D.4

The various set orderings described in the MDBS manual (SORTED, FIFO, LIFO, NEXT, PRIOR and IMMAT) are supported by HDBS. Additionally, both AUTO and MANual set types are allowed. The many-to-many set relationship and the ability of a single record type to be owned by more than one non-SYSTEM record are not permitted. This means that while the DDL Description of Figures II.D.1 and II.D.2 are allowed in HDBS, the structures described in Figure II.D.3-6 are not.

Section II.D.5

ITEM Card (p. 52-53) - The read and write access levels (columns 26-28 and 30-32) are not used with HDBS. Depending items (columns 36-43) are not allowed since all records in HDBS are fixed length.

PASSWORDS Card (p. 55) - Only one password card may be specified in the HDBS system. The user read and write access levels (columns 26-28 and 30-32) are not used and should be left blank.

RECORD Card (p. 57) - The read and write access levels (columns 26-28 and 30-32) are not used with HDBS.

SET Card (p. 59-64) - The 1:N set type is the only set type supported by HDBS, so columns 22-24 must always contain "1:N". The read and write access levels (columns 26-28 and 30-32) are not used with HDBS. Since all sets are 1:N, the owner order (columns 8-13 and 17-24 of Card 2) should be left blank.

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Note that the DDL Input of Figure II.D.6 is not valid under HDBS since it contains access levels, multiple passwords, non-tree structured set relationships (S2 and S3, for example) and a set with multiple owners/members (S7).

Section II.E

Operation of the DDL Analyzer/Editor is the same under MDBS and HDBS. Note that the Data Description Format Commands (p. 80) reflect the formats for the HDBS command structures only. Several additional error messages generated by HDBS may be found in Appendix A of this manual.

Section III.A

The SMM command mentioned on P. 147 is not supported under HDBS.

Section III.B

The following features listed on page 148 differ between MDBS and HDBS:

3. All records in HDBS are fixed length.
5. Many-to-many, one-to-one and many-to-one sets are not supported under HDBS.
8. A single user/password may be used to restrict access to the data base.

Section III.D.1

The existence of set S7 in Figure III.D.3 makes a network data structure which is not permitted in the HDBS system.

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Referring to Figure III.D.6, we again have a network data structure. This structure can, with some loss of generality, be made into a hierarchical structure by the following steps:[1]

1. Remove either S2A or S2B. The two sets were used so that students could be accessed by either name (S2A) or number (S2B). Since in HDBS a record may be a member of at most one non-SYSTEM set, we may only use one of these sets. We arbitrarily choose to remove S2A.
2. Remove set S3. The CLASS records may be accessed through the appropriate TEACHER records (i. e., through sets S4 and S5).
3. Remove set S7. Set S7 allows one to determine the students enrolled in each class (through S7 and S6) and the classes which each student is taking (through S6 and S7). If S7 is removed, we could include the course title (TITLE) in the SCLASS record along with the student's GRADE in that course. However, this makes it difficult to generate a list of students taking any given course.

Note that the above restrictions make it difficult to perform two of the queries listed on p. 163-164 of the MDBS User's Manual (specifically, queries 2 and 8). Further, the processing for query 7 is now handled via sets S1, S2B and S6. The program to perform query 7 (formerly on p. 167) is reproduced later in this document.

[1]Revised illustrations of Figures III.D.4 through III.D.6 are reproduced later in this manual.

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Section III.D.3

Again, certain of the MDBS routines listed previously in this document are not available in HDBS.

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Modified Program to Process Query 7

(form p. 167 of MDBS User's Manual)

●7.

```
1   E0 = CALL (A0, "FMSK, S1,SCHOOL")
2   E0 = CALL (A0, "SOM, S2A ,S1")
3   E0 = CALL (A0, "FMSK, S2A ,NAME")
4   E0 = CALL (A0, "GFM, NAME, S2A, NAME")
5   E0 = CALL (A0, "GFM, NUMBER, S2A ,NUMBER")
6   E0 = CALL (A0, "GFM, GPA , S2A ,AVERAGE")
7   PRINT N$, N, A
8   E0 = CALL (A0, "SOM, S6, S2A ")
9   E0 = CALL (A0, "GFM, S6, GRADE")
10  E0 = CALL (A0, "GFM, S6, TITLE")
11  PRINT L$, G
14  E0 = CALL (A0, "FNM, S6")
15  IF E0 = 0 THEN 9
```

NOTES:

1 Find the school.

2 Link to students.

3 Find the student.

4 Get the data.

8 Link the student to his classes.

9 Fetch the grade.

10 Fetch the course title.

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```
RECORD SCHOOL                          ALL SCHOOLS
ITEM   NAME      CHAR  10              NAME OF SCHOOL

RECORD TEACHER                         ALL TEACHERS
ITEM   NAME      CHAR  20              TEACHER NAME
ITEM   SENIORTY  INT    8              SENIORITY

RECORD STUDENT                         ALL STUDENTS
ITEM   NAME      CHAR  20              STUDENT NAME
ITEM   NUMBER    INT    8              STUDENT NUMBER
ITEM   GPA       REAL   8              GRADE POINT AVERAGE

RECORD CLASS                           ALL CLASSES OFFERED
ITEM   TITLE     CHAR  30              COURSE TITLE
ITEM   ROOM      INT    8              ROOM NUMBER
ITEM   SEMESTER  INT    8              SEMESTER OFFERED

RECORD SCLASS                          STUDENT'S CLASSES
ITEM   GRADE     INT    8              GRADE RECEIVED
ITEM   TITLE     CHAR  30              COURSE TITLE
```

FIGURE III.D.4

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```
SET     S1        AUTO 1:N      Schools sorted by name
                                SORT      NAME
OWNER   SYSTEM
MEMBER  SCHOOL

SET     S2B       MAN  1:N      Students sorted by number
                                SORT      NUMBER
OWNER   SCHOOL
MEMBER  STUDENT

SET     S4        MAN  1:N      Teachers in a school
                                SORT      NAME
OWNER   SCHOOL
MEMBER  TEACHER

SET     S5        MAN  1:N      Teachers teach classes
                                FIFO
OWNER   TEACHER
MEMBER  CLASS

SET     S6        MAN  1:N      Students take classes
                                FIFO
OWNER   STUDENT
MEMBER  SCLASS
```

FIGURE III.D.5

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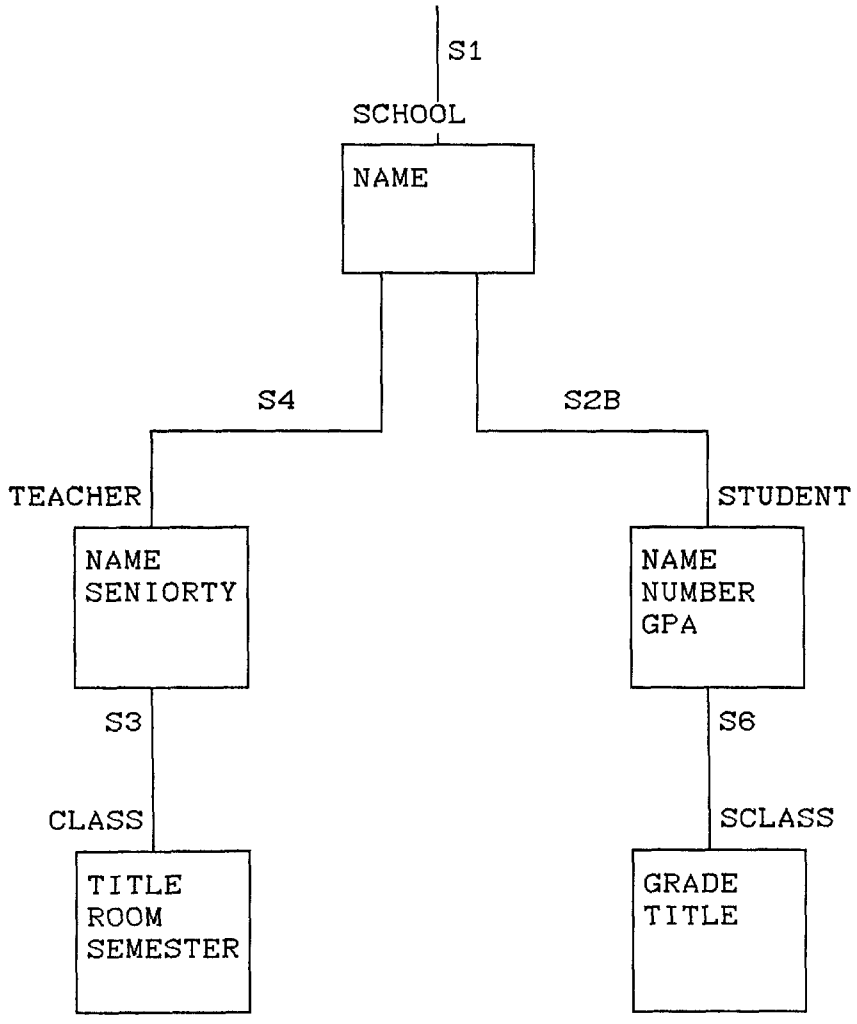

FIGURE III.D.6

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HDBS Appendix A

Additional Error Messages Generated by HDBS.DDL

*** ONLY ONE PASSWORD ALLOWED

*** NO DEPENDING ON ITEM ALLOWED

*** ONLY ONE OWNER AND MEMBER ALLOWED PER SET

*** NETWORK STRUCTURE INDICATED ... USE MDBS

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