A MAGNETIC TAPE LIBRARY SYSTEM
FOR THE COMPUTER SCIENCE DEPARTMENT NPGS;
REQUIREMENTS ANALYSIS, DESIGN, AND IMPLEMENTATION

by

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December 1985

Thesis Co-Advisors: Daniel Dolk Barry Frew

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This thesis describes the development of a magnetic tape library system (TLS) for the Computer Science Department of the Naval Postgraduate School, Monterey, California. The TLS was developed using the Ingres VM UNIX Version 2.1/15 VE.04 database management system on the 4.2 BSD UNIX operating system. The thesis includes a requirements analysis and design, and a description of implementation.
A Magnetic Tape Library System for the Computer Science Department NPGS; Requirements Analysis, Design, and Implementation

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ABSTRACT

This thesis describes the development of a magnetic tape library system (TLS) for the Computer Science Department of the Naval Postgraduate School, Monterey, California. The TLS was developed using the Ingres VM UNIX Version 2.1/15 VE.04 database management system on the 4.2 BSD UNIX operating system. The thesis includes a requirements analysis and design, and a description of implementation.
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Documentation is incomplete without my acknowledgement of the hours of work and patience contributed to this thesis by a few generous people. My thesis advisors Barry Frew and Dan Dolk were always available to share their advise, experience, and reassurance. They kept me going when I believed the end would never come. Sue Whalen and Al Wong of the Computer Science Department were forever patient and instructive during the many hours I spent in their offices becoming familiar with the library, the UNIX operating system, Ingres, and "C". The suggestions, patience, and hours of creativity of Nita Raichart, my typist and thesis "molder", deserve special thanks, especially as I compare the final document to the original roughs from which she worked. And most of all I thank my mother for the hours of proofreading and motherly support she provided during her most unusual visit to California.
I. INTRODUCTION

The Computer Science Department maintains a variety of magnetic tapes for their instruction laboratory. The current combination manual/computerized library system is inefficient. The department wants a computer-based system by which librarians may add, locate, update, and provide reports regarding tapes in the library. There are currently six librarians who are staff members of the department. In addition to their librarian duties, they are responsible for some form of maintenance of the department's two VAX 11/780 and one VAX 11/750 computers. The maintenance administration is performed with the VAX 11/780/UNIX operating system. The department wants a tape library to be developed using the Ingres (VM UNIX Version 2.1/15VE.04) database management system (DBMS), the 4.2 BSD UNIX operating system.

The database development process will be used to build a tape library system (TLS). It will be developed in four stages -- requirements specification, evaluation, design, and implementation.

A. REQUIREMENTS SPECIFICATION

The management of the Computer Science Department has already defined the need, and estimated the cost/benefit of the project. They approved its continuation when they requested that the library be developed by a thesis student.
The current tape library is a combination of a casual computer listing of approximately 600 tapes, and opened cabinets in which tapes are segregated by type.

The library system must facilitate use by the six librarians. The need to store and catalog tapes dependably is critical. It must ensure the security of the data and tapes. Guidance for logging data must be well defined and interactively prompted to ensure input of all necessary information.

Development of the library by a thesis student for use on the VAX 11/780/UNIX operating system and Ingres database will keep costs to a minimum. No new hardware, software, or personnel purchases will be required. Because all the librarians have extensive experience with the system, minimum training will be required. This thesis describes development of the TLS.

Detailed user requirements will be determined by extensive interviews with the users. The department has assigned a user team leader. The current system and desired changes will be documented in Chapter II by a narrative and data flow diagrams. The proposed system will be documented by data flow diagrams, process mini-specifications, data items, and a specification data dictionary. The new system will be reviewed and approved by the users before the evaluation stage commences.
B. EVALUATION

The evaluation stage will be limited because the department has already delineated the system hardware, operating system, application language, data technology, and people. The database design, application program, and procedural alternatives will be developed for evaluation and selection by the user. A project plan, outlining major development tasks, will be documented for use by the developer and user in following project development.

C. DESIGN

The design stage will include definition of the database structure application program, security and control, and functions of the database administrator.

In Chapter III, the database structure will first be defined logically, independent of the requirements of Ingres, according to the rationale of the data record relationships and fields. These relationships will be illustrated by data structure diagrams (Bachman diagrams). They will be defined in a logical schema.

In Chapter IV, the logical structure will be mapped to the physical structure of Ingres. The relations, data, formats, and the functions and interfaces of the modules will be included in the design data dictionary. The application program will be designed in parallel with the database design. Security and control procedures will be designed.
into the application program to ensure that only authorized users may access the library.

A tutorial will be developed in parallel with the application program and will be included as Appendix G. It will include operating procedures, security specifications, and the database administrator's responsibilities for maintenance of the library.

D. IMPLEMENTATION

The application will be coded in the Ingres DBMS language. A small representative database will be loaded into the database. All modules will be tested. Users will be trained. Full loading of the 600 tapes will be accomplished by the staff librarians. Instructions for implementation are provided in Appendix F. Final conclusions and recommendations will be included in Chapter V.
II. REQUIREMENTS ANALYSIS

A. NARRATIVE

1. Background

The Computer Science Department's current tape library is a combination of a casual computer listing of 600 tapes, and opened cabinets in which tapes are segregated by type. Tape labels contain as much information as possible in case the information in the library listing is inaccurate, incomplete, or nonexistent. The information in the listing is not standardized. It consists of whatever one of eight librarians considered necessary for identification or retrieval when (s)he entered the tape into the library. Frequently customers help themselves to shelved tapes, and new boxed tapes sometimes disappear. Few staff and student personnel request the library to store their tapes. The department would like to provide secure, dependable library services.

Compounding the problem, the computer facilities are rapidly expanding. Dependence on the facilities is increasing and people are requesting better library services. Concurrently, requests for backup tapes are increasing as is the length of time between when a backup is created and retrieved. More tapes are getting lost. The need to store and catalog tapes dependably is critical.
2. **Users**

   Approximately six to seven staff personnel, all extensively familiar with computers, perform librarian duties and will have access to the library and tapes. Because of the large number of librarians, guidance for logging data must be well-defined and interactively prompted to ensure that all necessary information is input.

3. **Storage**

   The tapes will be stored in locked cabinets with separate slots for each tape. The staff would prefer not to physically separate the tapes by category and not to have descriptive information on the tape labels. This will help to prevent customers from helping themselves to tapes they need if cabinets are inadvertently left unlocked. Only the librarians should have access to the tapes.

4. **Tape Entry**

   Tapes are received into the library in three ways: 1) boxes of new tapes; 2) tapes from vendors, and 3) written tapes requested for safekeeping by private owners. To prevent pilferage, it is desired that new tapes be identified and placed into the library immediately. Physical information about these blank tapes must be included. They will eventually be used to write backups. Vendor tapes are identified and catalogued as soon as possible. They are never retired for use as backups. Tapes input for safekeeping must be identified. If abandoned by the user, they may be used
for backups. Essentially, the moment a tape is received by
the library, it should be identified with as little informa-
tion as possible on the label. It should be labelled with an
identification number only, which can be used to locate
assigned space in the cabinet and its descriptive information
in the library.

5. **Backups**

It is the function of the tape librarians to perform
backups. They do routine system backups, and "individual"
backups by special request for staff, faculty, or student
personnel. For individual requests, the owner's tapes main-
tained by the library may be reviewed to determine if there
is sufficient space available on one to read the disk files
requested to the partially used tape. To perform an individ-
ual backup when an appropriate, partially used tape cannot be
found, or to perform any other backup, the librarian must
first find a "scratch" tape, either new or previously used.
It must be of sufficient condition, density capacity, and
length to accommodate the backup. After the information on
backup tapes is retired, the librarian makes the tape avail-
able for rewrite.

a. **Routine Backup**

Daily disk backups are written to tape each week.
Weekly, disks are written to tapes. Full backups of the
system are written to tape monthly. Information kept in the
library must enable the librarian to access the tapes and write them back to disk. They must be identified by the date and time of backup, the system, utility, software used to generate the tape, and path information such as partition or disk, or source. Each daily backup is 1-2 tapes long, weeklys require 2-3 tapes, and monthly’s 4-6 tapes. The library will save dailies for one month, weeklys for two months, and monthlys for six months.

When a Computer Science class graduates (14-17 students) the librarian creates a tape backup of graduated student disk files for each system. Each is 1-2 tapes long. Again, the librarian must find a tape of the appropriate length, condition, and density capacity. After writing the tape, the librarian must catalogue information which will enable retrieval of a student’s files to write them to disk or another tape. This information must include date, student name, the specific files, the operating system hardware and utility used to generate, and device. The tapes will be kept for two years.

DATA RETENTION

<table>
<thead>
<tr>
<th>BACKUPS</th>
<th>RETENTION</th>
</tr>
</thead>
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<tr>
<td>DAILY BACKUPS</td>
<td>1 MONTH</td>
</tr>
<tr>
<td>WEEKLY BACKUPS</td>
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<td>MONTHLY BACKUPS</td>
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<td>GRADUATION BACKUPS</td>
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<td>INDIVIDUAL BACKUPS</td>
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<tr>
<td>VENDOR BACKUPS</td>
<td>5 YEARS</td>
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</tbody>
</table>
b. Nonroutine Backups (Individual Tapes)

Staff, faculty, or students frequently request that a disk file be written to tape. The librarian first checks to see if the individual currently owns a tape in the library of the same system, copied with the same utility and device as required to access the file(s), that has a sufficient unused portion to write the file(s) requested. If an appropriate tape is found and used, the addition of the new file(s) must be recorded into the library. If there are none, the librarian must look for an adequate scratch tape. If a new tape was used because the owner had no previous tape(s) on file, the librarian identifies it as a new set with a new sequential order. A set of individual tapes can include up to three volumes. After copying the tape, the librarian catalogs the information necessary to find which tape the new file is on and how to write it to disk or another tape.

6. Administrative

a. Condition of Tapes

The librarian is responsible for monitoring the condition of the tapes and to recopy or throw out tapes as required. Condition is determined in one of two ways: errors and bit age.

(1) Errors

Errors are unreadable bit spaces on the tape and are communicated to the librarian by the utility each
time the tape is read or written. Ten to twelve errors (after head cleaning) is considered maximum life. The librarian must catalogue this information each time the physical tape is read or written. Physical tapes exceeding their maximum cycle or error life are permanently deleted from the library and thrown away.

(2) Bit Age

Bit age has to do with the information written on the tape and applies only to active tapes (vendor or backups). It is the age of the oldest bit on the tape. Bits deteriorate after five years so the tape information must be copied to another tape. The physical tape, however, may be reused. Checks for bit age must be done on all tapes on a periodic basis.

b. Retirement of Tapes

The librarian requires a flexible means of controlling the length of time all active tapes are retained by the library, other than by condition. The reasons could vary per type of active tape. When the retirement date occurs, a disposition decision will be made.

c. Lending of Tapes

Vendor, scratch, and individual tapes may be loaned. The library must maintain information regarding which tapes are on loan, and to whom.
7. **Deleting Tapes**

Backup tapes may be retired to scratch tapes, or any tape may be thrown away. For retiring backups, the librarian must provide a means to delete backup information but retain the physical tape information. It must allow deletion of all tape information and reflect the availability of a vacant labelled slot in the cabinet when a tape is thrown away.

B. **DATA FLOW DIAGRAMS (DFD)**

1. **Current Library**

An overview of the current TLS described in the narrative is illustrated by a DFD (Figure 1). Minispecifications and file descriptions follow the DFD.

2. **Proposed Library**

A general overview of proposed library procedures is reviewed in DFD(O) (Figure 2). All procedures are to be performed by a librarian. Subsequent DFDs (Figures 3–10) are more detailed. The procedures are numbered 1–9. The procedures and data input and output for each procedure varies according to the function the librarian performs. A DFD is written for each function to illustrate the specific procedures and data inputs and outputs required. Functions are assigned letters A–H. Mini-specifications of the procedures and a specification data dictionary follow each DFD. The procedure numbers of the functional DFDs match the procedure to the definition provided in the overview DFD(O) and are
preceded by the appropriate function letter. For example: "A.2" should be read - Function A, Procedure 2.

For some functions, a procedure is broken down into sub-procedures. Sub-procedures retain the function and procedure number, followed by a decimal number (i.e., A.2.1 should read - Function A, Procedure 2, Sub-procedure 1).

Cabinets and the database will be the only files used to store library objects and information. Cabinets will consist of labelled slots, consecutively numbered left to right, top to bottom. The range of the numbering system will be expanded as tapes are added. Cabinets will be known by the range of numbers assigned. For example, a cabinet may be known as 100-300.

The library data will be the only source of information regarding labelled cabinet spaces, the physical condition of tapes assigned, and the data preserved on active tapes (vendor tapes and backup tapes). A backup tape is a tape with information which the library safeguards.
Figure 1. Current System Overview
MINI-SPECIFICATION: THE OLD SYSTEM LIBRARY - OVERVIEW

1. **Edit Request**
   The librarian or requestor edits the request at this time to determine what action to take.

2. **Query for Tape(s)**
   The requestor or librarian searches for the tapes which will satisfy the request.

3. **Select Appropriate Equipment**
   The librarian or requestor selects the equipment, if required, to satisfy the request.

4. **Get Tape(s)**
   The librarian gets appropriate tape(s).

5. **Perform Read/Write**
   The librarian or requestor performs the read/write, if required.

6. **Return Tape(s)**
   The librarian returns the tape(s) to the cabinet; the requestor might or might not.

7. **Update Database**
   The librarian updates the database; the requestor does not.

**FILES**

Four objects serve as files in the current library.

**CABINETS**
Cabinets have slots which hold the tapes. These slots are not numbered. The tapes which are contained in them have labels with numbers and tape information. An attempt is made to place reels of similar systems and tapes in specific sections of the cabinets. The cabinets are opened and easily accessible to anyone at NPS.

**DATABASE**
A vaguely defined computerized file of tape numbers with information for the librarian regarding the tape. Information required to perform subsequent functions is frequently omitted. This data is also written onto the tape label.

**NEW BOXED**
New tapes received are left in boxes near the cabinets. The physical parameters of the tapes appears on the labels. The bcx is accessible to anyone.

**SINK**
Tapes sometimes disappear.
a. DFD(O): Proposed System Overview

Figure 2. Proposed System Overview
Function: General Procedures of the Proposed Library

Mini-specifications

The following procedures are required by most of the functions the librarian performs. The combination of procedures and the data input and output for each procedure will vary according to the function requested.

1. Edit
   An event/discussion with a requestor to determine the function required.
   For example:
   - Add empty cabinet slots
   - Add scratch tapes
   - Add vendor tapes
   - Write disks to tape:
     - To partially used individual tape
     - To backup tape
     - To scratch tape
   - Read active tape to disk
   - Loan Tape
   - Receive returned loaned tape
   - Delete tapes

2. Query TLS Data
   Provide criteria upon which the information requested is retrieved.

3. Select IDs
   Select the id numbers which are required to perform the function.

4. Label
   Make labels for, and label objects for each id number selected.

5. Get Tape(s)
   Go to the cabinet slot labelled with the selected id number and withdraw the tape(s).

6. Perform Read/Write
   Perform write disk to tape or read tape to disk, as appropriate.

7. Replace Tape(s)
   Replace tape(s) to the cabinet slot which matches the identification number on the tape label.

8. Update TLS Data
   Add to, or update TLS data with new information regarding the operation performed.
Figure 3. Add New Scratch Tapes to Library
Function: Add new scratch Tapes to Library

Mini-specifications A

1. Edit: Log Scratch
   Request to log scratch. Log new un-labelled tape(s) upon arrival. Read physical parameters from manufacturer's label.

2. Query Empty Slots
   Query library data for lowest empty id.

3.1 Calculate New id
   If no empty slots are available, calculate new id number.

3.2 Assign id(s)
   Select the id(s) to assign to the scratch tape.

4.1 Label Tape(s)
   Label the tape(s) with the assigned id number.

4.2 Label Cabinet
   Label the cabinet space with the new id.

8. Add Scratch
   If id was of an empty slot, update tape physical parameters to the id record. If new id, add id and tape parameters.

Data Items A

Physical = length + density
Type = (type = empty)
Empty Slot id = id + (type = empty)
None = no empty slots
New id Selected = max id + 1
Labelled Tape = Tape + id
Label = a label with an id number to be put on the cabinet space
Scratch Record = id + (Type = scratch) + length + density
c. DFD(B)

Figure 4. Add Vendor Tapes
Function: Add Vendor Tapes

Mini-specification B

1. Edit: Vendor
   The tape is software from a vendor for the library to log and maintain

2. Query Empty Slots
   Query the library data for lowest empty id

3.1 Assign id(s)
   Assign the id to the vendor tape

3.2 Calculate New id Numbers
   If no empty slots are available, calculate the new id number

4.1 Label Tape(s)
   Label the tape(s) with the assigned slot id number

4.2 Label Cabinet Space(s)
   Label the cabinet space with the new id

8. Add Vendor Tape(s) to TLS
   Add software tape(s) record to the library data

Data Items B

Physical
   = bpi

Software
   = (type = vendor) + system + utility + label + date received + retirement date + owner + contact phone + software + vendor + description + sequence

Type
   = Type empty

Slot id
   = id + (type = empty)

None
   = No empty slots

New id
   = max id + 1

Software Tape Record
   = id + (type = vendor ) + bpi + software
Figure 5. Write Individual's Disk to Tape
Function: Write Individual's Disk to Tape

Mini-specification C

1. Edit: Write Disk to Tape
   If type = individual staff, faculty, or student backup. If not go to DFD(E).

1.1 Determine File Location and Length of Files
   By discussion or may require searching files.

1.2 Select Equipment
   The computer and operating system combination determines the device. The device determines the density which can be used.

2. Query Owner's Tape(s)
   Query the library data for a listing of the owner's backup tapes which may be used to copy the files requested.

3. Select Tape
   Select a backup tape which may be used to write the requested file.

D.1.2 Go to Procedure D.1.2
   If none of the owner's tapes are appropriate to use, go to Procedure 1.2 of DFD(D) and resume looking for a scratch tape to perform the write.

5. Get Tape

6. Perform Backup
   Write disk files to the tape.

7. Return Tape

8. Update TLS
   Add the record of the new files to the library data. If the utility reads error information different than that recorded for the tape, update.
<table>
<thead>
<tr>
<th>Data Items C</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>= individual, staff, faculty, or student backup</td>
</tr>
<tr>
<td>Owner</td>
<td>= the owner of the individual backup tape</td>
</tr>
<tr>
<td>Approximate File Path</td>
<td>= (some or all) (system + owner + partition/disk)</td>
</tr>
<tr>
<td>Type</td>
<td>= individual, staff, faculty, or student</td>
</tr>
<tr>
<td>Density</td>
<td>= bits per inch (bpi)</td>
</tr>
<tr>
<td>Tape Requirements</td>
<td>= (some or all) (type = individual) + owner + system + density</td>
</tr>
<tr>
<td>Owner Tape Listing</td>
<td>= id + length + density + loaned + system + utility + label, percent used + retirement date</td>
</tr>
<tr>
<td>File Path</td>
<td>= Partition/disk + saveset/source</td>
</tr>
<tr>
<td>File Lengths</td>
<td>= Approximate length of magnetic tape needed to copy the files</td>
</tr>
<tr>
<td>Utility</td>
<td>= Utility</td>
</tr>
<tr>
<td>None</td>
<td>= No tapes meet the requirements for the backup</td>
</tr>
<tr>
<td>Errors</td>
<td>= Error, date of errors</td>
</tr>
<tr>
<td>Record of Backup</td>
<td>= id + errors + date of errors + partition/disk + saveset/source</td>
</tr>
</tbody>
</table>
Figure 6. Write Disk to Scratch Tape
Function: Write Disk to Scratch Tape

Mini-specification D

1. Edit: Write Disk to Scratch
   If type = daily, weekly, monthly, or graduation backup

   1.1 Determine File Location and Length
       By discussion or may require searching files

   1.2 Select Equipment Required
       The computer and operating system combination determines the device. The device determines the density which can be used. The utility is determined by the system and the density

2. Query Scratch
   Query the database for scratch tapes which have the physical parameters required by the edit procedure

3. Select Scratch Tape(s)
   Select ids from the listing of scratch tape(s) provided by the database

5. Get Tape(s)
   Retrieve tape(s) with the id(s) selected

6. Perform Backup
   Write disk files requested to the tape

7. Return Tape(s)

8. Add to TLS
   Enter the information regarding the backup to the library data

Data Items D

Function: Write Disk to Scratch

Approximate File = (some or all) (system + part/disk + Path
                  saveset/source)

Type Backup = daily, weekly, monthly, graduation, or individual backup

Type Tape = Type = scratch
Density = bits per inch (bpi)

Tape Requirements = (Type = scratch) + length + density + errors + date of errors

Scratch Tape List = id + length + density + errors + date of errors + loan

File Length = Approximate length of magnetic tape needed to copy the file(s)

File Path = Partition/disk + saveset/source

Equipment = System + utility + density

Errors = Error + date of errors

Equipment = System + utility + density

Record of Backup = Various according to type:

Daily = id(s) + type + errors + date of errors + label + sequence + date created + retirement date + system + utility + description + partition/disk + saveset(s)/source(s)

Weekly/Monthly = id(s) + type + errors + date of errors + label + sequence + date created + retirement date + system + utility + description + partition/disk + saveset/source(s)

Graduation = id(s) + type + errors + date of errors + label + sequence + date of graduation + retirement date + system + utility + description + partition/disk(s) + saveset(s)/source(s)

Individual = id(s) + type + errors + date of errors + label + sequence + percent used + date created + retirement date + system + utility + description + owner + advisor + contact phone + partition/disk(s) + saveset(s)/source(s)
Figure 7. Read Tape to Disk
Function: Read Tape to Disk

Mini-specification E

1. Edit: Read Tape to Disk
   Requestor would like a vendor or backup tape read to disk.

2. Query Backup/Vendor Tapes
   Query the library with as much information as the requestor can provide concerning the tape.

3. Select Backup Tape(s)
   Select from the database listing the exact tapes needed to perform the read.

4. Get Tape(s)
   Retrieve tape(s) with the id numbers selected.

6.1 Select Equipment
   Select the equipment defined in the database.

6.2 Perform Read

7. Return Tape(s)

8. Update TLS
   If the physical information provided by the utility regarding the tape is different than that in the library data, update.

Data Items E

General Backup Description = (Some or all) type + date created + system + name of owner + software + vendor

Approximate Tape = (Some or all) Varies according to type:

Vendor = (Type = vendor) + system + software + vendor

Periodic = (Type = daily, weekly, monthly, or graduation) + date + system + partition/disk

Individual = (Type = staff, faculty, student) + system + owner
Tape List = Varies according to type backup:

Vendor = id(s) + density + loan + errors + label(s) + sequence + date received + system + utility + description + owner + contact phone + software + vendor + partition/disk + saveset(s)/source(s)

Periodic = id(s) + (type = daily, weekly, monthly, or graduation) + errors + label + sequence + date + system + utility + description + partition/disk + saveset(s)/source(s)

Individual = id(s) + (type = staff, faculty, student) + density + loan, errors + label(s) + sequence + percent used + date + system + utility + owner + advisor (if student) + contact phone + description + partition(s)/disk(s) + saveset(s)/source(s)

Equipment = system + utility + density

File Path = partition/disk + saveset/source

Errors = errors + date of errors

Error Record = id + error update
Figure 8. Loan Tapes
Function: Loan Tapes

Mini-specification F

1. Edit: Request to Borrow Tape(s) If requested by anyone but a librarian to remove a tape(s) from the library. Type tape must be vendor, individual, staff, student, faculty. Permission from the owner should be obtained before lending.

2. Query for Tape(s) Requested Query database for id of tape(s) requested.

3. Select Tape(s) to Lend Select ids of requested tape(s) from database listing.

5. Get Tape(s) Retrieve tape(s) with the id numbers selected.

8. Add (Loan Information) to TLS Update the library to contain information regarding the loan.

Data Items F

General Backup Description = (Some or all) type + date created + system + name of owner + software + vendor

Approximate Key = (Some or all) Varies according to type:

Vendor = (Type = vendor) + system + software + vendor

Periodic = (Type = daily, weekly, monthly, or graduation) + date + system + partition/disk

Individual = (Type = staff, faculty, student) + system + owner

Tape List = Varies according to type backup:

Vendor = id(s) + density + loan + error + label(s) + sequence + date period + system + utility + description + owner
Periodic = id(s) + (type = daily, weekly, monthly, or graduation) + errors + label(s) + sequence + date + system + utility + description + partition/disk + saveset(s)/source(s)

Individual = id(s) + (type = staff, faculty, student) + density + loan, errors + label(s) + sequence + percent used + date + system + utility + owner + advisor (if student) + contact phone + description + partition(s)/disk(s) + saveset(s)/source(s)

Loan Agreement = loan + date loaned + estimated date of return + loanee + loanee's contact phone

Record of Loan = id + loan agreement
h. DFD(G)
Function: Returned Loaned Tapes

Mini-specification G

1. Edit: Returning Borrowed Tape(s)  The requestor (loanee) returns tape(s) borrowed from the library.

2. Query Loaned Tape(s)  Query the library to find which tapes are held by the loanee.

3. Verify Correct Tape(s)  Verify the returned tape(s) belonging to the library, that all are present, etc.

5. Replace Tape(s)

8. Delete Loan  Delete the record(s) of the loan from the library data.

Data Items G

Tape = tape + id

Loaned Tape List = loanee + id(s)

Updated Record(s) = id + (loan = no) + (delete record of loan)
Figure 10. Delete Tapes
Function: Delete Tapes (erase backup or trash physical tape)

Mini-specification H

1. Edit: Request to Delete Backup or Tape(s) Valid if:
   - Any type tape is first copied to another tape and then logged into the library.
   - Daily, weekly, monthly, or graduation backup = retirement date \( \leq \) current date.
   - Vendor or individual staff, faculty, student = owner = requestor.

2. Query for Tape(s) Query library for a listing of tape(s) which satisfy the requestors description of the tape(s).

3. Select Tape(s) Select the id(s) of the tape(s) desired for deletion.

4. Get Tape(s) Included only if trashing tape(s).

8. Delete Records Delete records to reflect the erasure of backup or the trashing of a physical tape

Data Items H

- **General Backup Description** = (Some or all) type + date created + system + name of owner + software + vendor

- **Approximate Key** = (Some or all) Varies according to type:
  - **Vendor** = (Type = vendor) + system + software + vendor
Periodic = (Type = daily, weekly, monthly, or graduation) + date + system + partition/disk

Individual = (Type = staff, faculty, student) + system + owner

Expired Retirement Date = Requirement date <= today's date

Tape List = Varies according to type backup:

Vendor = id(s) + density + loan + errors + label(s) + sequence + date received + system + utility + description + owner + contact phone + software + vendor + partition(s)/disk(s) + saveset(s)/source(s)

Periodic = id(s) + (type = daily, weekly, monthly, or graduation) + errors + label(s) + sequence + date + system + utility + description + partition/disk + saveset(s)/source(s)

Individual = id(s) + (type = staff, faculty, student) + density + loan, errors + label(s) + sequence + percent used + date + system + utility + owner + advisor (if student) + contact phone + description + partition(s)/disk(s) + saveset(s)/source(s)

ids = ids

New Record:

If to Delete Tape Data = (type = scratch) delete backup record

If to Trash Tape = (type = empty) delete physical and backup record
C. DFD DATA DICTIONARY

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advisor</td>
<td>The name of a student's advisor</td>
</tr>
<tr>
<td>Contact Phone</td>
<td>The phone number of the owner</td>
</tr>
<tr>
<td>Date of Errors</td>
<td>The date the errors were provided by the utility</td>
</tr>
<tr>
<td>Date of Graduation</td>
<td>The graduation date of the students whose files are contained in a graduation backup tape</td>
</tr>
<tr>
<td>Date Loaned</td>
<td>The date a tape is loaned</td>
</tr>
<tr>
<td>Date Received</td>
<td>The date the tape was received by the library</td>
</tr>
<tr>
<td>Density</td>
<td>The bits per inch which may be read to tape</td>
</tr>
<tr>
<td>Description</td>
<td>Notes by the librarian regarding the software</td>
</tr>
<tr>
<td>Disk</td>
<td>Used with the VMS operating system to define a major subdivision of files of disk</td>
</tr>
<tr>
<td>Errors</td>
<td>The number of &quot;bad bits&quot; on a physical tape. The figure is provided by the utility when a tape is read or written</td>
</tr>
<tr>
<td>Estimated Date of Return</td>
<td>The date the librarian assigns as the date the tape should be returned to the library</td>
</tr>
<tr>
<td>Identification Number (id)</td>
<td>A unique number assigned a slot in the cabinet. Slots are numbered consecutively left to right, top to bottom, so the number may be used to locate the slot. When a tape is logged into the library it is assigned the identification number of the slot in which it is stored.</td>
</tr>
</tbody>
</table>
Label = The VMS operating system requires that each tape be assigned a "label" by the librarian. When the tape is mounted, the label verifies to the system that the tape is VMS. If the "copy" utility is used to read or write the tape, the label must be entered by the librarian when mounting the tape.

Length = The total length of a reel of tape

Loaned = Whether or not the tape is loaned from the library

Loanee = The person to whom the tape is loaned

Loanee Contact Phone = The phone number of the loanees

Owner = The name of the owner of the tape

Partition = Used by the UNIX operating systems to define a major subdivision of files

Percent Used = The percent of the tape containing backup data

Retirement Date = The date the librarian assigns to the tape for retirement

Saveset = Used with the VMS "backup" utility to mark the beginning of each file or set of files

Software = The name of the software on the tape

Source = Used with other than VMS operating system, and "backup" or "copy" utilities to describe a file or set of files on a tape

System = The combination hardware and operating system by which the tape data may be read or written

Type = The use of a tape maintained by the library
<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
<td>Disks are read to tape each day. These daily tapes are written to one set of tapes each week and identified as a daily backup</td>
</tr>
<tr>
<td>Graduation</td>
<td>A backup tape containing disk files of students of a graduated class</td>
</tr>
<tr>
<td>Individual</td>
<td>The type tape is an individual staff, faculty, or student's backup tape</td>
</tr>
<tr>
<td>Monthly</td>
<td>Each month, all disks are read to tape and identified as monthly backups</td>
</tr>
<tr>
<td>Scratch</td>
<td>Blank tapes assigned to slots in the library available to read data from disk</td>
</tr>
<tr>
<td>Vendor</td>
<td>Tapes containing vendor software</td>
</tr>
<tr>
<td>Weekly</td>
<td>Each week, all disks are read to tape and identified as a weekly backup</td>
</tr>
<tr>
<td>Utility</td>
<td>The software utility which must be used to read or write the tape data</td>
</tr>
<tr>
<td>Vendor</td>
<td>The name of the company which produced the software</td>
</tr>
</tbody>
</table>
III. LOGICAL SCHEMA

A. BACHMAN DIAGRAM

B. SPECIFICATION DATA DICTIONARY

The Specification Data Dictionary defines the entities and data elements in the tape library. It groups each of the data elements under the entity to which it is logically related. The definitions describe the meaning and use of the entities and elements in the library. The Specification Data Dictionary is provided in Appendix A.
IV. DESIGN

In this chapter the design of the TLS is described in detail. First the logic of the design is discussed. It is followed by a description of the tables. A chart of the application module and a description of each frame is provided. The modules association with the functions described by the DFDs are provided by charts. Integrity, security, the database administrator, and validation and test are discussed. The design data dictionary and frames definition are derived from this chapter and are provided in Appendices C and D for ease in future reference.

A. LOGIC OF THE DESIGN

Several factors were considered before mapping the logical schema to the Ingres database. They were prioritized as follows:

User
Interactive standardization and validation of input
Simplicity
Librarian functions

Ingres
Database requirements
Query by forms (QBF) limitations
Report by forms (RBF) flexibility
Applications by forms (ABF) capabilities

Logical Schema
1. User

Non-standard record input, incorrect data input, and an inability to control the sequential consecutive assignment of identification (id) numbers are the major problems in the current library system. An interactive forms-based input method with validation capabilities can correct these problems. The TLS must be kept simple and quick to facilitate the task of logging tapes and retrieving data.

2. Ingres

Ingres is a relational DBMS. It provides a means to store data in tables. The basic method for entering, retrieving, and manipulating data is by use of its data manipulation language, "QUEL". The user of QUEL must understand the language commands and syntax, and the structure and content of each table. Data manipulation with QUEL is too time consuming and distracting for the daily functions of the librarians. However, Ingres provides Query By Forms (QBF), an automated forms processing interface, which simplifies data manipulation. The user may interactively append, delete, replace, or retrieve data from one table at a time in the database without knowledge of QUEL.

QBF provides an automated method for the functions of append, query, update, and deletion of values of records of the table at a time. It presents forms to the user which contain fields from the appropriate table. By default, QBF displays all of the table's fields to the user. The user
may be edited by the application developer by using the Visual Forms Editor (VIFRED) to limit the data the user can input or manipulate. The editing capabilities include the deletion or addition of fields in a form, definition of field parameters, and definition of field attributes for validation, mandatory input, error messages, automatic repetition of field values, and special display modes.

QBF requires different user procedures for each of its functions. The Append function must be used for initial entry of a record. The Append function has an automated facility which simplifies the sequential input of records which have many fields of equal value. After the first record is entered, the user may duplicate the field values in subsequent records by pressing a function key. This simplifies input and can be used to remind the user of the previous value input.

The Update function must be used in QBF to replace or delete values in existing records. When using Update, the first display of fields is presented for the user to query the record or records desired. After the query is entered, Ingres retrieves the records and displays them on the terminal, one at a time, for update. Update does not have the Duplication facility.

Four limitations of QBF greatly affected design: 1) The automatic field value duplication facility may be used in record only; 2) When more than one record is retrieved by
query in the Update function, they appear on the terminal one at a time. This format is not useful for reports or records; 3) QBF only allows manipulation of data on one table at a time; and 4) QBF does not provide for any internal manipulation and assignment of data values.

Report By Forms (RBF) is a forms-based record specifier available for retrieving reports without knowledge of QUEL. RBF allows the developer to select, design, and present multiple record reports from one table at a time, through the use of views. RBF's facility to present reports with data from multiple tables greatly influenced the design of the application.

The developer may integrate the functions and forms of QBF and RBF into a single application by using Ingres Applications By Forms (ABF). The application uses forms as the vehicle for interaction between the application and user. The user uses menus to select operations desired and forms to append, query, or update, or to retrieve reports from the database. Knowledge of QUEL is not required. ABF allows the developer greater flexibility than the functions available in QBF and RBF. RBF, however, was sufficient for the library in certain cases, whereas QBF was not. In most cases, it was impossible to match a task with only one table. In RBF, the task would have required the librarian to perform similar functions on several tables. To maintain data on users,
librarian. Additionally, the assignment of id numbers required control to prevent duplication and ensure consecutive, sequential numbers. This required a search of current id numbers, a possible arithmetic operation on the maximum id and assignment of the result to the form. ASP enables such flexibility by allowing development and integration of procedures into the application by the developer. The procedures may be used with forms developed by the use of VIPRED. The forms have the same capabilities as those described above. AFF will be discussed further in Section D.

3. Logical Schema

a. Data Class TAPE

The data class TAPE was mapped intact to table TAPE in the logical schema. The fields values in table TAPE provide physical tape characteristics which retain their importance throughout the life of the tape's existence in the library whether or not any data on the tape is of importance to the library.

The TAPE table stores all of the id numbers assigned in the library. As discussed above, assignment of tapes to id numbers, and the addition of new ids to the library are controlled by the application. The librarian will typically enter the values (id, length, and byt) of the TMR record when adding new blank tapes or new vendor tapes to the library. Some tapes will have the same values for length and byte count, but tapes are usually tailored to specific...
the field attribute of repeating values to the form definition. Data integrity and future retrieval is assured by writing validation criteria into the form definition. Two fields, errors and date of errors, are entered and maintained by the librarian at other times - after the tape is read or written. As a separate task, the record is updated. After an active tape is retired, but the physical tape is retained by the library for rewrite, all of the values in TAPE are retained. If the tape is thrown away, all of the values of TAPE are updated to null except the id number which is retained. Such an id number is known as an empty slot and will be used by the application for future assignment to a new scratch or vendor tape.

b. Data Class SET

Data class SET must be related to TAPE so that the id number in SET allows the librarian to access the physical characteristics in TAPE when a tape is to be read or written.

The key to data class SET is long and various according to its type active tape. Therefore, field id was added to SET. Since data class ACTIVE TAPE values are entered and deleted at the same time as SET, and since ACTIVE TAPE is logically closely related to SET, it is contained with data class SET, in a table named SETS. New records are added to SET when the vendor is paid, or when a new vendor is assigned. When an id number is thrown away, it is retained in
tapes are added, SETS values are appended to the SETS table by the application.

The timing for entering backup tape data is different. In order to read a backup to tape, the librarian must first find an appropriate scratch tape in table TAPE. New records are added to table SETS using QBF-append. As each record is added for each id, common values (those of data class SET) are automatically called to the form after the first entry. Only the fields expected to be different for each id (those of data class ACTIVE TAPES) will be entered by the librarian. If the librarian loses track of which id was previously entered, (s)he may use the function key to recall it.

c. Data Class FILE PATH

Data class FILE PATH is contained in table FILE. There are many file paths on one active tape or one file path on several tapes of one set.

Each FILE PATH record must be linked to an id number so the librarian can locate the particular tape id on which the file path was located. Therefore, id was added to table TAPE. File records are usually added at the same time new SETS records are added, i.e., when a new vendor tape is received or when a new backup is read. In this case, new FILE records are added using the QBF-append function. Since one id may have many FILE records, or one FILE record may have many ids, no repeating values are defined in the file.
field attributes. The librarian may repeat values by using the function key. The only exception to the time of entry of FILE PATH discussed above is on the infrequent occasion when the librarian adds a new file path to an individual's old tape. This task requires fields from two tables to be changed - FILE and SETS. In this case, a separate procedure is provided in the application to ensure the integrity of both tables.

d. Data Class STUDENT

Data class STUDENT is contained in table STUDENT. New records are added to STUDENT each time a new graduation backup is added to SETS. Eventually, the librarian must find on which tapes student files are contained by student name. Therefore, id was added to STUDENT. New records are added using QBF-append. A student may have files on many tapes. Data class STUDENT fields are, therefore, repeated by the form after the first entry.

e. Data Class LOAN

Data class LOAN is included in table LOAN. Files tapes are added to table LOAN on an individual basis as frequently as they are by SETS, id was added to the table. LOAN records are added when a tape is loaned using the QBF-append. They are deleted when a tape is returned.
B. TABLES AND VIEWS

Initial input of library data are stored in the hash storage structure in which records are stored randomly; new rows are added to the bottom. Therefore, the entire table must be scanned for retrieval. The majority of retrievals and comparisons in the library involve selection of records based on id number. Hash tables store each row at an address determined by a column or columns in a record. Records may be located directly by the value of the address, without scanning the entire table. The hash storage structure can greatly accelerate queries run on tables with a large number of rows. After the current library is input, it is recommended that all tables be converted to the "hash" Storage Structure [Refs. 1 and 2], using the id number as the "address" column. Thereafter, the hash structure should be modified when 20 percent of the table is changed. The tables and views are contained in Appendix B.

<table>
<thead>
<tr>
<th>TABLES</th>
<th>VIEWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>file</td>
<td>vind</td>
</tr>
<tr>
<td>loan</td>
<td>vloan</td>
</tr>
<tr>
<td>sets</td>
<td>vpe</td>
</tr>
<tr>
<td>student</td>
<td>vretire</td>
</tr>
<tr>
<td>tape</td>
<td>vsclloan</td>
</tr>
<tr>
<td></td>
<td>vscratch</td>
</tr>
<tr>
<td></td>
<td>vstudent</td>
</tr>
</tbody>
</table>
C. DESIGN DATA DICTIONARY

The Specification Data Dictionary (Appendix A) defines fields in terms of how they are used in the library. The Design Data Dictionary (Appendix C) defines fields in terms of how they are used in the TLS application. Both should be read for full comprehension of the field's use.

D. THE APPLICATION

The tape library was developed using Ingres Application By Forms (ABF), and is an interactive application with a forms interface. The application user interacts with the form by filling in fields with data. The application interfaces with the form by getting values from it, and sometimes placing values on it.

ABF applications are built by the use of frames. The frame is the principal vehicle for interaction between the user and the forms application. Each full screen the user sees is a frame. A frame is composed of a form and a procedure. The upper portion of the frame is the form.

The developer designs the form. It may include trim and/or fields. When defining a form the developer only includes the fields which may be manipulated by the frame. Fields and their attributes are included in the form definition. Attributes include validation criteria, validation failure messages, and value "display only", and mandatory input requirements.
Below the form on the lower left of the frame is a command menu defined and placed on the frame by the procedure. The menu includes a list of operations which the user may select. By selecting a command, another procedure is called to execute the operation. The library application commands include procedures for movement to other frames, input or retrieval of data, and a few arithmetic operations.

Frames may be designated as one of four types or usages by the developer. Three are used in the library - QBF, RBF, and User Specified (User).

(1) QBF - When encountering a QBF-defined frame, ABF calls on the QBF subsystem. QBF allows append, query, and update operations to be performed on one table of the database. The developer may limit which of these operations may be performed by the frame when defining the frame. A form and one table are associated with a QBF frame. The procedure is automatically provided by QBF.

(2) Report Writer - When encountering a "report"-defined frame in the library, ABF calls on the Ingres RBF subsystem. Reports and optional forms are associated with report frames. By defining the report, the developer controls the output mode format and report inclusion and layout. The developer may provide a form in the frame definition. The form allows the user flexibility in report retrieval. The user may select records by field values or ranges.

(3) User - When ABF encounters a user-specified frame, it calls on procedures written by the developer. Procedures and forms are associated with user frames. In the library, procedures are written in either the ABF Operations Specification Language Code (OSL) or in a combination "C" language and QUEL. OSL simply calls other frames or procedures, or exits from the application. "C" and QUEL were used where such a program would be more efficient, simpler, or more secure than QBF, or where an operation required data input to or retrieval from more than one table.
E. FRAMES

The frames of the tape library are provided as charts in Appendix D. They are defined briefly in the frame description section below. The frames, and their associated forms, procedures, reports, and tables are listed and defined in greater detail in Appendix E.

F. FRAMES DESCRIPTION

1. Topframe (1)

Topframe (1) is a user frame which provides a menu form. The form spells out the commands available in the operations menu. The user may select one of six operations which call the OSL procedure. The first five call another frame - TQuery/Report (1.1), PQuery/Report (1.2), Add (1.3), Update (1.4), and Delete (1.5). The last, Exit, ends the application.

2. TQuery/Report (1.1)

PQuery (1.1) and all of its subordinate frames provide either a path to retrieval, or retrieval of a report from the database to the terminal. Terminal reports were designed for use by the librarian to search the database for a particular tape or set of tapes. The fields, formats, and sorting was selected for easy reference and relevance to the librarian. PQuery is a User frame which provides a menu form. The form defines the commands available on the operations menu. The user may select one of nine operations
which call the OSL procedure. The first eight call another frame — Scratch (1.1.1), Periodic (db, wb, mb, gb) (1.1.2), Individual (is, if, iu) (1.1.3), Vendor (1.1.4), Student (1.1.5), Loaned (1.1.6), and Date to Retire (1.1.7). By selecting Return, the OSL calls Topframe (1). Exit leaves the application.

(1) Scratch (1.1.1), Periodic (1.1.2), Individual (1.1.3), Vendor (1.1.4), Student (1.1.5), Backup or Vendor (1.1.6.2), and Date to Retire (1.1.7). Each of these frames are report frames which display a parameter form. The form includes fields in which the user must enter data to define records to be included in the report. RBF provides three commands at the bottom of the form, Help, Report, and End. Help provides the user with assistance. Report enters the parameters and causes the appropriate data to be listed. End returns to the previous frame. The fields and field attributes of each form and the report definitions are provided in Appendix E under the appropriate frame definition.

(2) Loaned (1.1.6) is a User frame which provides a menu form. The form lists four commands available on the operations menu. The user may select one of the operations to call an OSL procedure. The first three call another frame — Scratch (1.1.6.1) and Backup —
Vendor (1.1.6.2). Return calls the previous frame

TQuery/Report (1.1). Exit terminates the application.

(3) Scratch (1.1.6.1) is a report frame which has no associated form for parameter selection. RBF presents a command menu with the commands Help, Report, and End. Help provides assistance to the user. Report causes the loaned scratch tape report to be listed on the terminal. End calls the previous frame - Loaned (1.1.6). The report fields and format are described in Appendix E under the appropriate frame definition.

3. PQuery/Report (1.2)

PQuery/Report (1.2), and all of its subordinate frames, provide either a path to retrieval, or retrieve a report from the database to a file in the librarian's personal UNIX workspace. The librarian may then print the file using the UNIX operating system. The primary reason for providing printed reports (except in the case of dump reports) was to provide a means for the librarian to communicate with library users. Therefore, the fields, format, and sorting was selected to group data in a format relevant to users. Dump reports were designed to provide the librarian with a printed list of each relation in a format which would facilitate comparisons between relations. All printed reports were designed to conserve paper. Ingres documentation describes a method for printing reports directly from RBF. However, this method does not work because of a bug in RBF.
in all of the current Ingres versions. It will be corrected in the upcoming Version III. Therefore, this slightly more cumbersome method of "write to file" was used. TQuery is a User frame which provides a menu form. The form spells out the operations available on the command menu. The user may select one of nine operations which call the OSL procedure. The first nine call another frame - Scratch (1.2.1), Periodic (1.2.2), Individual (1.2.3), Vendor (1.2.4), Student (1.2.5), Loaned (1.2.6), Date to Retire (1.2.7), Dump (1.2.8). Return calls the previous frame. Exit terminates the application.

1) Scratch (1.2.1), Periodic (1.2.2), Individual (1.2.3), Vendor (1.2.4), Student (1.2.5), Backups or Vendor (1.2.6.2), and Date to Retire (1.2.7). Each of these frames are report frames which display a parameter form. The form includes fields in which the user must enter data to define the records to be included in the report. It also provides the name of the output files to the user. RBF provides three commands at the bottom of the form - Help, Report, and End. Help provides assistance to the user. Report enters the parameters, selects data, and writes the report to file. End returns to the previous frame - TQuery/Report (1.2). The reports definitions are provided in Appendix F.

2) Loaned (1.2.6) is a User frame which provides a menu form which writes out the operations available on the
command menu. The first two call the OSL to call frame Scratch (1.2.6.1) or Backup or Vendor (1.2.6.2). Return returns to the previous frame - PQuery/Report (1.2). Exit terminates the application.

(3) Scratch (1.2.6.1) is a report frame which provides a form that communicates the name of the output file of the report to the user. RBF provides three operations on the command menu - Help, Report, Return. Help provides assistance to the user. Report writes a report of scratch tapes to the output file. End returns to the previous frame - Loaned (1.2.6)

(4) Dump (1.2.8) is a User frame which provides a menu form which writes out the operations included in the command menu. The first six call frames - Tape (1.2.8.1), Sets (1.2.8.2), File (1.2.8.3), Student (1.2.8.4), and Loan (1.2.8.5). Return calls PQuery/Report (1.2). Exit terminates the application.

(5) Tape (1.2.8.1), Sets (1.2.8.2), File (1.2.8.3), Student (1.2.8.4), and Loan (1.2.8.5) are report frames which provide the name of the output file to the user. RBF provides the operations on the command menu - Help, Report, and Return. Help provides assistance to the user. Report selects, sorts, and writes the report to file. Return calls the previous frame - Dump (1.2.8). The report definitions are included in Appendix F.
4. **Add (1.3)**

Add (1.3), and all the frames subordinate to it, provide the means or a path to a means for the librarian to add a new record to a table or to more than one table of the database. Add is a User frame which provides a menu form that defines the operations available on the command menu. The user may select one of seven operations. All call the OSL to call a frame - Scratch (1.3.1), Vendor (1.3.2), Backup (1.3.3), Files (1.3.4), Students (1.3.5), Loan (1.3.6). Return calls the previous frame - Add (1.3).

(1) **Scratch (1.3.1)** is a User frame with a form and three procedures. The form provides fields for data input into one table. The first procedure is an OSL procedure which provides a command menu at the bottom of the form of three operations - Id, Add, and Return. By selecting Id, the OSL calls on procedure sgetid. The purpose of sgetid (and vgetid (1.3.2)) is to ensure empty slots of the library are filled and that new ids assigned are the maximum id plus one. New ids are assigned to the database only when scratch tapes or vendor tapes are added. Sgetid id (like vgetid id in frame 1.3.2) assigns the id labels to tapes or tapes and slots and informs the librarian of the old or new id. Sgetid places the id on the form and prompts the user to enter new data and select Add. By selecting Add, the OSL calls procedure acquire for input.
updates the fields of an empty slot record in the TAPE table or appends a new record to the TAPE table if the entered data meets the procedure and form validation criteria. It informs the user of the action taken and what labelling action the librarian should take. By selecting Return, the previous frame - Add (1.3) is called.

(2) Vendor (1.3.2) is a user frame with a form and three procedures. The form provides fields for data input to two tables. The first procedure is an OSL procedure which provides a command menu at the bottom of the form which includes three operations - Id, Add, and Return. By selecting Id, the OSL calls on procedure vgetid which retrieves the lowest empty slot, or new id number from the database and puts it on the form. It tells the user if the id is that of an empty slot or a new id and prompts the user to enter the new input and select Add. By selecting Add, the OSL calls procedure avendorc which enters the new data on the two tables if it meets the field attributes and the procedure's validation criteria. The procedure prompts the user to inform him or her of action taken. By selecting Return the previous frame - Add (1.3) is called.

(3) Backup (1.3.3) is a user frame which provides a menu which writes out the operations provided in the
OSL procedure. The OSL procedure provides a command menu of three operations on the bottom of the form which call other frames - Periodic (1.3.3.1), Individual (1.3.3.2), and Return to the previous frame - Add (1.3.3).

(4) Periodic (1.3.3.1), Sets (1.3.3.2), New Backups or Vendor (files) (1.3.4.1), Students (1.3.5), and Loan (1.3.6), are QBF-append only frames. Each frame provides a form for data input. QBF provides a command menu at the bottom of the form which includes three operations - Help, Add, and Return. Help provides assistance to the user in the use of QBF. Add appends the data to the appropriate table. Return returns to the previous frame.

(5) Files (1.3.4) is a User frame which provides a menu form which writes out the operations provided by the OSL in the command menu. The OSL provides three operations which call frames - Periodic (1.3.3.1), Individual (1.3.3.2), Return calls the previous frame - Add (1.3).

(6) Old Partial Individual (1.3.4.2) is a User frame with a form and two procedures. The form provides fields and validation criteria for data input to two tables. The OSL procedure provides three operations on the form's command menu. Add calls procedure - addfile which appends a record to the file table and updates the
sets table. Return calls the previous frame - Files (1.3.4). Exit terminates the application.

5. **Update (1.4)**

Update (1.4), and the frames subordinate to it, allow the librarian to update selected information in the database. The data may require update because the values changed since they were entered or because they were entered incorrectly. Update is a User frame with a menu form and an OSL procedure. The form writes out the four operations provided by the CSL in the command menu. The first four call the OSL to call other frames - Errors (1.4.1), Backup (1.4.2), and Loan (1.4.3). Return calls the previous frame - Topframe (1).

Errors (1.4.1), Backup (1.4.2), and Loan (1.4.3) are QBF update only frames. Each has one form which provides selected fields which enable update of one table by the librarian. QBF provides the command line which prompts the user for query of the old record, then update.

6. **Delete (1.5)**

Delete (1.5) is the only frame which allows deletion of records from the database tables. Delete is a User frame with a form and four procedures; tdelete.osl, dloanc, dbacks, and dtapec. The form provides a field and lists the operations in the command menu provided by the OSL procedure. The user enters into the field the id number of the tape for which records will be deleted. The OSL procedure provides the operations in the command menu. Form calls procedure
dloanr which deletes records from the LOAN table. Backup calls procedure dbbackc which deletes records from the SETS, STUDENT, and FILE tables. Tape calls procedure dtapec which deletes records from the SETS, FILE, STUDENT, and LOAN tables and all fields from the TAPE table except id. The id number in the TAPE table will then be an empty slot.

G. DFDS/FRAMES

<table>
<thead>
<tr>
<th>FUNCTION</th>
<th>PROCESS</th>
<th>FRAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2, 3, 8</td>
<td>1.3.1</td>
</tr>
<tr>
<td>B</td>
<td>2, 3, 8</td>
<td>1.3.2</td>
</tr>
<tr>
<td>C</td>
<td>2</td>
<td>1.1.3</td>
</tr>
<tr>
<td>C</td>
<td>8</td>
<td>1.3.3.2, 1.3.4.1, 1.4.1</td>
</tr>
<tr>
<td>D</td>
<td>2</td>
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</tr>
<tr>
<td>D</td>
<td>8</td>
<td>1.3.3.1, 1.3.3.2, 1.3.4.1, 1.3.5, 1.4.1</td>
</tr>
<tr>
<td>E</td>
<td>2</td>
<td>1.1.2, 1.1.3, 1.1.4, 1.1.5</td>
</tr>
<tr>
<td>E</td>
<td>8</td>
<td>1.4.1</td>
</tr>
<tr>
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<td>2</td>
<td>1.1.1, 1.1.3, 1.1.4</td>
</tr>
<tr>
<td>F</td>
<td>8</td>
<td>1.3.6</td>
</tr>
<tr>
<td>G</td>
<td>2</td>
<td>1.1.6.1, 1.1.6.2</td>
</tr>
<tr>
<td>G</td>
<td>8</td>
<td>1.5</td>
</tr>
<tr>
<td>H</td>
<td>1</td>
<td>1.1.7</td>
</tr>
<tr>
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<td>2</td>
<td>1.1.2, 1.1.3, 1.1.4</td>
</tr>
<tr>
<td>H</td>
<td>4</td>
<td>1.5</td>
</tr>
</tbody>
</table>

H. INTEGRITY

Database integrity is maintained in seven ways.

1. Permits are defined to allow only the librarians to perform any functions on the tables of the TIS.

2. All but two fields are limited to only one table. The exceptions are in, which is used as the link between tables, and name. Design is in DFDS and STUDENT.
The student record is created when the student graduates. At that time, all of their files are written to the graduation backup, including any individual student backups they may have owned. All SET records regarding the student are deleted at this time (including the SET contph). Therefore when the student's contph number is entered to STUDENT, it no longer is recorded in SET.

(3) Data is validated upon input. Where allowed values were limited and known not to change frequently, validations were defined in forms. They are listed in Appendix E.

(4) "Repeat previous value facility". Librarians have many other duties which may distract them while entering data on a form. To remind them of their previous entry, they may simply press a function key for a display of previous fields entered when using QBF-append.

(5) Programming. To ensure the consecutive, sequential assignment of ids to cabinet spaces and new tapes, the assignment is performed by the application.

(6) Update. Values which change in the course of time, or values which have no validation or input may be updated by the librarian by using the update frames.

(7) The dump reports provide listings of all tables sorted by IL number. The librarian may use these to report the values recorded for each IL number in each field.
I. SECURITY

As discussed in Section H, only personnel to whom permits have been granted may affect the tables of the database. Only the librarians are assigned permits. Any additional security measure is login symbols. Login symbols provide access to the application.

A login symbol is defined in the login files of each of the librarians to grant them access to the TLS. No one else may gain access.

J. DATABASE ADMINISTRATOR

The database administrator will perform the following functions to maintain the TLS.

(1) Implementation - instructions for implementation are provided in Appendix F.

(a) Load the current library records
(b) Change the storage structure of all tables

(2) Maintenance - Instructions for maintenance of the library are included in the tutorial in Appendix C

(a) To maintain peak performance, system modifications must be run on each table when 20 percent of the records in the table have been changed. Monthly system modifications are recommended in the tutorial.

(b) Maintain the integrity of the library by destroying and defining permits to tables as personnel are relieved of their librarian duties and new librarians are assigned.

(c) Define the TLS login symbol in the login files of new librarians assigned. Delete the login file from the login files of personnel relieved of librarian duties.
K. VALIDATION AND TEST

Frames were developed in a top-down fashion, Topframe and each of the menu frames first. Append frames were then developed and tested. Records of 34 tapes, backup data, and associated data, were entered into the library using the new frames. The update frames were then tested. The librarian verified the functionality of the frames and appropriateness of the fields. The terminal report frames were then developed and tested followed by the printed report frames. The librarian verified the reports' inclusion and format. All frames were tested together using the small, representative library data and a scenario of the various processes performed in the library.

Various bugs in the Ingres DBMS were discovered during testing:

1. The Ingres documentation does not describe how to select records from one table which are not in another table. This was resolved by an Ingres representative.

2. The VM UNIX Version 2.1/15VE.04 interface between ABF and QBF malfunctions. A corrected version has been sent to NPGS.
   (a) In QBF-update mode, updates were not performed.
   (b) In QBF - all modes, validations could not be performed between sets.

3. The Ingres documentation does not describe how to interface parameter forms with RBF reports. An Ingres representative explained the procedure.

4. A known bug exists in the RBF facility. The documentation describes how to flag Ingres to output reports directly to a printer. The process is coded incorrectly and will not be corrected until the next
version of Ingres, Version III is developed. Therefore, the TLS outputs reports to be printed to the user's UNIX workspace. The report must then be printed from UNIX.
V. RECOMMENDATIONS AND CONCLUSIONS

Recommendations regarding the use of the TLS, observations regarding Ingres, and an opinion on use of the requirements analysis and design process are presented.

A. THE LIBRARY

The tape library system (TLS) is designed to enable the Computer Science Department to provide secure, dependable library services. They may do so by implementing the TLS described in this thesis, and by locking the cabinets in which they keep the tapes. There are ways, however, in which data can be entered incorrectly. They exist because: 1) either there is no means of validating the entry; 2) the likelihood of making the error can be reduced by methods other than validation; or 3) the potential error is not critical or can be easily recognized and corrected by the librarian.

(1) Ingres forms allow validations which refer to other fields in the same or other tables. However, these values are recorded for comparison at the time the form is initialized. Forms are initialized when CBF is called. Therefore, when adding records to a set, the values added after CBF was called will not be included in the validation. Tables which store
values through QBF-append (SETS, FILE, LOAN, STUDENT) are vulnerable to this lack of validation. Double entries of id numbers or entry of id numbers which are not logged in the library can occur. This likelihood is kept low because of the two procedures provided in a. and b. below. If either error occurs, it may be caught and corrected by c.

(a) In order to write a backup the librarian must get a scratch tape and an id number. They must be found in the scratch tape list, there is no other place to find available tapes or id numbers. The scratch tape list is created and maintained by the application and has very tight integrity.

(b) If the librarian is entering records into the tables, and forgets the last id number entered, a control function may be used to see which was the last id number entered.

(c) If an id is listed in SETS, FILES, STUDENT, or LOAN which was not assigned in the library or which duplicated a previously assigned number it will be discovered when a routine backup or vendor report is run, or when the librarian runs a dump of the table.

(2) Librarians occasionally enter the wrong dates, especially the year. Ingres does not allow arithmetic operations on dates in QBF validation. Therefore, the application will not validate date input. However, current date entry errors are quickly discovered in the library. In the TLS they may be corrected using the update frames.

(3) When reports are retrieved by selecting parameters by value, the value must be exact (or * for all or no
letter or any word). Upper case letters are considered different than lower case. It is recommended that all entries be in lower case letters and that the librarians standardize input as recommended in the data dictionaries (Appendices A and C). Where likely discrepancies occur, the * symbol may be used within a word to mean "any letters," or by itself to mean "any value."

B. INGRES

Various other strengths and weaknesses of Ingres were learned during the study.

Ingres promotes the use of QBF, RBF, and ABF in its documentation. RBF and ABF are efficient and comprehensive for use for the tape library and much more complicated applications; QBF is not. When a QBF form is called from ABF, at least 15 seconds pass before a form appears on the screen. This time, and the limitations on validations available, are burdensome to the user. Input time is faster than it would be by use of a procedure, but for simple append and updates, it doesn't save enough time to compensate. RBF takes as long to produce a report, which is acceptable considering the data retrieval, selection, and sorting process involved. ABF is a powerful and convenient tool for building and testing applications.

Ingres documentation is incomplete. As discussed in
Chapter IV, certain procedures were omitted.

Various bugs were revealed in Ingres. This was the developers first intimate experience with a commercial software product. This experience and discussions with more experienced developers indicates software, at any price, is always in the test and development stages. It is recommended that the CS staff maintain close liaison with the helpful hotline at RTI to improve the NPGS purchase and the RTI product.

C. REQUIREMENTS ANALYSIS AND DESIGN

A requirements analysis and design process similar to those described by Kroenke [Ref. 3] and DeMarco [Ref. 4] was implemented. Although there were times when it seemed the process was in the way of progress, it was followed diligently. As has been written by Boehm [Ref. 5], and many others, time consuming requirements result in fewer surprises during the design process. By the time the design stage was started, both the library and Ingres were well known. Only Ingres bugs or deficient documentation caused surprises during design and implementation.
APPENDIX A

SPECIFICATION DATA DICTIONARY

A. DATA CLASS: SLOT (included in Tapes)*

**Definition**  A slot in a tape cabinet. Only one tape is stored in a slot. Each slot in a cabinet is identified and labelled with an identification number. Slots are labelled consecutively left to right, top to bottom.

**Elements**

<table>
<thead>
<tr>
<th>Identification</th>
<th>A unique number assigned to a slot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attribute</td>
<td>id**</td>
</tr>
</tbody>
</table>

**Type**  Type is an attribute of tape. Therefore, if no tape is assigned to a slot, the TAPE table will have a null entry in all tape attributes except "id".

* If all attributes other than "id" in table TAPE have null values, the record represents an empty slot. If the id and any other attributes in table TAPE have values, the slot id number is the same as the tape id number.

** Key
B. DATA CLASS: TAPE

**Definition**
A 7/9 track reel of magnetic tape up to 3600 feet long, to be used or being used to store data useful to the CS department. Attribute values impact the librarian's decision of whether or not to use the tape for a specific "read to tape" request.

**Elements**

**Identification**
A unique identifier of a tape. The same as the identification number of the slot to which it is assigned.

*Attribute id*
*Constraint* unique, key, mandatory

**Length**
The length of the tape. Tapes are normally 300, 350, 400, 450, 550, 600, 650, 1200, 2400, or 3600 feet long.

*Attribute length*
*Constraint* mandatory

**Density**
The bits per inch the tape may copy. Densities are 800, 1600, 6250, a combination 1600/6250, or 10,000. Combinations shall be recorded as 6250.

*Attribute bpi*
*Constraint* mandatory

**Errors**
The number of bad bits on the tape. The utility provides the number when a tape is read or written. Used to determine the condition of the tape. If over 10, the librarian will run it again when the heads are freshly changed to get a more accurate reading. If the figure remains greater than 10, it is considered unacceptable to use to read certain types of backups.

*Attribute err*

**Date of Errors**
The date the errors were last checked.

*Attribute herr*
C. DATA CLASS: SET

Definition
A conceptual entity which is one or more tapes of recorded data (may be called an active tape) which, together, are identified as a whole.

Elements

Type
The category of the active tape(s) by virtue of what is recorded on it. Types are:

- daily system backup (db)
- weekly system backup (wb)
- monthly system backup (mb)
- graduated student's backup (gb)
- individually owned-staff (is)
- individually owned-faculty backup (if)
- individually owned-student backup (iu)
- vendor software (v)

Attribute type
Constraints
key, mandatory
if w or v, value must = db, wb, mb, gb, is, if, iu, or v

System
A code representing a combination hardware and operating system from which the tape was read. Current codes are:

- irisl
- irisl2
- microvax1
- microvax2
- pdpl
- pdp2
- scaldl
- scalld2
- sunl
- sun2
- unixl
- vms1
- vms2

Attribute system
Constraints
key, mandatory

Utility
The software utility which was, and must be used to read or write the set of tapes. Utilities currently used by the department are:

- /ingres
- /nps$user1
- /nps$user2
- /nps$user3
- /user
- /usrc
- /vsl
- /vms$sys
- 'work
Attribute | utility
Constraints | mandatory
Density | See "Data Class: TAPE"
Attribute | bpi
Constraints | must be the same value as Data Class: TAPE
Date Created | The date the first bit of the active set was read to tape. Used to determine the age of the bits and the period of time the tape represents. The date to be recorded varies according to the type of the set.
Attribute | dcreate
Constraints | key, mandatory
value for each tape is limited to:

- \( db, wb, mb, is, if, iu = \text{date read to tape} \)
- \( gb = \text{the date the class graduated} \)
- \( v = \text{the first day of the month the tape was received by the owner or department} \)
Retirement Date | The date the active set should be converted to scratch. (In the case of individual sets, the owner's permission must be obtained before conversion.) Varying according to type.
Attribute | dretire
Constraints | mandatory
value for each type limited to:

- \( db = \text{dcreate} + 1 \text{ month} \)
- \( wb = \text{dcreate} + 3 \text{ months} \)
- \( mb = \text{dcreate} + 6 \text{ months} \)
- \( gb = \text{dcreate} + 2 \text{ years} \)
- \( v = \text{dcreate} + 5 \text{ years} \)
- \( is = \text{dcreate} + 2 \text{ years} \)
- \( if = \text{dcreate} + 2 \text{ years} \)
- \( iu = \text{dcreate} + 2 \text{ years} \)
Description | Narrative comments about the set
Attribute | descr
Constraints | none
Name of Owner  The name of the owner of the tape(s). Used only in individual or vendor set types.

Attribute  owner
Constraints  is, if, iu = mandatory and key
          v = optional
          db, wb, mb, gb, = null

Advisor  The name of the student's advisor. Used only in individual student set type.

Attribute  advisor
Constraints  u, i = optional
          db, wb, mb, gb, is, if, v = null

Contact Phone  A phone number. Only used in individual or vendor set types. The person whose number is recorded varies according to set type.

Attributes  contph
Constraints  is, if, v = owner's phone number
          iu = advisor's phone number

Software  The name of the software on the tape, including the version number. Only used for set type vendor.

Attribute  software
Constraints  v = mandatory, key
          db, wb, mb, gb, is, if, iu = null

Vendor  The name of the vendor company which produced the software. Used only for set type vendor.

Attribute  vendor
Constraints  v = optional
          db, wb, mb, gb, is, if, iu = null
D. DATA CLASS: ACTIVE TAPE

Definition
A conceptual entity which is one tape which, by virtue of its recorded data is a member of a set. Attributes are dependent upon the fact it has recorded data and is a member of an active set.

Element

Identification
A unique identifier of a reel, the same as the identification number of the slot to which it is assigned

Attribute id
Constraint unique, key, mandatory

Label
The VMS operating system requires that each tape be assigned a label by the librarian. When the tape is mounted, the label verifies to the system that the tape is for VMS read/write. If the "copy" utility is used to read or write the tape, a label must be entered by the librarian when mounting the tape. It is not necessary for the librarian to know the label name when using the other VMS utility-"backup". The librarian chooses a label name which indicates what is recorded on the tape.

Attribute label
Constraint if (utility = copy) mandatory
if (utility = backup) optional

Sequence
The sequential order of the tape in the total number of tapes which make up the set

Attribute seq
Constraint if number of tapes in the parent set > 1, then mandatory

Percent Used
The percent of the tape which contained data used for tapes which are members of set type individual only; and only tape is partially used.

Attribute perusd
Constraint if (is. if, iu) and partially used, then optional
E. DATA CLASS: FILE PATH

Definition
A conceptual entity which provides the path to the disk location of one or more files. Inherent in the file path name construed by the librarian as the file content.

Elements

Partition
A major subdivision of files in the UNIX operating system. The partition from which the files were read

Attribute
part
Constraint
if system = UNIX* then mandatory, key
if system = UNIX* then null

Disk
A major subdivision by disk in the VMS operating system. The disk from which the files are read

Attribute
disk
Constraint
if system = VMS* then mandatory, key
if system = UNIX** then null

Saveset
When using VMS "backup" utility, marks the beginning of each file or set of files. Terminates with an end-of-file marker. When using the "backup" utility for read/write, the saveset must be entered by the librarian in order to mount the tape. Librarians assign saveset names which indicate what is in the file

Attribute
sav
Constraint
if utility = backup then mandatory, key

Source
Systems other than VMS and utilities other than backup and copy do not require the assignment of label or saveset names. The librarian has contrived a "source" to be assigned to a file or set of files on a tape which is read by other than VMS backup and copy utilities. The assigned name indicates the file(s) contents

Attribute
src
Constraint
if utility = backup or copy and
set type = gb, then mandatory
if utility = backup or copy and
set type = gb, then optional
F. DATA CLASS: STUDENT

Description
The name given to a person who has graduated from NPGS and whose files are contained in a set of graduation tapes.

Elements

Name
The last and first name of the student

Attribute
name
Constraint
required key

Advisor
The name of the student's advisor

Attribute
advisor
Constraint
mandatory

Contact Phone
The telephone number of the advisor

Attribute
contph

G. DATA CLASS: LOAN

Definition
A conceptual entity which describes the agreement under which a tape is loaned.

Element

Loanee
The name of the person to whom the tape was loaned

Attribute
loanto
Constraint
mandatory key

Date Loaned
The date the tape is loaned

Attribute
dloan
Constraint
none

Estimated Date of Return
The date the tape should be returned to the library

Attribute
edr
Constraint
edr > dloan

Contact Phone
The phone number of the loanee

Attribute
lcntph
Constraint
none
APPENDIX B

TABLES AND VIEWS

A. TABLES [Ref. 4]

File, Loan, Sets, Student, Tape

<table>
<thead>
<tr>
<th>Table:</th>
<th>File</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner:</td>
<td>crawford</td>
</tr>
<tr>
<td>Row Width:</td>
<td>26</td>
</tr>
<tr>
<td>Saved Until:</td>
<td>1-Jan-1999 00:00:00</td>
</tr>
<tr>
<td>Number of Rows:</td>
<td>21</td>
</tr>
<tr>
<td>Number of Pages:</td>
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</tr>
<tr>
<td>Journaling:</td>
<td>disabled</td>
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<tr>
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<tr>
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<td>user table</td>
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</table>

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<th>length</th>
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</table>

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<td>52</td>
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<th>length</th>
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<td>i</td>
<td>2</td>
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</tr>
<tr>
<td>edr</td>
<td>date</td>
<td>12</td>
<td>loanto</td>
<td>c</td>
<td>15</td>
</tr>
<tr>
<td>length</td>
<td>c</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table: Sets

- **Owner:** crawford
- **Row Width:** 126
- **Saved Until:** 1-Jan-1999 00:00:00
- **Number of Rows:** 12
- **Number of Pages:** 1
- **Journaling:** disabled
- **Storage Structure:** heap
- **Table Type:** user table

<table>
<thead>
<tr>
<th>column name</th>
<th>type</th>
<th>length</th>
<th>column name</th>
<th>type</th>
<th>length</th>
</tr>
</thead>
<tbody>
<tr>
<td>id</td>
<td>i</td>
<td>2</td>
<td>type</td>
<td>c</td>
<td>2</td>
</tr>
<tr>
<td>dcreate</td>
<td>date</td>
<td>12</td>
<td>dretire</td>
<td>date</td>
<td>12</td>
</tr>
<tr>
<td>system</td>
<td>c</td>
<td>9</td>
<td>utility</td>
<td>c</td>
<td>6</td>
</tr>
<tr>
<td>owner</td>
<td>c</td>
<td>9</td>
<td>advisor</td>
<td>c</td>
<td>9</td>
</tr>
<tr>
<td>contph</td>
<td>c</td>
<td>4</td>
<td>software</td>
<td>c</td>
<td>15</td>
</tr>
<tr>
<td>vendor</td>
<td>c</td>
<td>20</td>
<td>label</td>
<td>c</td>
<td>6</td>
</tr>
<tr>
<td>descr</td>
<td>c</td>
<td>15</td>
<td>sequ</td>
<td>f</td>
<td>4</td>
</tr>
<tr>
<td>perusd</td>
<td>i</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table: Student

- **Owner:** crawford
- **Row Width:** 30
- **Saved Until:** 1-Jan-1999 00:00:00
- **Number of Rows:** 4
- **Number of Pages:** 1
- **Journaling:** disabled
- **Storage Structure:** heap
- **Table Type:** user table

<table>
<thead>
<tr>
<th>column name</th>
<th>type</th>
<th>length</th>
<th>column name</th>
<th>type</th>
<th>length</th>
</tr>
</thead>
<tbody>
<tr>
<td>id</td>
<td>i</td>
<td>2</td>
<td>name</td>
<td>c</td>
<td>15</td>
</tr>
<tr>
<td>advisor</td>
<td>c</td>
<td>9</td>
<td>contph</td>
<td>c</td>
<td>4</td>
</tr>
</tbody>
</table>
Table: Tape  
Owner: crawford  
Row Width: 19  
Saved Until: 1-Jan-1999 00:00:00  
Number of Rows: 18  
Number of Pages: 1  
Journaling: disabled  
Storage Structure: heap  
Table Type: user table

<table>
<thead>
<tr>
<th>column name</th>
<th>type</th>
<th>length</th>
<th>column name</th>
<th>type</th>
<th>length</th>
</tr>
</thead>
<tbody>
<tr>
<td>id</td>
<td>i</td>
<td>2</td>
<td>length</td>
<td>i</td>
<td>2</td>
</tr>
<tr>
<td>bpi</td>
<td>i</td>
<td>2</td>
<td>err</td>
<td>i</td>
<td>1</td>
</tr>
<tr>
<td>derr</td>
<td>date</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

B. VIEWS

vind, vloan, vpe, vretire, vsclon, vscratch, vstudent, vven

**VIEW VIND DEFINED**

range of t is tape  
range of s is sets  
range of f is file  
define view vind (  
    id = s.id,  
    type = s.type,  
    owner = s.owner,  
    advisor = s.advisor  
    contph = s.contph  
    dcreate = s.dcreate,  
    system = s.system,  
    utility = s.utility,  
    bpi = t.bpi,  
    label = s.label,  
    part_disk = f.part_disk,  
    sav_src = f.sav_src,  
    descr = s.descr,  
    err = t.err,  
    length = t.length,  
    perusd = s.perusd,  
    sequ = s.sequ)  
where (s.id = f.id)  
and (t.id = s.id)  
and (s.type = "i*")
VIEW VLOAN DEFINED

range of t is tape
range of s is sets
range of l is loan

define view vloan (  
  id = t.id,  
  type = s.type,  
  system = s.system,  
  eequ = s.sequ,  
  owner = s.owner,  
  software = s.software,  
  dloan = l.dloan,  
  loanto = l.loanto,  
  lcntph = l.lcntph,  
  edr = l.edr)  
where (t.id = s.id)  
and   (l.id = t.id)

VIEW VPE DEFINED

range of s is sets
range of t is tape
range of f is file

define view vpe (  
  id = s.id,  
  type = s.type,  
  dcreate = s.dcreate,  
  system = s.system,  
  utility = s.utility,  
  bpi = t.bpi,  
  label = s.label,  
  part_disk = f.part_disk,  
  sav_src = f.sav_src,  
  descr = s.descr,  
  err = t.err,  
  sequ = s.sequ)  
where (t.id = s.id)  
and   (s.id = f.id)  
and   (s.type = "*b")
VIEW VRETIRE DEFINED

range of t is tape
range of s is sets
declare view vretire (  
dretire = s.dretire,  
type = s.type,  
dcreate = s.dcreate,  
system = s.system,  
sequ = s.sequ,  
id = s.id,  
length = t.length,  
bpi = t.bpi,  
err = t.err)
where (t.id = s.id)

VIEW VSCLOAN DEFINED

range of t is tape
range of s is sets
range of l is loan
declare view vscloan (  
id = l.id,  
edr = l.edr,  
dloan = l.dloan,  
loanto = l.loanto,  
lcntph = l.lcntph)
where (t.bpi != 0)
and (t.length != 0)
and (any(s.id by t.id
where (t.id = s.id)) = 0)
and (t.id = l.id)

VIEW VSCRATCH DEFINED

range of t is tape
range of s is sets
declare view vscratch (  
id = t.id,  
length = t.length,  
bpi = t.bpi,  
err = t.err,  
derr = t.derr)
where (t.length != 0)
and (any(s.id by t.id
where (t.id = s.id)) = 0)
and (t.bpi != 0)
VIEW VSTUDENT DEFINED

range of t is tape
range of s is sets
range of rv2 is student
range of f is file
define view vstudent ( 
    name = rv2.name,
    dcreate = s.dcreate,
    id = s.id,
    system = s.system,
    utility = s.utility,
    bpi = t.bpi,
    label = s.label,
    part_disk = f.part_disk,
    sav_src = f.sav_src,
    descr = s.descr,
    sequ = s.sequ,
    advisor = rv2.advisor,
    contph = rv2.contph)
where (f.id = rv2.id)
    and (s.id = f.id)
    and (t.id = s.id)
    and (s.type = "gb")

VIEW VVEN DEFINED

range of t is tape
range of s is sets
range of f is file
define view vven ( 
    id = s.id,
    software = s.software,
    vendor = s.vendor,
    system = s.system,
    utility = s.utility,
    bpi = t.bpi,
    label = s.label,
    part_disk = f.part_disk,
    sav_src = f.sav_src,
    descr = s.descr,
    sequ = s.sequ,
    owner = s.owner,
    advisor = s.advisor
    contph = s.contph
    err = t.err,
    sequ = s.sequ)
where (s.id = f.id)
    and (t.id = s.id)
    and (s.type = "v")
In Appendix A, the parameters of integers and floating point numbers were expressed in bytes, as Ingres does. The parameters of these data types are expressed in bits. Read "i2" as "integer, two digits." Read f1.1 as "one digit decimal one digit."

Field: advisor
Name: advisor
Data Class: set
Definition: The name of the student's advisor.
Parameters: c9
Constraints: First eight letters of last name, first initial of first name; no spaces or commas.
Where Used: Source Input: Table Frame
sets 1.3.2, 1.3.3.2
student 1.3.5
Maintenance: Table Frame Action
sets 1.4.2 update
student 1.5 delete
sets 1.5 delete
Other: 1.1.3, 1.1.4, 1.1.5, 1.2.3,
1.2.4, 1.2.5, 1.2.8.2, 1.2.8.4
Storage: sets, student
View: vstudent
Field: bpi
Name: density
Data Class: tape
Definition: The bits per inch capacity of the tape.
Parameters: i4
Constraints: Valid values: [800, 1600, 6250, 10,000] Mandatory
Where Used: Source Input: Table Frame
  tape  1.3.1, 1.3.2
Maintenance: Table Frame Action
  tape  1.5 delete
Other: 1.1.1, 1.1.2, 1.1.3, 1.1.4,
  1.1.5, 1.1.7, 1.2.1, 1.2.2,
  1.2.3, 1.2.4, 1.2.5, 1.2.7,
  1.2.8.1
Storage: tape
View: vind, vpe, vretire, vscratch, vstudent, vven
Field: contph
Name: contact phone
Data Class: set

Definition: If field advisor = null then the phone number of the owner
If field advisor != null then the phone number of the advisor

Parameters: i4

Constraints: Last four digits of the telephone number Mandatory

Where Used: Source Input:
- Table: sets
  - Frame: 1.3.2, 1.3.3.2
- Table: student
  - Frame: 1.3.5

Maintenance: Table: sets
- Frame: 1.4.2
- Action: update
- Frame: student
- Action: delete

Other:
- 1.1.3, 1.1.4, 1.1.5, 1.2.3,
- 1.2.4, 1.2.5, 1.2.8.2, 1.2.8.4

Storage: sets
View: vstudent, vind
Field: dcreate  
Name: date created  
Data Class: set  

Definition: If type = db, wb, mb, is, if, iu then the date the backup was created  
            If type = gb then the date the class graduated  
            If type = v then the date the tape was received by NPGS  

Parameters: c8  

Constraints: mm/dd/yr (last two digits)  
            Mandatory  

Where Used: Source Input:  
            Table | Frame  
            sets  | 1.3.2, 1.3.3.1, 1.3.3.2  

Maintenance: Table | Frame | Action  
               1.4.2 | update  
               1.5 | delete  

Other: 1.1.2, 1.1.3, 1.1.5, 1.1.7, 1.2.2, 1.2.3, 1.2.5, 1.2.8.2  

Storage: sets  
View: vind, vpe, vretire, vstudent
Field: derr
Name: date of errors
Data Class: tape

Definition: The date the errors were last checked.

Parameters: c8

Constraints: mm/dd/yr (last two digits)

Where Used: Source Input:

Table | Frame
--- | ---
tape | 1.4.1

Maintenance: Table | Frame | Action
--- | --- | ---
tape | 1.4.1 | update
tape | 1.5 | delete

Other: 1.1.1, 1.2.1, 1.2:8.1

Storage: tape
View: vscratch
A MAGNETIC TAPE LIBRARY SYSTEM FOR THE COMPUTER SCIENCE 2/3
DEPARTMENT NPGS (U) NAVAL POSTGRADUATE SCHOOL
MONTEREY CA  B E CRAWFORD DEC 85
Field: desc
Name: description
Data Class: set
Definition: Librarian's notes about the set.
Parameters: c15
Constraints: none
Where Used: Source Input:
Table Frame
sets 1.3.2, 1.3.3.1,
1.3.3.2
Maintenance:
Table Frame Action
1.4.2 update
1.5 delete
Other: 1.1.2, 1.1.3, 1.1.4, 1.1.5,
1.2.2, 1.2.3, 1.2.4, 1.2.5,
1.2.8.2
Storage: sets
View: vind, vpe, vstudent, vven
Field: dloan
Name: date loaned
Data Class: loan
Definition: The date a tape is loaned.
Parameters: c8
Constraints: mm/dd/yr (last two digits) Mandatory
Where Used: Source Input: Table Frame
loan 1.3.6
Maintenance: Table Frame Action
1.5 delete
Other: 1.1.6.1, 1.1.6.2, 1.2.6.1, 1.2.6.2, 1.2.8.5
Storage: loan
Views: vloan, vsclloan
Field: dretire
Name: retirement date
Data Class: set

Definition: If type = db, wb, mb, gb, is, if, iu, then the date the backup should be converted to scratch
If type = v then the date the vendor tape should be replaced due to old bit age
If type = is, if, iu, then permission must be obtained from the owner before conversion
Recommended values by type:

- db = dcreate + 1 month
- wb = dcreate + 3 months
- mb = dcreate + 6 months
- gb = dcreate + 2 years
- v = dcreate + 5 years
- is, if, iu = dcreate + 2 years

Parameters: c8
Constraints: Mandatory

Where Used: Source Input:
Table  Module
sets  1.3.2, 1.3.3.1,
      1.3.3.2

Maintenance: Table  Module  Action
1.4.2  update
1.5  delete

Other: 1.1.7, 1.2.7, 1.2.8.2

Storage: sets
View: vretire
Field: edr
Name: estimated date of return
Data Class: loan

Definition: The date the librarian assigns for a loaned tape to be returned to the library.

Parameters: c8

Constraints: mm/dd/yr (last two digits)

Where Used:
Source Input: Table Frame
loan 1.3.6

Maintenance:
Table Frame Action
1.4.3 update
1.5 delete

Other: 1.1.6.1, 1.1.6.2, 1.2.6.1, 1.2.8.5

Storage: loan
View: vloan, vsclloan
Field: err
Name: errors
Data Class: tape

Definition: The number of bad bits on a tape.

Parameters: i2
Constraints: 1-99

Where Used: Source Input:
Table Frame
tape 1.4.1

Maintenance:
Table Frame Action
tape 1.4.1 update
tape 1.5 delete

Other:
1.1.1, 1.1.2, 1.1.3, 1.1.4,
1.1.7, 1.2.1, 1.2.2, 1.2.3,
1.2.4, 1.2.7, 1.2.8.1

Storage: tape
View: vind, vpe, vretire, vscratch, vven
**Field:** id
**Name:** identification
**Data Class:** tape
**Definition:** The unique number assigned to all cabinet slots and tapes; key to all tables.

**Parameters:** i5

**Constraints:** 1-10000
Mandatory input in all tables

**Where Used:** Source Input:

<table>
<thead>
<tr>
<th>Table</th>
<th>Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>tape</td>
<td>1.3.1, 1.3.2,</td>
</tr>
<tr>
<td>sets</td>
<td>1.3.3.1, 1.3.3.2</td>
</tr>
<tr>
<td>file</td>
<td>1.3.4.1, 1.3.4.2</td>
</tr>
<tr>
<td>student</td>
<td>1.3.5</td>
</tr>
<tr>
<td>loan</td>
<td>1.3.6</td>
</tr>
</tbody>
</table>

**Maintenance:**

<table>
<thead>
<tr>
<th>Table</th>
<th>Frame</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>sets</td>
<td>1.5</td>
<td>delete</td>
</tr>
<tr>
<td>file</td>
<td>1.5</td>
<td>delete</td>
</tr>
<tr>
<td>student</td>
<td>1.5</td>
<td>delete</td>
</tr>
<tr>
<td>loan</td>
<td>1.5</td>
<td>delete</td>
</tr>
</tbody>
</table>

**Other:**

1.1.1, 1.1.2, 1.1.3, 1.1.4,
1.1.5, 1.1.6.1, 1.1.6.2, 1.1.7,
1.2.1, 1.2.2, 1.2.3, 1.2.4,
1.2.5, 1.2.6.1, 1.2.6.2, 1.2.7,
1.2.8.1, 1.2.8.2, 1.2.8.3,
1.2.8.4, 1.2.8.5, 1.4.1, 1.4.2,
1.4.3

**Storage:** tape, sets, file, student, loan

**Views:** vind, vloan, vpe, vretire, vsclcan, vscratch, vstudent, vven
Field: label
Name: label
Data Class: active tape
Definition: Required by the VMS operating system. The name of a tape, assigned by the librarian.
Parameters: c6
Constraints: if system = VMS then Mandatory
Where Used: Source Input: Table Frame
                sets 1.3.2, 1.3.3.1, 1.3.3.2
                Maintenance: Table Frame Action
                              1.5 delete
                Other: 1.1.2, 1.1.3, 1.1.4, 1.1.5,
                              1.2.2, 1.2.4, 1.2.5, 1.2.8.2
Storage: sets
Views: vind, vpe, vstudent, vven
Field: loanph
Name: loanee contact phone
Data Class: loan
Description: Phone number of the person to whom a tape is loaned.
Parameters: c11
Constraints: Three numbers of area code, space, seven numbers of phone number (no hyphen)
Mandatory
Where Used: Source Input: Table Frame
loan 1.3.6

Maintenance: Table Frame Action
1.4.3 update
1.5 delete

Other: 1.1.6.1, 1.1.6.2, 1.2.6.1, 1.2.6.2, 1.2.8.5

Storage: loan
Views: vloan, vsclonan
Field: length
Name: length
Data Class: tape
Definition: The length in feet of a magnetic tape.
Parameters: i4
Constraints: Valid Value: [300, 400, 450, 555, 600, 650, 1200, 2400, or 3600]
Mandatory
Where Used: Source Input: Table Frame
tape 1.3.1
Maintenance: Table Frame Action
1.5 delete
Other: 1.1.1, 1.1.3, 1.1.7, 1.2.1,
1.2.3, 1.2.7, 1.2.8.1
Storage: tape
Views: vind, vretire, vscratch
Field: loanto
Name: loanee
Data Class: loan

Definition: The name of the person to whom a tape is loaned.

Parameters: c15

Constraints: Last name, comma, as much of first name that will fit
Mandatory

Where Used: Source Input: Table Frame
loan 1.3.6

Maintenance: Table Frame Action
1.4.3 update
1.5 delete

Other: 1.1.6.1, 1.1.6.2, 1.2.6.1,
1.2.6.2, 1.2.8.5

Storage: loan
Views: vloan, vsclloan
<table>
<thead>
<tr>
<th>Field</th>
<th>name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name:</td>
<td>name</td>
</tr>
<tr>
<td>Data Class:</td>
<td>student</td>
</tr>
</tbody>
</table>

**Definition:** The name of a student who has graduated from NPGS and whose files are maintained on a graduation backup tape.

**Parameters:** c15

**Constraints:** Last name, comma, as much of first name that will fit Mandatory

**Where Used:**
- **Source Input:** Table Frame
  - student 1.3.5
- **Maintenance:** Table Frame Action
  - 1.5 delete

**Other:** 1.1.5, 1.2.5, 1.2.8.4

**Storage:** student

**View:** vstudent
Field: owner
Name: owner
Data Class: set
Definition: The name of owner of the data on the tape.
Parameters: c9
Constraints: First eight letters of first name, first initial of last name; no spaces or commas Mandatory if type = individual
Where Used: Source Input: Table Frame
sets 1.3.2, 1.3.3.2
Maintenance: Table Frame Action
1.4.2 update
1.5 delete
Other: 1.1.3, 1.1.4, 1.1.6.2, 1.2.3, 1.2.4, 1.2.6.2, 1.2.8.2
Storage: sets
Views: vind, vloan, vven
Field: part_disk
Name: partition or disk
Data Class: file path

Description: Partition is a major subdivision of files in the UNIX operating system. Disk is a major subdivision of files by disk in the VMS operating system.

Parameters: c9
Constraints: Mandatory

Where Used: Source Input: Table | Frame
file | 1.3.2, 1.3.4.1, 1.3.4.2

Maintenance Table | Frame | Action
1.5 | delete

Other: 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.2.2, 1.2.3, 1.2.4, 1.2.5, 1.2.8.3

Storage: file
Views: vind, vpe, vstudent, vven
Field: perusd
Name: percent used
Data Class: active tape

Definition: If type = is, if, or iu then the percent used of the last tape of a sequence of tapes which make up a set. Use only if percent is less than 100.

Parameters: 12
Constraints: 1-99

Where Used Source Input: Table Frame
sets 1.3.3.2, 1.3.4.2

Maintenance: Table Frame Action
Action 1.5 delete

Other: 1.1.3, 1.2.3, 1.2.8.2

Storage: sets
View: vind
Field: sav_src
Name: savset or source
Data Class: file path
Definition: If VMS backup utility then marker for beginning of each set of files. If not VMS backup utility, then librarians name of a set of files
Parameters: c15
Constraints: Mandatory
Where Used: Source Input: Table Frame
  file 1.3.2, 1.3.4.1, 1.3.4.2
Maintenance: Table Frame Action
  1.5 delete
Other: 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.2.2, 1.2.3, 1.2.4, 1.2.5, 1.2.8.3
Storage: file
Views: vind, vpe, vstudent, vven
Field:sequ
Name:sequence
Data Class:active tape

Definition: The sequential number of a tape in the total number of tapes which make up a set (read "1.4" as "one of four").

Parameters: fl.1

Constraints: Express as sequence number decimal point total number (e.g. 1.4)

Where Used:

<table>
<thead>
<tr>
<th>Source Input:</th>
<th>Table</th>
<th>Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>sets</td>
<td></td>
<td>1.3.3.1, 1.3.3.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Maintenance:</th>
<th>Table</th>
<th>Frame</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1.4.2</td>
<td>update</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.5</td>
<td>delete</td>
</tr>
</tbody>
</table>

Other: 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.6.2, 1.1.7, 1.2.2, 1.2.3, 1.2.4, 1.2.5, 1.2.6.2, 1.2.7, 1.2.8.2, 1.3.2

Storage: sets
Views: vind, vloan, vpe, vretire, vstudent, vven
Field: software
Name: software
Data Class: sets

Definition: The name of the software of a vendor tape.

Parameters: c15

Constraints: Include version number after name. If the name is too long leave off enough letters to include version number as last entry.

Mandatory

Where Used: Source Input: Table Frame sets 1.3.2

Maintenance: Table Frame Action 1.5 delete

Other: 1.1.4, 1.1.6.2, 1.2.4, 1.2.6.2, 1.2.8.2

Storage: sets
Views: vloan, vven
**Field:** system  
**Name:** system  
**Data Class:** set  

**Definition:** Combination hardware and operating system code.

**Parameters:** c9  
**Constraints:** Valid Values: 
- iris1  
- iris2  
- microvax1  
- microvax2  
- nbi1  
- nbi2  
- nbi3  
- nbi4  
- nbi5  
- nbi6  
- nbi7  
- nbi8  
- pdp1  
- pdp2  
- unix1  
- vms1  
- vms2  

**Mandatory**

**Where Used:** Source Input:  
<table>
<thead>
<tr>
<th>Table</th>
<th>Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>sets</td>
<td>1.3.2, 1.3.3.1, 1.3.3.2</td>
</tr>
</tbody>
</table>

**Maintenance:**  
<table>
<thead>
<tr>
<th>Table</th>
<th>Frame</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>delete</td>
</tr>
</tbody>
</table>

**Other:**  
- 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.6.2, 1.1.7, 1.2.2, 1.2.3, 1.2.4, 1.2.5, 1.2.6.2, 1.2.7, 1.2.8.2

**Storage:** sets  
**Views:** vind, vloan, vpe, vretire, vstudent, vven
<table>
<thead>
<tr>
<th>Field: type</th>
<th>Name: type</th>
<th>Data Class: set</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition: The category of active tape by virtue of what is recorded on it.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parameter: c2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constraints: db, wb, mb, gb, is, if, iu, v Mandatory</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Where Used: Source Input: Table Frame |
| sets | 1.3.2, 1.3.3.1, 1.3.3.2 |

| Maintenance: Table Frame Action |
| 1.5 | delete |

| Other: 1.1.2, 1.1.3, 1.1.6.2, 1.1.7, 1.2.2, 1.2.3, 1.2.6.2, 1.2.7, 1.2.8.2 |

| Storage: sets |
| Views: vind, vloan, vpe, vretire |
Field: utility
Name: utility
Data Class: set

Definition: The software utility used to read or write the backup or vendor tape.

/ingres
/nps$user1 /nps$user3 /usrc /vms$sys
/nps$user2 /user /vlsl /work

Parameters: c6

Constraints: Mandatory

Where Used: Source Input: Table Frame
sets 1.3.2, 1.3.3.1, 1.3.3.2

Maintenance: Table Frame Action
1.5 delete

Other: 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.2.2, 1.2.3, 1.2.4, 1.2.5, 1.2.8.2

Storage: sets
Views: vind, vpe, vstudent, vven
Field: vendor
Name: vendor
Data Class: set
Definition: The name of the vendor of a vendor tape.
Parameter: c20
Constraints: Mandatory
Where Used: Source Input: Table Frame
sets 1.3.2
Maintenance: Table Frame Action
1.5 delete
Other: 1.1.4, 1.2.4, 1.2.8.2
Storage: sets
View: vven
<table>
<thead>
<tr>
<th>MENU</th>
<th>Delete</th>
</tr>
</thead>
<tbody>
<tr>
<td>FRAME</td>
<td>tdelete</td>
</tr>
<tr>
<td>USAGE</td>
<td>user</td>
</tr>
<tr>
<td>FORM</td>
<td>tdelete</td>
</tr>
</tbody>
</table>
| PROCEDURES | tdelete.osl
dloanc.qc
dbackc.qc
tapeq.qc |
|          | 1.5 |
APPENDIX E

FRAME DEFINITIONS

1.
MENU: Topframe
FRAME: topframe
USAGE: user
FORM: topframe

SELECT FUNCTION

<table>
<thead>
<tr>
<th></th>
<th>query/report (terminal)</th>
<th>query/report (printer)</th>
<th>add</th>
<th>update</th>
<th>delete</th>
<th>exit</th>
</tr>
</thead>
<tbody>
<tr>
<td>t</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>p</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PROCEDURE: topframe.osl

```plaintext
t = [callframe tquery;]
p = [callframe pquery;]
add = [callframe tadd;]
update = [callframe update;]
delete = [callframe tdelete;]
ext = [exit;]
```
1.1

MENU: TQuery/Report (terminal)
FRAME: tquery
USAGE: user
FORM: tquery

QUERY/REPORT TO TERMINAL

scratch
periodic (db, wb, mb, gb)
individual (is, if, iu)
vendor
student
loaned
date to retire
return
exit

SCRATCH PER IND VEN STU LOAN DATE RETURN EXIT:

PROCEDURE: tquery.osl

scratch = (callframe rscratch;)
per = (callframe rpe;)
ind = (callframe rind;)
ven = (callframe rvendor;)
stu = (callframe rstudent;)
loan = (callframe reploan;)
date = (callframe rdate;)
return = (return;)
exit = (exit;)

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### ENTER SCRATCH REPORT PARAMETERS

<table>
<thead>
<tr>
<th>min_length:</th>
<th>max_length:</th>
</tr>
</thead>
</table>

HELP REPORT RETURN:

Field Attributes: Mandatory - max_length

---

REPORT: rscratch

<table>
<thead>
<tr>
<th>11-SEP-1985</th>
<th>10:33:04</th>
</tr>
</thead>
<tbody>
<tr>
<td>REPORT ON SCRATCH TAPES</td>
<td></td>
</tr>
<tr>
<td>Table is: vscratch</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>id</th>
<th>length</th>
<th>bpi</th>
<th>err</th>
<th>derr</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i5)</td>
<td>(i4)</td>
<td>(i5)</td>
<td>(mm/dd/yr)</td>
<td>(mm/dd/yr)</td>
</tr>
</tbody>
</table>

Report Definition: Sort by length, bpi, errors, id
Select length by range at runtime
Output to terminal
Command flag - L80

TABLE: rscratch
1.1.2
MENU: Periodic
FRAME: rpe
USAGE: report
FORM: rperf

ENTER PARAMETERS FOR PERIODIC BACKUP REPORT
Table is: vpe

type: system:
min_dcreate: max_dcreate:
part_disk: sav_src:

HELP REPORT RETURN:

Field Attributes:
Mandatory - type, system, max_dcreate, part_disk, sav_src (type = db, wb, mb, gb, or * only)
Validation- type in [db, wb, mb, gb, *]
system (refer to Appendix C) * selects "all"

REPORT: rper

11-SEP-1985 10:34:12
REPORT ON PERIODIC BACKUPS
Report on Table: vpe

type: dcreate: mm/dd/yy utility:
id: i5 system: bpi: i5
sequ: p4.1 part_disk:
sav_src:

type: system:
min_dcreate: max_dcreate:
part_disk: sav_src:

Report Definition: Sort by type, dcreate, system, part_disk, sequ, sav_src
Select dcreate by range at runtime
Select type, system, part disk, sav_src by value at runtime
Output to terminal
Command Flag - L80

TABLE: vpe
1.1.3
MENU: Individual
FRAME: rind
USAGE: report
FORM: rindf

ENTER INDIVIDUAL BACKUP REPORT PARAMETERS

<table>
<thead>
<tr>
<th>type</th>
<th>system</th>
<th>owner</th>
<th>part_disk</th>
<th>sav_src</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

HELP REPORT RETURN:

Field Attributes:
- Mandatory - type, owner, system, part_disk, sav_src
  (type = is, if, iu, or * only)
- Validation - type in ["is", "if", "iu", "*"]
  System (refer to Appendix C)
  "*" selects all

REPORT: rind

11-SEP-1985  10:36:04
REPORT ON INDIVIDUAL BACKUPS
Table is: vind

<table>
<thead>
<tr>
<th>type</th>
<th>system</th>
<th>utility</th>
<th>length: (i4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>owner</td>
<td>part_disk</td>
<td>label</td>
<td>perusd: (i2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>dcreate</td>
<td>sav_src</td>
<td>bpi: (i5)</td>
<td>err: (i2)</td>
</tr>
<tr>
<td>(mm/dd/yy)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>id: (i5)</td>
<td>descr</td>
<td>sequ: (f4.1)</td>
<td>advisor:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Report Definition: Sort by type, owner, dcreate, system, sequence
Select type, owner, system, part_disk, sav_src by value at runTime
Output to terminal
Command flag - L80

TABLE: vind
1.1.4
MENU: Vendor
FRAME: rvendor
USAGE: report
FORM: rvendorf

ENTER PARAMETERS FOR VENDOR REPORT
Table is: vven

software: vendor:

system:

HELP REPORT RETURN

Field Attributes:
Mandatory - software, vendor, system
Validation - system (Appendix C) * selects all

REPORT: rvendor

11-SEP-1985 12:48:35
REPORT ON VENDOR TAPES
Report on Table: vven

software: part disk: utility:
vendor: sav src:
system: descr:
owner: advisor:
id: (i5) contph:
sequ: (f4.1)

Report Definition: Sort by software, vendor, system, owner, sequ
Select software, vendor, system, by value by runtime
Output to terminal
Command flag - L80

TABLE: vven
1.1.5
MENU: Student
FRAME: rstudent
USAGE: report
FORM: rstudentf

ENTER PARAMETERS FOR STUDENT REPORT
Table is: vstudent

min_dcreate: max_dcreate:
name: system:

HELP REPORT RETURN:

Field Attributes:
Mandatory - max_dcreate, name, system
Validation- System (Appendix C) *selects all

REPORT: rstudent

11-SEP-1985 10:37:26
REPORT ON STUDENT TAPES
Report on Table: vstudent

dcreate: (mm/dd/yr) system: label:
name: part_disk: utility:
sequ: (f1.1) sav_src: bpi: (i5)
id: (i5) descr: advisor:

Report Definition: Sort by dcreate, name, system,
part_disk, sequ, sav_src
Select dcreate by range at runtime
Select name, system by value at runtime
Output to terminal
Command flag - L80

TABLE: vstudent
1.1.6
1.1.6
MENU: Loaned
FRAME: reploan
USAGE: user
FORM: reploan

SELECT TYPE OF LOANED TAPES TO REPORT

scratch
backup or vendor
return
exit

SCRATCH BACKUP RETURN EXIT

PROCEDURE: reploan.osl

scratch = {callframe lnscratch;}
backup = {callframe rloan;}
return = {return;}
exit = {exit;}

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1.1.6.1
MENU: Scratch
FRAME: lnscratch
USAGE: report
FORM: default blank

HELP REPORT RUN:

REPORT: lnscratch

11-SEP-1985

REPORT ON LOANED SCRATCH TAPES
Report on Table: vscl0an

id: (i5)   edr: (mm/dd/yr)   loanto:
dloan: (mm/dd/yr)   lcntph:

Report Definition: Sort by id
Output to terminal
Command flag - L80

TABLE: vscl0an
1.1.6.2
MENU: Backup or Vendor
FRAME: rloan
USAGE: report
FORM: rloanf

ENTER PARAMETERS FOR LOANED TAPES REPORT
Table is: vloan

min_edr: max_edr:
loanto:

HELP REPORT RETURN:

Field Attributes:
   Mandatory - max_edr, loanto

REPORT: rloan

11-SEP-1985 10:40:26

REPORT ON LOANED BACKUP AND VENDOR TAPES
Report on Table: vloan

id: (i5) loanto: type:
edr: (mm/dd/yr) lcntph: software:
dloan: (mm/dd/yr) owner: system:
sequ: (f4.1)

Report Definition: Sort by id
 Select - edr by range at runtime
       loanto by value at runtime
Output file - terminal
Command flag - L80

TABLE: vloan
1.1.7
MENU: Date to Retire
FRAME: rdate
USAGE: report
FORM: rdatef

ENTER PARAMETERS FOR RETIREMENT DATE REPORT
Table is: vretire

min_dretire: max_dretire:
type:

HELP REPORT RETURN:

Field Attributes:
Mandatory - max_dretire, type

REPORT: rdatef

11-SEP-1985 12:50:55
REPORT ON RETIREMENT DATES
Report on Table: vretire

<table>
<thead>
<tr>
<th>dretire: (mm/dd/yr)</th>
<th>type:</th>
<th>length: (i4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>dcreate: (mm/dd/yr)</td>
<td>system:</td>
<td>bpi: (i5)</td>
</tr>
<tr>
<td>id: (i5)</td>
<td>sequ: (f4.1)</td>
<td>err: (i2)</td>
</tr>
</tbody>
</table>

Report Definition: Sort by dretire, type, dcreate, system, sequ
Select dretire by range at runtime
Select type by value at runtime
Output file - terminal
Command flag - L80

TABLE: vicon
1.2
MENU: PQuery/Report
FRAME: pquery
USAGE: user
FORM: pquery

<table>
<thead>
<tr>
<th>SELECT PRINTED REPORT</th>
</tr>
</thead>
<tbody>
<tr>
<td>scratch</td>
</tr>
<tr>
<td>periodic backups (db, wb, mb, gb)</td>
</tr>
<tr>
<td>individual backups (is, if, iu)</td>
</tr>
<tr>
<td>vendor</td>
</tr>
<tr>
<td>student</td>
</tr>
<tr>
<td>loaned</td>
</tr>
<tr>
<td>date to retire</td>
</tr>
<tr>
<td>dump</td>
</tr>
<tr>
<td>return</td>
</tr>
<tr>
<td>exit</td>
</tr>
</tbody>
</table>

SCRATCH PER IND VEN STU LOAN DATE DUMP RETURN EXIT:

PROCEDURE: pquery.osl

```plaintext
scratch = (callframe pscratch;)
per = (callframe pperiodic;)
ind = (callframe pindividual;)
ven = (callframe pvendor;)
stu = (callframe pstudent;)
loan = (callframe prloan;)
date = (callframe pdate;)
dump = (callframe pdump;)
return = (return;)
exit = (exit;)
```
1.2.1
MENU: Scratch
FRAME: pscratch
USAGE: report
FORM: pscratchf

ENTER SCRATCH REPORT PARAMETERS

min_length: 
max_length:

outputs to file: pscratch

HELP REPORT RETURN:

Field Attributes: Mandatory - max_length

REPORT: pscratch

11-SEP-1985
10:41:35

REPORT ON SCRATCH TAPES

Report on Table: vscratch

id  length  bpi  err  derr
(i5)  (i4)  (i5)  (i2)  (mm/dd/yr)

Report Definition: Sort by length, bpi, err, id
Select length by range at runtime
Output file - pscratch
command flag - L132

TABLE: vscratch
### 1.2.2

**Menu:** Periodic  
**Frame:** pperiodic  
**Usage:** report  
**Form:** pperf

---

**Enter Parameters for Periodic Backup Report**

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>type:</td>
<td>system:</td>
</tr>
<tr>
<td>min_dcreate:</td>
<td>max_dcreate:</td>
</tr>
<tr>
<td>part_disk:</td>
<td>sav_src:</td>
</tr>
</tbody>
</table>

Outputs to file: periodic  

---

**Help Report Return:**

**Field Attributes:**

- **Mandatory:** type, system, max_dcreate, part_disk, sav_src
- **Validation:** type = db, wb, mb, gb, *
  
System (Appendix C) * selects all  

**Report:** ppe

---

**11-SEP-1985 10:42:53**

**Report on Periodic Backup Tapes**

Report on Table: vpe

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>id: (i5)</td>
<td>type:</td>
</tr>
<tr>
<td>utility:</td>
<td>label:</td>
</tr>
<tr>
<td>dcreate: (mm/dd/yr)</td>
<td>bpi: (i5)</td>
</tr>
<tr>
<td>system:</td>
<td>err: (i2)</td>
</tr>
<tr>
<td>part_disk:</td>
<td>sav_src:</td>
</tr>
<tr>
<td>sequ: (f4.1)</td>
<td>descr:</td>
</tr>
</tbody>
</table>

**Report Definition:** Sort by type, dcreate, system, part_disk, sequ, sav_src  
Select type, system, part_disk, sav_src by value at runtime  
Select dcreate by range at runtime  
Output to file - pperiodic  
Command Flag - L132

**Table:** vpe
1.2.3
MENU: Individual
FRAME: pindividual
USAGE: report
FORM: pindf

ENTER INDIVIDUAL BACKUP REPORT PARAMETERS

<table>
<thead>
<tr>
<th>type:</th>
<th>owner:</th>
</tr>
</thead>
<tbody>
<tr>
<td>system:</td>
<td></td>
</tr>
<tr>
<td>part_disk:</td>
<td>sav_src:</td>
</tr>
<tr>
<td>outputs to file: pindividual</td>
<td></td>
</tr>
</tbody>
</table>

HELP REPORT RETURN:

Field Attributes: Mandatory - type, owner, system, part_disk, sav-src
(type = is, if, iu, or * only)

REPORT: pind

11-SEP-1985
REPORT ON INDIVIDUAL BACKUPS
Table is: vind

<table>
<thead>
<tr>
<th>type:</th>
<th>system:</th>
</tr>
</thead>
<tbody>
<tr>
<td>owner:</td>
<td>sequ: (f1.1)</td>
</tr>
<tr>
<td>dcreate: (mm/dd/yr)</td>
<td>id: (i5)</td>
</tr>
<tr>
<td></td>
<td>sav_src:</td>
</tr>
<tr>
<td></td>
<td>descr:</td>
</tr>
<tr>
<td>utility:</td>
<td>length: (i4)</td>
</tr>
<tr>
<td>label:</td>
<td>perusd: (i2)</td>
</tr>
<tr>
<td>bpi: (i5)</td>
<td>err: (i2)</td>
</tr>
</tbody>
</table>

Report Definition: Sort by type, owner, dcreate, system, sequ
Select type, owner, system, part_disk, sav_src by value
Output to file - pindividual
Command flag - L132

TABLE: vind

137
ENTER PARAMETERS FOR VENDOR REPORT
Table is: vven
software: vendor:
  system:
outputs to file: pvendor

HELP REPORT RETURN:

Field Attributes:
Mandatory - software, vendor, system
Validation- system (Appendix C) * selects all

REPORT: pvendor

11-SEP-1985 11:53:22
REPORT ON VENDOR TAPES
Report on Table: vven

software: system: part_disk: utility: err: (i2)
vendor: sequ: (f4.1) sav_src: label: advisor:
owner: id: (i5) descr: bpi: (i5) contph:

Report Definition: Sort by software, vendor, system,
  owner, sequ
Select software, vendor, system
  by value at runtime
Output to file - pvendor
Command flag - L132

TABLE: vven
ENTER PARAMETERS FOR STUDENT REPORT
Table is: vstudent

min_dcreate:  max_dcreate:
name:  system:

outputs to file: pstudent

HELP REPORT RUN

Field Attributes:
Mandatory - max_dcreate, name, system
Validation- system (Appendix C) * selects all

REPORT: pstud

11-SEP-1985 11:55:35
REPORT ON STUDENT TAPES
Report on Table: vstudent

dcreate: (mm/dd/yr)  name:  system:
id: (i5)  advisor:  part_disk:
sequ: (f4.1)  contph:  sav_src:
utility:  descr:
label:
bpi: (i5)

Report Definition: Sort by dcreate, name, system, part_disk, sequ, sav_src
Select dcreate by range at runtime
Select name, system by value at runtime
Output to file - pstudent
Command flag - L132

TABLE: vstud
1.2.6
MENU: Loaned
FRAME: prloan
USAGE: user
FORM: reploan

SELECT TYPE OF LOANED TAPES TO REPORT

scratch
backup or vendor
return
exit

SCRATCH BACK RETURN EXIT:

PROCEDURE: prloan.osl

scratch = {callframe plnscratch;}
back = {callframe ploan;}
return = {return;}
exit = {exit;}
1.2.6.1
MENU: Scratch
FRAME: plnscratch
USAGE: report
FORM: pinscratch

outputs to file: pinscratch

HELP REPORT RETURN:

REPORT: plnscratch

11-SEP-1985 11:08:19
REPORT ON LOANED SCRATCH TAPES
Report on Table: vsclloan

loanto: lcntph: edr: dloan: id: (i5)
(mm/dd/yr) (mm/dd/yr)

Report Definition: Sort by name, id, edr
Output to file - plnscratch
Command flag - L132

TABLE: vsclloan
1.2.6.2
MENU:  Backup or Vendor
FRAME:  ploan
USAGE:  report
FORM:  ploand

ENTER PARAMETERS FOR LOANED TAPES REPORT
Table is:  vloan

min_edr:  max_edr:
loanto:

outputs to file:  ploan

HELP REPORT RETURN:

Field Attributes: Mandatory - max_edr, loanto

REPORT:  ploan

11-SEP-1985  11:10:04
REPORT ON LOANED BACKUP AND VENDOR TAPES
Report on Table:  vloan

loanto:  edr: (mm/dd/yr)  dloan: (mm/dd/yr)
id: (i5)  lcntpl:
type:  owner:
software:  system:

Report Definition: Sort by name, edr, id
Select edr by range at runtime
Select loanto by value at runtime
Output to file - ploan
Command flag - L132

TABLE:  vloan

142
1.2.7
MENU: Date to Retire
FRAME: pdate
USAGE: report
FORM: pdatef

ENTER PARAMETERS FOR RETIREMENT DATE REPORT
Table is: vretire

min_dretire: max_dretire:
    type:
outputs to file: pretire

HELP REPORT RETURN:

Field Attributes: Mandatory - max_dretire, type

REPORT: pdate

11-SEP-1985  10:47:51
REPORT ON RETIREMENT DATES
Report on Table: vretire

dretire: (mm/dd/yr)  type:  dcreate: (mm/dd/yr)
id: (i5)
system: sequ: length: bpi: err:
    (f4.1) (i4) (i5) (12)

Report Definition: Sort by dretire, type, dcreate,
    system, sequ
Select dretire by range at runtime
Select type by value at runtime
Output to file - pretire
Command flag - L132

TABLE: vretire
SELECT TABLE FOR DUMP REPORT

tape
sets
file
student
loan
return
exit

TAPE SETS FILE STU LOAN RETURN EXIT:

PROCEDURE: pdump.osl

tape = (callframe tape;)
sets = (callframe sets;)
file = (callframe file;)
stu = (callframe student;)
loan = (callframe lcan;)
return = (return;)
extit = (exit;)

144
1.2.8.1
MENU: Tape
FRAME: tape
USAGE: report
FORM: tape

outputs to file: dtape

HELP REPORT RETURN:

REPORT: tape

11-SEP-1985 10:49:57
DUMP
Report on Table: tape

<table>
<thead>
<tr>
<th>id</th>
<th>length</th>
<th>bpi</th>
<th>err</th>
<th>derr (mm/dd/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>i5</td>
<td>i4</td>
<td>i5</td>
<td>i2</td>
<td>(mm/dd/yr)</td>
</tr>
</tbody>
</table>

Report Definition: Sort by id
Output to file - dtape
Command flag - L80

TABLE: tape

145
1.2.8.2
MENU: Sets
FRAME: sets
USAGE: report
FORM: sets

outputs to file: dsets

HELP REPORT RETURN:

REPORT: sets

11-SEP-1985
DUMP
Report on Table: sets

id: (i5) type: (c2) dcreate: (mm/dd/yr)
software: vendor:
descr:
dretire: (mm/dd/yr) system: utility:
owner: advisor:
label: perusd: (i2)
contph: sequ: (f4.1)

Report Definition: Sort by id
Output to file - dsets
Command flag - L132

TABLE: sets
1.2.8.3
MENU: File
FRAME: file
USAGE: report
FORM: file

outputs to file: dfile

HELP REPORT RETURN:

REPORT: file

11-SEP-1985
DUMP
Report on Table: file

    id      part_disk     sav_src
    (i5)                

Report Definition: Sort by id
Output to file - dfile
Command flag - L132

TABLE: file
1.2.8.4
MENU: Student
FRAME: student
USAGE: report
FORM: student

outputs to file: dstudent

HELP REPORT RETURN:

REPORT: student

11-SEP-1985                             10:51:51
DUMP
Report on Table: student

<table>
<thead>
<tr>
<th>id</th>
<th>name</th>
<th>advisor</th>
<th>contph</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i5)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Report Definition: Sort by id
Output to file - dstudent
Command flag - L80

TABLE: student
1.2.8.5
MENU: Loan
FRAME: loan
USAGE: report
FORM: loan

outputs to file: dloan

HELP REPORT RETURN:

REPORT: loan

11-SEP-1985 10:52:33
DUMP
Report on Table: loan

<table>
<thead>
<tr>
<th>id</th>
<th>dloan</th>
<th>edr</th>
<th>loanto</th>
<th>lcntph</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i5)</td>
<td>(mm/dd/yr)</td>
<td>(mm/dd/yr)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Report Definition: Sort by id
Output to file - dloan
Command flag - L132

TABLE: loan
1.3
MENU: Add
FRAME: tadd
USAGE: user
FORM: tadd

<table>
<thead>
<tr>
<th>SELECT ADD</th>
</tr>
</thead>
<tbody>
<tr>
<td>scratch</td>
</tr>
<tr>
<td>vendor</td>
</tr>
<tr>
<td>backup</td>
</tr>
<tr>
<td>files</td>
</tr>
<tr>
<td>students</td>
</tr>
<tr>
<td>loan</td>
</tr>
<tr>
<td>return</td>
</tr>
</tbody>
</table>

| SCRATCH VENDOR BACKUP FILES STUDENTS LOAN RETURN: |

PROCEDURE: tadd.osl

```
scratch = {callframe ascratch;}
vendor = {callframe avendor;}
backup = {callframe abackup;}
files = {callframe aafiles;}
students = {callframe astudents;}
loan = {callframe aloan;}
return = {return;}
```
1.3.1
MENU: Scratch
FRAME: ascratch
USAGE: user
FORM: anoscratch

ADD SCRATCH TAPES
Table is: tape

id: length: bpi:

select id; enter data, add

ID ADD RETURN:

Field Attributes:
Display only - id
Repeat values for - length, bpi
Mandatory - length, bpi
Validation - length, bpi (Appendix C)

PROCEDURE (1): ascratch.osl

id = [callproc sgetid;]
add = [callproc ascratchc;]
return = [return;]
1.3.1 (Continued)

PROCEDURE (2): sgetid.qc

sgetid()
[
## int low;
## int top;
## int new;

int i;

i=low=0;
## retrieve (low=min(tape.id where (tape.length=0 and
## (tape.bpi=0)))
## [  i=i+1;
## ]
## if (low!=0)
## [  putform anoscratch (id=low) *put the id on the form
##    message "OLD ID"
##    sleep 2
##    return;
## ] else *if no empth slots exist
## [  retrieve (top=max(tape.id))
##    [  i++;
##    ]
##    if (top>0)
##    [  new=1+top; *increment the max id
##      putform anoscratch
##      (id=new)
##      message "NEW ID"
##      sleep 2
##      return;
##    ]
## ]
]

TABLE: tape
1.3.1 (Continued)

PROCEDURE (3): ascratchc.qc

```c
ascratchc()
{
    ## int nu;
    ## int le;
    ## int b;
    ## int check;

    int i;

    i=check=0;
    ## getform anoscratch(nu=id, *get the values from the
    ## le=length, b=bpi) form
    if (nu==0)
    {
        ## message "Select ID before entering data"
        ## sleep 2
        return;
    }
    ## retrieve (check=tape.id) *find a record of an
    ## where tape.id=nu empty slot with the id
    ## number
    i++;
    ## if (check>0) *if an empty slot of the
    ## number exists
    else
    {
        ## replace tape
        ## (length=le, bpi=b)
        ## where tape.id=nu
        ## message "Added to old
        ## ID; label tape only"
        ## sleep 2
        ## putform anoscratch
        ## (id=0)
        return;
    }

    ## append to tape
    {
        ## id=nu,
        ## length=le,
        ## bpi=b
    }
}
```
1.3.1 (Concluded)

```awk
## message "Added to new
## ID, label slot and tape"
## sleep 2
## putform anoscratch *to prevent double entry
## (id=0)
```

TABLE: tape, sets
### ADD VENDOR TAPES

Tables are Tape and Sets

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>id</td>
<td>mandatory, unique</td>
</tr>
<tr>
<td>type</td>
<td>mandatory, choice</td>
</tr>
<tr>
<td>dcreate</td>
<td>mandatory</td>
</tr>
<tr>
<td>dretire</td>
<td>mandatory</td>
</tr>
<tr>
<td>system</td>
<td>mandatory</td>
</tr>
<tr>
<td>utility</td>
<td>mandatory</td>
</tr>
<tr>
<td>label</td>
<td>optional</td>
</tr>
<tr>
<td>bpi</td>
<td>optional</td>
</tr>
<tr>
<td>owner</td>
<td>optional</td>
</tr>
<tr>
<td>advisor</td>
<td>optional</td>
</tr>
<tr>
<td>contph</td>
<td>optional</td>
</tr>
<tr>
<td>software</td>
<td>optional</td>
</tr>
<tr>
<td>vendor</td>
<td>optional, unique</td>
</tr>
<tr>
<td>descr</td>
<td>optional</td>
</tr>
<tr>
<td>sequ</td>
<td>optional</td>
</tr>
</tbody>
</table>

Select id; enter data; add

### ID ADD RETURN:

**Field Attributes:**
- Display only - id, type
- Repeat values for all except id
- Mandatory - dcreate, dretire, system, utility, bpi, software, vendor
- Validation - system (Appendix C) * selects all,
  bpi (Appendix C)

### PROCEDURE (1): avendor.osl

```plaintext
id = (callproc vgetid;)
add = (callproc avendorc;)
return = (return;)
```
PROCEDURE (2): vgetid.qc

vgetid()
{
  int low;
  int top;
  int new;
  int i;

  i=low=0;
  retrieve (low=min(tape.id * retrieve an empty slot
  where (tape.length=0) and with the lowest id
  (tape.bpi=0)))
  {
    i=i+1;
  }
  if (low!=0)
  {
    putform advendor
    (id=low, type ="v")
    message "OLD ID"
    sleep 2
    return;
  }
  else
  {
    retrieve (top=max
    (tape.id))
    {
      i++;
    }
    if (top>0)
    {
      new=1+top;
      putform advendor
      (id=new, type="v")
      message "NEW ID"
      sleep 2
      return;
    }
  }
}

TABLE: tape, vendor
1.3.2 (Continued)

PROCEDURE (3): avendorc.qc

    avendorc.qc()
    {
    ## int nu;
    ## char ty[2];
    ## char da[26];
    ## char dr[26];
    ## char sy[9];
    ## char ut[6];
    ## char ow[9];
    ## char co[4];
    ## char so[15];
    ## char ve[20];
    ## char la[6];
    ## float se;
    ## int b;
    ## char de[15];
    ## char ad[9];
    ## int check;
    
    int i;
    
    ## getform advendor (nu=id, ty=type, da=dcreate, dr=dretire, sy=system, ut=utility, ow=owner, co=contph, so=software, ve=vendor, la=label, se=sequ, b=bpi, de=descr, ad=advisor)
    
    if (nu==0) {
        ## message "Select id before selecting add"
        ## sleep 2
        return;
    }
    
    i=check=0;
    
    ## retrieve (check=tape.id) where tape.id=nu
    ## [ i++;
    ## ]
    
    if(check > 0) {
        ## replace tape (bpi=b) where tape.id=nu
        
        *get the values from the form
        *if the user tried to enter data prior to getting an id
        *find a record of the empty slot with the id number
        *if an empth slot of the id number exists
        *update the record of the empty slot in the tape table

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1.3.2 (Concluded)

```plaintext
## append to sets(id=nu, type=ty, 
## dcreate=da, dretire=dr, 
## system=sy, utility=ut, owner=ow, 
## contph=co, software=so, vendor=ve, 
## label=la, sequ=se, descr=de, 
## advisor=ad)
## message "Added to old ID;
## label tape only"
## sleep 2
## putform advendor(id=0)
return;
}
else
    *if the id is not in the
    tape table
    
## append to tape(
##    id=nu, bpi=b
## )
## append to sets(id=nu, type=ty, 
## dcreate=da, dretire=dr, 
## system=sy, utility=ut, owner=ow, 
## contph=co, software=so, vendor=ve, 
## label=la, sequ=se, descr=de, 
## advisor=ad)
## message "Added to new ID;
## label slot and tape"
## sleep 2
## putform advendor(id=0)    *to prevent double entry
}
```

TABLE: tape, set
1.3.3
MENU: Backup
FRAME: abackup
USAGE: user
FORM: abackup

ADD BACKUP TO SCRATCH

periodic (db, wb, mb, gb)
individual (is, if, iu)
return

PERIODIC INDIVIDUAL RETURN:

PROCEDURE: abackup.osl

periodic = {callframe aperiodic;}
individual = {callframe aindividual;}
return = {return;}
1.3.3.1
MENU: Periodic (db, wb, mb, gb)
FRAME: aperiodic
USAGE: QBF-append
FORM: aperiod

ADD ID AND BACKUP DATA FOR EACH ID IN SET
Table is: sets

id: label: sequ:
type: dcreate: dretire:
system: utility:
descr:

APPEND #1 (CONTROL F TO ADD, <MENU KEY> TO RETURN:

Field Attributes:
Mandatory - id, type, dcreate, dretire,
        system, utility
Repeat values for - type, dcreate, dretire,
        system, utility, label, descr
Validation- Not id in sets
          Type in [db, wb, mb, gb]
        System (Appendix C) * selects all

TABLE: sets
1.3.3.2
MENU: Individual (is, if, iu)
FRAME: aindividual
USAGE: QBF-append
FORM: aindividual

ADD ID AND BACKUP DATA FOR EACH ID IN SET
Table is: sets

id:    label:    sequ:    perusrd:
type:    dcreate:    dretire:
system:    utility:
owner:    advisor:    contph:
descr:

APPEND #1 (CONTROL F TO ADD, <MENU KEY> TO RETURN)

Field Attributes:
Mandatory - id, type, dcreate, dretire, system, utility, owner
Repeat values for type, dcreate, system, utility, owner, advisor, contph, descr
System (Appendix C) * selects all
Validation- Not id in sets
Type in [is, if iu]

TABLE: sets
ADD FILE PATHS TO

new backups or vendor
old partial individual tape (and change perusd)
return
exit

NEW OLD RETURN EXIT:

PROCEDURE: aafiles.osl

new = {callframe afiles;}
old = {callframe adfold;}
return = {return;}
exit = {exit;}

1.3.4
MENU: Files
FRAME: aafiles
USAGE: user
FORM: aafiles
1.3.4.1
MENU: New Backups or Vendor
FRAME: afiles
USAGE: \texttt{\textbackslash l-append}
FORM: afiles

\begin{verbatim}
ADD FILE PATH
Table is: file

id: part_disk:
sav_src:

IF ONE FILE PATH HAS MORE THAN ONE ID, ADD ID AND FILE PATH FOR EACH ID. IF ID CONTAINS MORE THAN ONE FILE PATH, ADD ID AND FILE PATH FOR EACH FILE PATH.

APPEND #1 (CONTROL F TO ADD, \texttt{<MENU KEY> TO RETURN}).

Field Attributes:
Mandatory - id, part_disk, sav_src
\end{verbatim}

TABLE: file
1.3.4.2
MENU: Old Partial Individual
FRAME: aafold
USAGE: user
FORM: afold

ADD FILE PATH TO OLD PARTIAL INDIVIDUAL
Tables are: file and sets

id: part_disk: sav_src:

perusd:

enter data and select add

ADD RETURN EXIT:

Field Attributes: Mandatory - id, part_disk, sav_src

PROCEDURE (1): adfold.osl

add = {callproc afloldc;}
return = {return;}
exit = {exit;}

PROCEDURE (2): afoldc.qc

aflcldc()
[
## int nu;
## char pd[9];
## char ss[15];
## int pr;

## getform afofold (nu=id, pd=part_disk, ss=sav_src,
## pr=perusd)
if( nu == 0)
{
## message "You must enter an ID before selecting
## add"
    return;
}

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1.3.4.2 (Continued)

## append to file (id=nu, part_disk=pd, sav_src=ss)
## replace sets (perusd=pr)
##

TABLE: file, sets
ADD ID AND STUDENT DATA
FOR EACH ID THE STUDENT'S FILES ARE IN
Table is: student

id: name:
advisor: contph:

APPEND #1 (CONTROL F TO ADD, <MENU KEY> TO RETURN):

Field Attributes:
  Mandatory - id, name, advisor, contph
  id in sets
  Repeat values for name, advisor, contph

TABLE: student
ADD ID AND LOAN DATA FOR EACH ID LOANED
Table is: loan

id: dloan: edr:
loanto: lcntph:

APPEND #1 (CONTROL F TO ADD, <MENU KEY> TO RETURN)

Field Attributes: Mandatory - id, dloan, edr, loanto

TABLE: loan
1.4

MENU:  Update
FRAME: update
USAGE: user
FORM:  update

SELECT UPDATE

errors
backup
loan
return
exit

PROCEDURE: update.osl

errors = {callframe errors;}
backups = {callframe ubackup;}
loan = {callframe uloan;}
return = {return;}
extit = {exit;}

163
1.4.1
MENU: Errors
FRAME: error
USAGE: QBF-update
FORM: errors

UPDATE ERRORS
Table is: tape

id: 

err: 

derr:

ENTER QUERY (<MENU KEY> TO RETURN OR TO RUN):

Field Attributes: Mandatory - id

TABLE: tape
1.4.2
MENU: Backup
FRAME: ubackup
USAGE: QBF-update
FORM: ubackup

**UPDATE BACKUP OR VENDOR DATA**
Table is: sets

id: dcreate: dretire:
owner: advisor: contph:
descr: sequ:

ENTER QUERY (<MENU KEY> TO RETURN OR TO RUN):

Field Attributes: Mandatory - id

TABLE: sets
1.4.3
MENU: Loan
FRAME: uloan
USAGE: QBF-update
FORM: uloan

```
UPDATE LOAN DATA
Table is: loan

id:
edr:
loanto:
lcntph:

ENTER QUERY (<MENU KEY> TO RETURN OR TO RUN):

Field Attributes: Mandatory - id
```

TABLE: loan
1.5
MENU: Delete
FRAME: tdelete
USAGE: user
FORM: tdelete

DELETE

id:
loan record (return tapes)
backup (retire)
tape (permanently remove)
return
exit

PROCEDURE (1): tdelete.osl

loan = {callproc dloanc;}
backup = {callproc dbackc;}
tape = {callproc dtapec;}
return = {return;}
ext = {exit;}
1.5 (Continued)

PROCEDURE (2): dloanc.qc

\[
\begin{align*}
&\text{dloanc}() \\
&\text{[} \\
&\quad \#\text{ int } \text{nu}; \\
&\quad \#\text{ getform tdelete (nu=id)} \\
&\quad \#\text{ delete loan where loan.id = nu} \\
&\text{]}
\end{align*}
\]

TABLE: loan

PROCEDURE (3): dbackc.qc

\[
\begin{align*}
&\text{dbackc}() \\
&\text{[} \\
&\quad \#\text{ int } \text{nu}; \\
&\quad \#\text{ getform tdelete (nu=id)} \\
&\quad \#\text{ delete file where file.id = nu} \\
&\quad \#\text{ delete sets where sets.id = nu} \\
&\quad \#\text{ delete student where student.id = nu} \\
&\text{]}
\end{align*}
\]

TABLE: file, sets, student

PROCEDURE (4): dtapec.qc

\[
\begin{align*}
&\text{dtapec}() \\
&\text{[} \\
&\quad \#\text{ int } \text{nu}; \\
&\quad \#\text{ getform tdelete (nu=id)} \\
&\quad \#\text{ delete file where file.id = nu} \\
&\quad \#\text{ delete loan where loan.id = nu} \\
&\quad \#\text{ delete sets where sets.id = nu} \\
&\quad \#\text{ delete student where student.id = nu} \\
&\quad \#\text{ replace tape (length=0, bpi=0, derr=" ")} \\
&\quad \text{where tape.id = nu}
\end{align*}
\]

TAPE: file, loan, sets, student, tape
The tape library system (TLS) application for the Computer Science (CD) Department was created using the 4.2 BSD UNIX operating system and the Ingres VMUNIX Version 2.1/15 VE.04 DBMS. It was created under the name talibrary cs using login name crawfordb. It was developed using Ingres Applications by Forms (ABF). An executable image [Ref. 4] has been built in the file /work/crawford talibrary.exe topframe. It is defined with the symbol cslib.

A. LOADING

The current library may be loaded into the tables at this time. Chapters III and IV of this thesis should be read before loading the library data. Data may be loaded into each table from a file using the copy command. The Ingres Self Instruction Guide [Ref. 5, p. 8-1] provides a comprehensive explanation of the procedure. The following comments regarding the initial loading of data to file, or directly via the application will ensure the system operates as designed.

1. General

Ingres reads the value of an upper case letter differently than the value of a lower case letter. Many of the
reports are called by value. It is recommended that fields be reviewed prior to loading, and where applicable, values be standardized where validation criteria is not written into the application. Computer records may not be duplicated in the library.

2. Tables

a. TAPE. All tapes in the library must have at least an id number and either length or bpi. If both length and bpi are null, the application will report the id number as one of a scratch tape.

b. SETS. The table SETS fields—owner, software, and vendor—are the most vulnerable to inconsistent value entry. When a record is loaded into table SETS, a record of the same id must also be entered in table TAPE. The same id should never appear twice within SETS.

c. FILE. More than one record in table FILE may have the same id. If an id is included in TAPE, however, it must also be in SETS.

d. STUDENT. Student records are kept only for students whose files are contained in graduation backup tapes created for a graduating class. All of the graduated students' files should be recorded on the graduation backup tape. The id numbers refer to the graduation backup tapes on which their files are recorded. An id may appear more than once in the table STUDENT. All ids in the STUDENT table should be included in tables FILE, SETS, and TAPE.
e. **LOAN.** An id should not appear more than once in table **LOAN.** All id(s) in **LOAN** should appear at least in table **TAPE,** and may appear in table **SETS** and **FILE.**

**B. TABLE STORAGE STRUCTURE**

The storage structure of all tables is defined as a "heap". When the current library is loaded, the storage structure should be converted to "hash" to accelerate performance of queries. This may be done by the following procedure. (%UNIX,*Ingres)

* modify <tablename> to hash

%ingres talibrary


**C. ACCESS**

Only the librarians should have access to the library. To provide access, the library symbol "cslib" (no quotes) must be defined in the login files of each of the librarians. When the librarian retrieves a printed report from the library, it is written to their UNIX work spaces. Therefore the librarians need work spaces large enough to store all reports defined in the application. Reports are described in Chapter IV, Section G. Documentation regarding the provision of access to users is in Applications by Forms [Ref. 6, pp.5-3].
APPENDIX G

TUTORIAL:
OPERATION OF THE COMPUTER SCIENCE DEPARTMENT
TAPE LIBRARY SYSTEM (TLS)

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This Appendix describes the operation of the TLS. Before using the TLS, librarians must read Chapter III, Section B, Specification Data Dictionary; Chapter IV, Section B, Tables and Views; and Section C, Design Data Dictionary, of the thesis in order to understand the tables, data fields, and codes used in the application. Thorough descriptions and illustrations of the frames, forms, procedures, and reports are provided in Chapter IV, Section E, Frames; and Section G, Frames Definition. These should be referred to by frame number. Numbers are provided below.

This tutorial is in three parts. The first part describes the types of forms used in the library and their use. The second part describes the application and which tasks or functions the various frames perform. The third part describes procedures for the database administrator to maintain the library.

The TLS is a frame-based application. Each frame has a form and/or report and a procedure associated with it. The librarian communicates with the application by the use of forms. The application responds to the user by the use of forms and reports.

The user may perform the functions of add, update, delete and retrieve. Data input is standardized and controlled through validation criteria. Operations are selected through the use of menus. The structure of the library and forms match the functions the librarian performs.
A. FORMS

There are six types of forms associated with frames in the library:

(1) Menu,
(2) Parameter Entry for Reports,
(3) Run Report Forms,
(4) Append,
(5) QBF-update, and
(6) Delete.

Each form has an operations menu at the bottom starting at the left hand corner. Many of the operation menus include the operations RETURN and/or EXIT. By selecting RETURN, the form of the previous frame will be displayed. EXIT will terminate the application and return to UNIX. To execute an operation, the user must enter a unique letter, or set of letters, which represent the operation to the right of the menu. For example, if the command menu is:

SCRATCH STUD RETURN EXIT:

enter sc to select SCRATCH or enter r to select RETURN. Depress <ESC> to execute the operation. Operations are executed on all forms by using this procedure. The term "select" hereafter will be defined to mean "type" the representative command symbol, then depress <ESC>.

When using forms which include fields for data input, the cursor must be moved from field to field. It will move to the next field automatically if the number of characters or integers of the value entered fills the field. If it does
not, however, the cursor can be moved to the next field by depressing the TAB key. To move it back to the previous field, depress control P.

1. **Menu Forms**

Menu forms provide movement to other frames. They contain the list of other frames on the upper portion and a matching list on the command menu line. A menu form is shown in Figure 11.

```
SELECT FUNCTION

 t query/report (terminal)
p query/report (printer
add
update
delete
exit

 T P ADL UPDATE DELETE EXIT:
```

*Figure 11. Menu Form*
When the menu form is displayed, the cursor will always appear to the right of the operations menu. To move to another frame, select the frame desired. The new form will be displayed.

Frames 1, 1.1, 1.1.6, 1.2, 1.2.6, 1.2.8, 1.3, 1.3.3, 1.3.4, and 1.4 display menu forms.

2. Parameter Entry (for reports) Forms

Parameter Entry Forms call reports based on values or ranges entered by the user. The forms contain fields in the upper portion and a command menu at the bottom. A parameter entry form is shown in Figure 12.

<table>
<thead>
<tr>
<th>ENTER PARAMETERS FOR PERIODIC BACKUP REPORT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table is: vpe</td>
</tr>
<tr>
<td>type:</td>
</tr>
<tr>
<td>min_dcreate:</td>
</tr>
<tr>
<td>part_disk:</td>
</tr>
<tr>
<td>system:</td>
</tr>
<tr>
<td>max_dcreate:</td>
</tr>
<tr>
<td>sav_src:</td>
</tr>
</tbody>
</table>

HELP REPORT RETURN:

Figure 12. Parameter Entry Form
"Range" fields always include the prefix min_ or max_. Those that do not are "value" fields. Input to value fields is mandatory. If a report is desired of all values of the value field, an "*" may be entered. Only the max_ range field is mandatory. If all range values are desired, do not enter a value in the min_ range field and enter the largest value allowed in the max_ range field. Parameter Entry Forms always include the operations HELP, REPORT, and END. HELP will provide assistance to the user, REPORT will run the report, and END returns to the previous frame. When a Parameter Entry Form is first displayed, the cursor is always on the first field.

HELP may be selected at any time during parameter entry. The form will be redisplayed intact after HELP has been obtained. Select REPORT to run the report after ranges and values have been entered. Select END to return to the previous frame without running the report.

Frames 1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.6.2, 1.1.7, 1.2.1, 1.2.2, 1.2.3, 1.2.4, 1.2.5, 1.2.6.2, and 1.2.7, display Parameter Entry Forms.

3. Run Report Forms

Run Report Forms are used to run reports. No selection of values is available to the user. A Run Report Form is shown in Figure 13.
The upper portion is either blank or displays a line informing the user to which file the report will be written. The command menu line is the same as report parameter entry forms.

Frames 1.1.6.1, 1.2.6.1, 1.2.8.1, 1.2.8.2, 1.2.8.3, 1.2.8.4, and 1.2.8.5 display Run Report Forms.

4. **Append Forms**

Append forms allow the user to append new records to the library. They display fields on the upper portion for data entry and a command menu line at the bottom. Append is simple; there are three variations of Append Forms.

a. The first type of Append Form provides programmed id assignment, and is shown in Figure 14.

This type of form is associated with a procedure which automatically assigns an id number and perhaps another value to the form. The fields which are automatically assigned are for display only. The cursor will always appear
ADD SCRATCH TAPES
Table is: tape

id: length: bpi:
select id; enter data, add
ID ADD RETURN:

Figure 14. Append Form (Programmed id Assignment)

on the first field in which data may be entered when the form is initially displayed. Before entering new data, the id number must be assigned. The command line at the bottom displays operations ID, ADD, and RETURN.

To get an id assigned, first move the cursor to the command line by depressing <ESC>, then enter i RETURN. An id and perhaps other data will be assigned. Relevant notes regarding the labelling of cabinet spaces and/or tapes will be displayed next to the command line for two seconds. If the display says OLD ID, it means the cabinet space has been previously labelled, and the space is empty. Therefore, only the tape need be labelled. If the display states NEW ID, no spaces were empty and a new id has been added to the library. Both the space and the tape must be labelled.

After the id is obtained, the cursor will appear in the first field in which data may be entered. To add the
data, move the cursor to the command menu line and select ADD. After the append has been completed the form will be redisplayed. All fields will contain the old values except id. A new record may be entered which has all the same values, except id, by simply selecting ID, then ADD, or a new record may be entered by selecting ID and typing over the displayed values, then select ADD. When all new records have been added, select RETURN to display the previous frame.

Frames which display programmed id assignment forms are 1.3.1 and 1.3.2.

b. Another type of append frame is the programmed append, shown in Figure 15.

```
ADD FILE PATH TO OLD PARTIAL INDIVIDUAL
Tables are: file and sets

id:                      part_disk:       sav_src:

perusd:

enter data and select add

ADD RETURN EXIT:
```

Figure 15. Append Form (Programmed Append)
In the upper portion, the form displays fields into which data may be entered. It displays the command menu ADD, RETURN, and EXIT at the bottom. When the form is initially displayed, the cursor will always appear on id. To add new records, simply enter new data and select ADD.

Frame 1.3.4.2 displays a programmed append form. The third type of append form is a QBF-append. The initial display of a QBF-append form is shown below in Figure 16.

```
ADD ID AND LOAN DATA FOR EACH ID LOANED
Table is: loan

id:              dloan:         edr:
loanto:          lcntph:

APPEND #1 (CONTROL F TO ADD, <MENU KEY> TO RETURN)
```

Figure 16. QBF-append Form

To add data, fill in all the data fields displayed in the upper portion and depress control F; the cursor does not need to be on the command menu line. After the new record has been entered the following form (Figure 17) will be displayed.
ADD ID AND LOAN DATA FOR EACH ID LOANED
Table is: loan

id:    dloan:    edr:
loanto:  lcntph:

APPEND #2 (CONTROL F TO ADD, <MENU KEY> TO RETURN)

Figure 17. QBF-append Form

In some forms, some of the fields will retain the previous values. If the previous value is not displayed, it may be recalled by putting the cursor in the field and depressing control a. This will be especially helpful if you cannot remember the number of the last id entered. To add another record, simply change the appropriate values and enter control f. If you do not desire to add more records, depress the menu key <ESC> and the form shown in Figure 18 will be displayed.

HELP provides information regarding QBF. ADD allows you to continue adding data. If END is selected, the previous form will be displayed. Frames which display QBF-append forms are 1.3.3.1, 1.3.3.2, 1.3.4.1, 1.3.5, and 1.3.6. More detailed information regarding QBF-append frames is provided in the Ingres QBF Users Guide [Ref. 6].
5. **Update Forms**

Update forms are used to change values of records previously entered in the library. The update function consists of two states, the QUERY state and the GO state. While in the QUERY state, you may specify a query by filling in the form with the values of the records you are searching for. After filling in this form, QBF enters the GO state, retrieves the row(s) you asked for, and allows you to update each row, one by one. The changes are stored in a temporary buffer, as you move from row to row. After changing all the rows, you can write out the buffer containing the changes to the table. After you update the table, you are returned to the QUERY state to execute a new query. You can leave the QUERY or GO states at any time, either to execute another query or to return to the main menu of the operation system.
QBF-update frames display the form shown in Figure 19 when selected.

```
<table>
<thead>
<tr>
<th>TABLE</th>
<th>Field</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>loan</td>
<td>id</td>
<td>edr</td>
<td></td>
</tr>
<tr>
<td></td>
<td>loanto</td>
<td>lcntph</td>
<td></td>
</tr>
</tbody>
</table>
```

ENTER QUERY (<MENU KEY> TO RETURN OR TO RUN):

Figure 19. Update Form (Query State)

This is the QUERY state. Fill in the value or values of the records you wish to retrieve. For the TLS, you will usually call records for update by id. You may use comparison operators when specifying a query. These are:

- `>` greater than
- `<` less than
- `=` equal to
- `>=` greater than or equal to
- `<=` less than or equal to
- `!=` not equal to

While in the QUERY state, QBF does not check fields to make sure they contain valid data. This is done when you enter the CO state to run the query.

The QUERY state has a menu for running queries, restarting the query, and setting...
help. To call the menu, depress the <ESC> key. The menu appears at the bottom of the screen.

HELP QUERY GO END <command>

You may call the menu at any time; it does not affect your data. If the menu was accidently called, depress RETURN to return to your form. To exit UPDATE, select the END command and you will be returned to the previous frame. If you select QUERY, QBF clears all the fields on your form so that you can enter a new query. All data on the old form is lost. If you select GO the query is run. QBF enters the GO state.

QBF will now display the following form (Figure 20) with the values of the record(s) you requested. You can now edit the rows you have just asked for by typing the new data over the old.

```
UPDATE LOAN DATA
Table is: loan

id: 1                  edr: 9/28/85
loanto: crawford     lcntph: 032-

```

Figure 20. Update Form (GO State)
If no rows which satisfy the query are found, QBF displays the message - NO ROWS FOUND - and returns to the QUERY state so you may enter a new query.

If you wish to go to the next row specified by your query, depress the control F key. If no rows are left, NO MORE ROWS LEFT IN QUERY, is displayed.

At this point you have three options: (1) write your changes to the table; (2) start a new query; or (3) exit UPDATE, using the GO state menu.

Your changes are stored in a buffer each time you depress the control f key. These changes do not change the table in the library until you issue the WRITE command in the GO state menu.

To enter the GO state, depress the <ESC> key. The following menu will be displayed: HELP QUERY WRITE DELETE END. You may call this menu at any time. It does not affect your data. To exit without writing your changes, select END. You will be returned to the previous frame. If you want to begin your query again, select QUERY. The changes made will be erased from the buffer and the QUERY form will be displayed. The DELETE key deletes the current row displayed on the screen. There is no reason to use this key in the library.

To write the changes you have made to the row(s), select the WRITE operation. If you have made changes to data and do not select the WRITE operation, the following menu
is displayed: DO YOU WANT TO LEAVE UPDATE WITHOUT WRITING CHANGES? Enter y for yes and n for no.

Further information about UPDATE is provided in the Ingres QBF User's Guide [Ref. 6]. QBF UPDATE frames are 1.4.1, 1.4.2, and 1.4.3.

6. Delete Form

The Delete Form (Figure 21), is used to delete records.

```
DELET E

id:
loan record (return tapes)
backup (retire)
tape (permanently remove)
return
exit
```

LOAN BACKUP TAPE RETURN EXIT

Figure 21. Delete Form

On the upper portion, a field for id and a list of operations to be performed on the id number is displayed.
The command menu repeats the operations listed on the upper portion. Additionally, RETURN calls the previous frame; EXIT exits the application.

To use the delete frame, enter the id number of the tape on which the delete operation is to be performed. Move the cursor to the command menu and select the delete operation desired. The delete occurs immediately.

Frame 1.5 displays a delete form.

B. THE TLS APPLICATION

Each of the librarians has been granted access to the library. It may be called from UNIX by entering (% is the UNIX prompt): % cslib

The first TLS frame will display a form on the screen. The name of the frame is Topframe and is number 1 in Appendix D. Topframe is the main menu of the application. It displays the major operations performed in the library:

(1) TQuery/Report - print a report to the terminal
(2) PQuery/Report - print a report to the librarian's UNIX workspace.
(3) Add - add new records
(4) Update - correct incorrect values
(5) Delete - delete records
1. **TQuery/Report (1.1)**

If TQuery/Report is selected, a choice of the following reports is displayed on the terminal:

- **Scratch (1.1.1)** - for scratch tapes available.
- **Periodic (1.1.2)** - for aperiodic backups stored in the library (daily backup (db), weekly backup (wb), monthly backup (mb), or graduation backup (gb)).
- **Individual (1.1.3)** - backups belonging to individual staff (is), faculty (if), or students (iu) (before they graduate).
- **Vendor (1.1.4)** - vendor (v) tapes, no matter to whom they belong.
- **Student (1.1.5)** - graduated students and the tapes on which their accounts are logged.
- **Loaned (1.1.6)** - a choice of Loaned Scratch Tapes (1.1.6.1) or Loaned Backup or Vendor Tapes (1.1.6.2) (Date to Retire (1.1.7) tapes by retirement date).

2. **PQuery/Report (1.1.2)**

If PQuery/Report is selected, a choice of the same reports as in TQuery/Report, and one additional report is displayed. The additional report frame available is DUMP.

- **Dump (1.2.8)** - Dump provides a choice of five reports. They are each a "dump" of one of the five tables: Tape (1.2.8.1), Sets (1.2.8.2), File (1.2.8.3), Student (1.2.8.4), and Loan (1.2.8.5). They contain all of the fields in the tables and are sorted by id number.

The reports selected by the PQuery/Report frame will be written to your UNIX workspace file. The name of the file is displayed on the terminal. The file may then be printed by using UNIX.
3. **Add** (1.3)

Add should be selected whenever you desire to add any new records to the library. Add provides a choice of adding the following:

- **Scratch** (1.3.1) - to add new scratch tapes
- **Vendor** (1.3.2) - to add vendor tapes
- **Backup** (1.3.3) - to be used when a backup has been read to a scratch tape. Backup provides a choice to add:
  - Periodic backups (1.3.3.1) (type db, wb, mb, gb) or
  - Individual backups (1.3.3.2) (type is, if, iu)
- **Files** (1.3.4) - is to be used to record the file paths which have been read to each tape. A choice of situations is provided:
  - New Backup or Vendor (1.3.4.1) - This frame will be used to add file paths at all times except the following
  - Old Partial Individual (1.3.4.2) - This frame will be used only when an individual has requested a file path be read to tape and the librarian selects one of the individual's old partially used tapes to perform the read. The new file path should be recorded using the id of the old tape.

4. **Update** (1.4)

Update should be selected whenever you desire to change values which have been previously entered in the library. Update provides three choices for the changes:

- **Errors** (1.4.1) - After a tape is read or written, the utility may indicate that the number of tape errors is different than those recorded in the library. Use Errors to update the number of errors and the date the new errors are entered.
Backup (1.4.2) - Backup enables updates to the following fields concerning backup or vendor tape records:

- dcreate
- dretire
- owner
- advisor
- contph
- descr
- sequ

Loan (1.4.3) - Loan allows you to change fields edr, loanto, and lcntph.

5. **Delete (1.5)** - Delete is the only frame which should be used to delete records from the library. The operations available are:

- Loan - Use when a loaned tape is returned. This operation deletes the record of the loan.

- Backup - Use when a backup tape is retired or erased, but the tape is retained to be used as a scratch. All records of the backup are deleted from the library. The data regarding the physical characteristics and condition of the tape are retained. The tape keeps its id number, and must be left in its cabinet space.

- Tape - When a tape is permanently disposed. All records of the tape are deleted from the library. Only the id number of the cabinet space is retained and the TLS will define the id number as an empty slot. The tape must be removed from the cabinet space, and the id number must be removed from the tape. The cabinet space retains the id number.

C. MAINTENANCE PROCEDURES

As discussed in Chapter IV, Section J, the database administrator will be required to perform tasks to maintain peak performance, integrity, and the security of the database. The following is recommended.
1. **Peak Performance**

On a monthly basis, run a system modification on each table in the database. This may be done by entering the following at the UNIX operating system level (% UNIX):

```
% sysmod talibrary
% sysmod talibrary tape sets file student loan
```

2. **Integrity**

Only the librarians should be granted permits to affect the TLS tables. Destroy and define permits to tables as personnel are relieved of their librarian duties and new personnel are assigned. The procedure for granting and destroying permits is provided in Appendix F, Section D.

3. **Security**

Only librarians should have access to the library. Access is made available by defining the TLS login symbol in the login files of new librarians. The login sign should be deleted from the login files of personnel relieved of librarian duties. The procedure for providing and denying access is discussed in Appendix F, Section C.
REFERENCES


Chen, P., The Entity-Relationship Model—Toward a Unified View of Data, ACM Transactions on Database Systems, Volume 1, No. 1, March 1976


Orr, K., Structured Systems Development, Yourdon Press, 1977


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