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FOREST RESOURCE INFORMATION SYSTEM

Phase III Quarterly Report

for the period

1 July 1979 to 30 September 1979

Prepared for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Johnson Space Center
Earth Observations Division
Houston, Texas 77058

Contract: NAS 9-15325
Technical Monitor: R. E. Joosten/SF5

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16. Abstract

This report covers the second quarter of the fifteen-month System Transfer Phase of the Forest Resource Information System Application Pilot Test. The principal Activities during this quarter revolved around transferring software systems, and training St. Regis staff in Landsat analysis procedures.

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INDEX

FRIS PROJECT OVERVIEW

The Forest Resource Information System Project (FRIS) is a cooperative effort between the National Aeronautics and Space Administration (NASA) and St. Regis Paper Co. (STR). Purdue University's Laboratory for Applications of Remote Sensing (LARS), under contract to NASA, will supply technical support to the project.

FRIS is an Application Pilot Test (APT) Project funded by NASA. The project is interdisciplinary in nature involving expertise from both the public and private sectors. FRIS also represents the first APT to involve a large broad base forest industry (STR) in a cooperative with the government and the academic communities.

Purpose

The goal of FRIS is to demonstrate the feasibility of using computer-aided analysis techniques applied of Landsat Multispectral Scanner Data to broaden and improve the existing STR forest data base, thereby creating the foundation of a dynamic information system. The successful demonstration of this technology during the first half of the project will lead to the establishment by STR of an independently controlled operational forest resource information system in which Landsat data is expected to make a significant contribution. FRIS can be viewed by the user community as a model of NASA's involvement in practical application and effective use of space technology. Additionally, FRIS will serve to demonstrate the capability of Landsat MSS data and machine-assisted analysis technology to private industry by:

- Determining economic potentials,
- Providing visibility and documentation, and

- The ability to provide timely information and thus serve management needs.

The ultimate long term successfulness of FRIS can be measured through future development of remote sensing technology within the forest products industry.

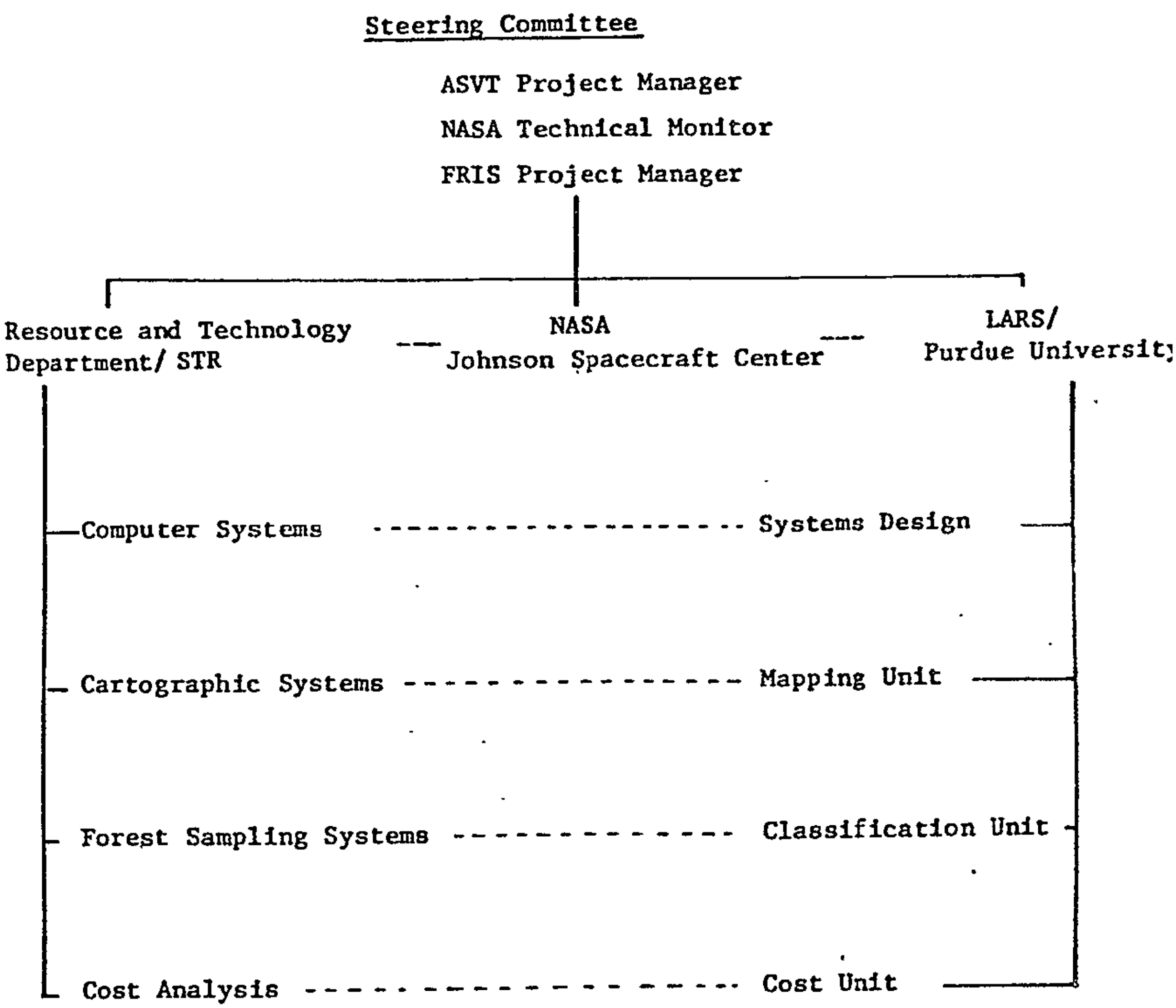
Scope

FRIS is funded as a modular or Phase project with an anticipated duration of three years. The original project concepts were developed in 1973, and a formal project plan was submitted to NASA by STR in 1976. The project officially began in October 1977 after the signing of a cooperative agreement between NASA and STR; and after the compeltion of contractual arrangements with Purdue University.

Organization

The organization of FRIS is depicted in the chart that follows. Since FRIS is a cooperative involving three independent agencies, a steering committee consisting of a project manager from each institution was formed to provide for overall guidance and coordination. Operationally, both STR and LARS have project managers and project staff to insure for the timely completion of acitivities within the project. The NASA technical coordinator monitors project activities and provides a liaison between the STR and LARS staffs. The solid lines on the chart indicate the flow of management responsibility. The dash lines reflect the technical and scientific inter-changes between operating units.

FRIS Organization



1.0 INTRODUCTION

The material appearing in this report is a reflection of the FRIS Project Staff activities for the period 1 July 1979 to 30 September 1979. This time frame encompasses the second quarterly reporting period for Phase III of the Forest Resource Information System Application Pilot Test (APT). Phase III of FRIS is directed at meeting the overall Project goal:

> To document and transfer remote sensing technology developed throughout the project that will provide St. Regis with an independent operational system, having Landsat data as a significant and viable contributor.

Phase III specifically addresses the transfer of software that will become the nucleus of the FRIS image processing subsystem.

The first quarter of Phase III was heavily involved in planning and preparation. During the second quarter the planning developed into action and significant strides were made toward reaching the Project goal. Noteworthy activities that occurred during this quarter are summarized below.

- o Terminal users workshop was conducted at Jacksonville.
- o Remote terminal user manual draft was prepared.
- o Image processing subsystem specifications were defined.
- o Preliminary transfer of image processing software was accomplished.
- o Application test was initiated.
- o Landsat 3 data was received, preprocessed and is being evaluated.

The remaining sections of this report will describe these activities in more complete detail.

2.0 TASK AREA ACTIVITIES

2.1 Technology Transfer Task

An important component of the entire System Transfer Phase involves training of St. Regis staff in the application of the remote sensing technology. The focal point of this training is a remote terminal to the LARS computer facility. Ther terminal is central to the training concept because it provides an opportunity for St. Regis staff in Jacksonville to access the Landsat digital data and classify it with the LARSYS software. This software will form the foundation of the FRIS image processing subsystem. The terminal also provides a focal point for training workshops to be held in Jacksonville, rather than at LARS. The in-house workshops do more than educate. They also convey the stability of the technology and committment to the concept by management. Thereby they form the first phase of the orderly transition of the technology for academia to industry.

Remote terminal hardware and the Jacksonville-West Lafayette communications capability was in-place and functional at the beginning of Phase III in April, 1979. In-house training plans were developed during the first quarter of Phase III. A preliminary training session was conducted during June in Jacksonville. This was followed by more specific "hands-on" training in utilization of the terminal capability in July.

As part of the July training an interim user handbook was developed. In addition to this handbook other standard LARSYS documentation was also made available at Jacksonville. A copy of the interim user document appears in Appendix A.

This document is considered as an interim manual since it defines LARSYS operations in a virtual machine environment. Final FRIS user documentation will be directed at user operations in a batch environment. Work in developing this draft documentation will begin when LARSYS has been installed and is useable at the St. Regis computer center.

Updated timelines for this activity appear in Exhibit 1 in Appendix B.

2.2 System Transfer Task

The System TRansfer activity is dedicated to the physical transfer, implementation, and testing of software to St. Regis. The software being transferred relates specifically to those routines required to prepare the Landsat digital data for analysis and those routines used to classify and display the data. These comprise respectfully the Preprocessing software and the LARSYS software. These elements will form FIPS the FRIS Image Processing Subsystem.

A subgroup of the Preliminary System Design Committee, which was created during Phase II, is responsible for the software transfer and installation task. The subgroup is comprised of personnel from both St. Regis and LARS. This group met in mid-July to outline the plan for transfer and installation of software. Highlights of their plan are presented below:

- o LARSYS ver 3.1 and LARSYSDV will be the foundation for the FRIS image processing subsystem.
- o LARS data preparation software will be the nucleus of the FRIS preprocessing software.
- o Software will be installed at the St. Regis Nation Computer Center in Dallas, Texas.
- o The software will operate in batch mode on either an IBM 3030 or 370/168 computer.
- o User interface will be provided via ROSCOE.
- o The Landsat CCT data and permanent intermediate files will be maintained on tape.
- o Temporary files will be kept on disk.

A listing of the LARSYS, LARSYSDV and preprocessing software that will be transferred appears in Appendix C. Responsibility for implementation of this software on the St. Regis computer will rest with St. Regis personnel. LARS staff will provide program tapes, listings and documentation for this software. They will also act as consultants during the software installation, providing assistance as needed.

As an aid to LARS staff during the system implementation activity a remote terminal link to NCC will be supported by St. Regis. The terminal, an IBM 3275, will operate under ROSCOE protocol, thereby allowing LARS to emulate a St. Regis remote site. Computer output will be acquired through a Data 100 printer. The printer will operate as a remote job entry terminal and be connected to NCC via a dial-up modem. Support for the RJE station will be provided through the FRIS contract.

The System Design Team plans to have the remote hardware to NCC functional at LARS sometime in November. Once the hardware is operational a ROSCOE training session will be held at LARS to train FRIS personnel. At the completion of these activities, which closely coincide with the initial installation of software at NCC, the system transfer activities can proceed.

The LARS/NCC terminal connection will be used to:

- Assist St. Regis staff debug the NCC installation of LARSYS and LARSYSDV.
- Suggest program updates or modifications to St. Regis staff based on ROSCOE remote batch operations on a NCC computer.
- Develop user documentation for batch Preprocessing and LARSYS operations initiated from a remote terminal via ROSCOE.
- Develop user training sessions for St. Regis analysts in the use of the St. Regis/LARSYS software.
- Develop analyst aids.

Remote terminal operations between LARS and Jacksonville will be maintained during this period to provide for continuing analyst training of St. Regis staff. When the preprocessing and LARSYS software has been tested and is "operational" at NCC the LARS/JAX terminal link will be disconnected.

Updated timelines and milestones for the System Transfer tasks appear in Exhibits 2 and 3 in Appendix B.

2.3 Applications Test

In mid-July the APT Manager requested that the project staff assess the feasibility of undertaking an operational test of the technology. Specifically, we were asked to provide classification of a tract of land in Baker County, Florida (figure 1) that St. Regis had recently acquired.

The new acquisition, here after referred to as the Knabb Tract, encompasses approximately 40,000 acres of land and is ecologically similar to the Fargo test site. St. Regis staff were of the opinion that the timber removals had been extensive in recent years. Furthermore, they felt that removals were especially extensive since 1977.

The application test was designed to address the feasibility of uisng Landsat classified data to:

1) Evaluate the areal extent of the standing timber resource, from 1979 data, and
2) determine the change in standing timber that was detected by Landsat that occurred between 1977 and 1979.

Our goal was to meet these objectives and to provide classification results by 1 November 1979. Timing was an important criteria to this application test because if the data could not be:

- o Acquired
- o Preprocessed
- o Classified, and
- o Final products available

by the deadline, than the timeliness of the technology would be seriously questioned. In November the window for photographic data collection opens, and this tract will be flown. If we are not able to provide Landsat information by the time the photography is collected and interpreted than the utility of Landsat will be seriously questioned.

Since the Knabb Tract is geographically close to the Fargo Test Site, it is therefore included on the same Landsat scene. The latest Landsat data available to the project was December, 1977. However,

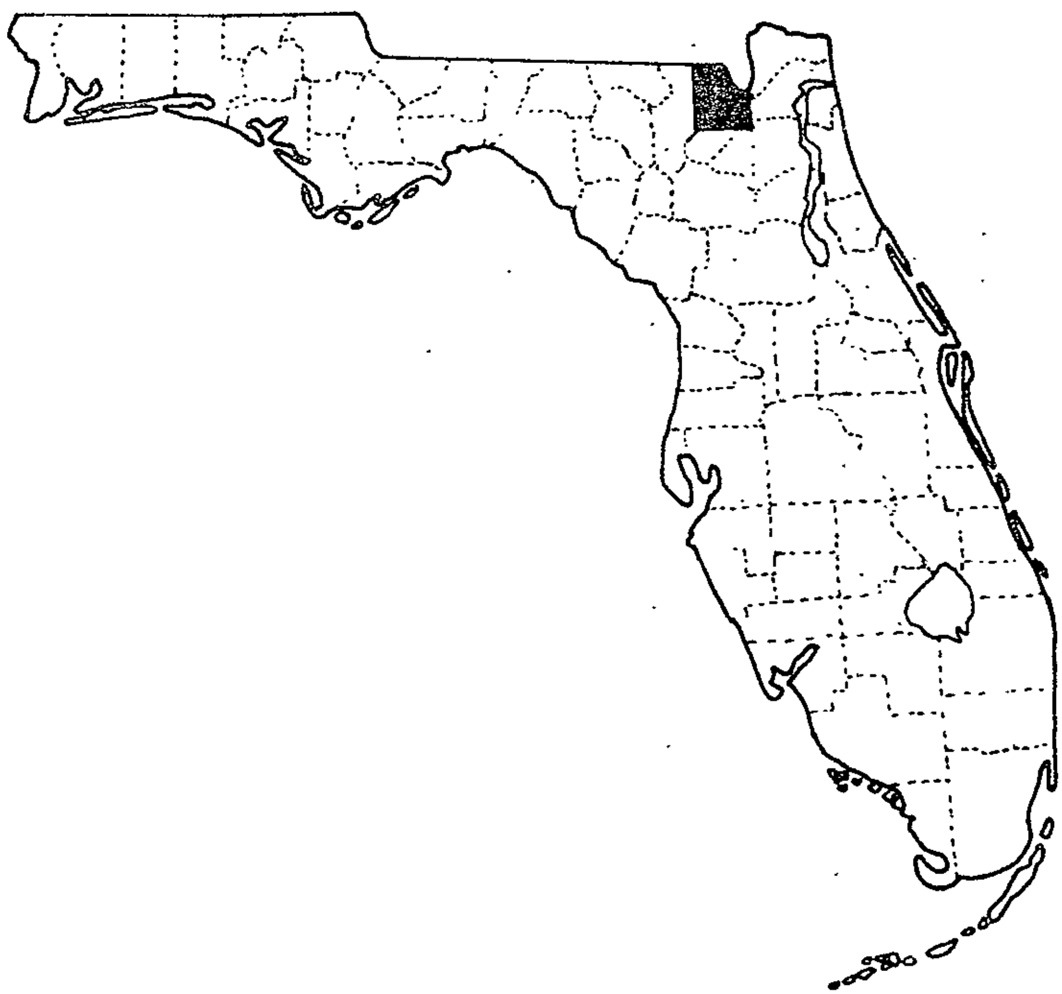


Figure 1. Location of Baker County, Florida and the Knabb Tract Application Test Site.

inadvertently during reformatting part of the raw data, the part which included the Knabb tract, was destroyed.

A search was requested from the EROS Data Center to identify a suitable set in the early 1979 time frame. Due to a ground system modification, EDC was only able to provide data collected after February 1, 1979. A February 12, 1979 data set was selected for the second date. Both the December 1977 and February 1979 data sets were ordered in early August.

In addition to the MSS data we were anxious to evaluate Landsat 3 RBV imagery for possible application. Unfortunately, the RBV data handling capability at both GSFC and EDC is not operational. Errors by EDC in image quality assessment made a January set of images unuseable. Replacement data was provided but the data collection date was too early. The idea of using the RBV data to provide a "quick-look" capability was abandoned.

The MSS data ordered in early August was received by mid-August. This rapid turn around provided by EDC was a tight requirement if the deadlines were to be met. The rapid turn around was a pleasant surprise, since data acquisition from EDC had been upwards of six months.

The data was in two formats. The December 1977 tape was the old Landsat format. The February 1979 data was in the new Landsat 3 format. This did not pose any problems in preparing the image overlay. The February data was expanded to fit the December data and the combined sets registered to the ownership channel. The only problem encountered with the February data is that it appears to be excessively noisey. Figure 2 is an example of the December data for Baker County, Florida. Figure 3 shows the same data set with the ownership boundary channel overlay.

During the latter half of August, personnel from St. Regis Southern Timberlands was at LARS to prepare the ownership boundary channel for the Knabb tract. Ownership boundaries were digitized, edited, connected, and check points located in the data within a one week time frame. In

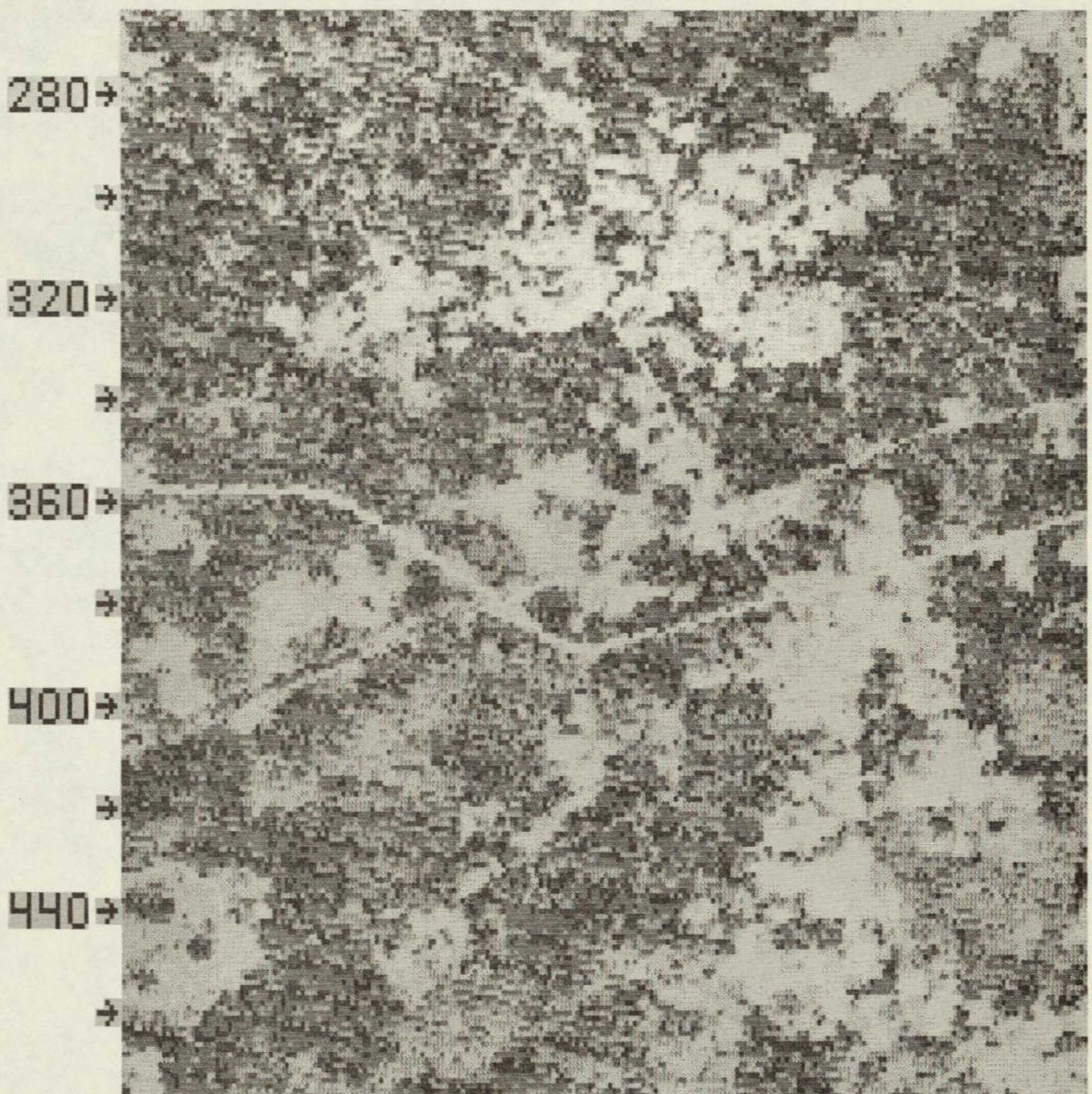


Figure 2 is an electrostatic printer greyscale output from Band 6 of the 1977 Landsat data of a portion of Baker County which includes the Knabb Tract.

ORIGINAL PAGE IS OF POOR QUALITY

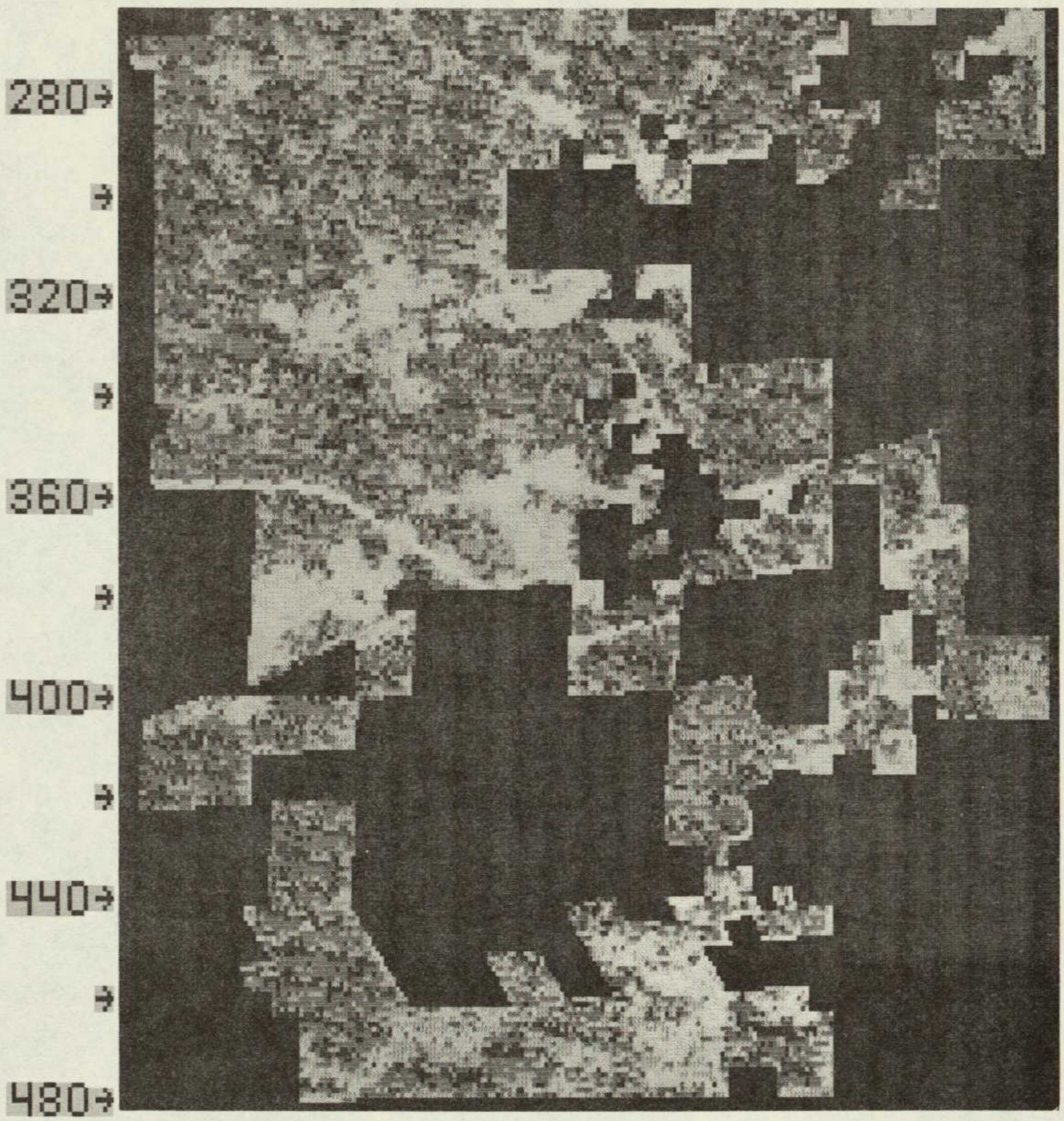


Figure 3 shows the same data as figure 2 except that the Knabb Tract ownership boundaries have been included.

short, everything necessary to create the final data set up to but not including the data set registrations was completed by the end of August.

The Knabb classifications would involve testing the feasibility to extend Fargo training statistics. Supplemental training would be added were appropriate. Preliminary classification would be quickly field checked before final products were prepared. The classification activity began as soon as data had been reformatted and coarsely corrected and before the final set was ready for classification.

To date this application test is closely tracking internal project timelines. We anticipate a site visit in early October and production of final products in early November. A detailed report of results will be included in the next Quarterly Progress report.

2.4 Management

The management activity oversees day-to-day project operations and is responsible for all technical and fiscal project reports. Status of these activities are shown in Exhibit 4, Appendix B.

In addition to the management function, special studies including the Cost Evaluation and the Knabb Applications Test are monitored from this task. The major emphasis of the Cost Evaluation activity has been on the part of the St. Regis Staff and is being monitored by the APT Manager. Generally, this acitivity has revolved about the development of cost proposals for the FRIS hardware and software systems. Project Staff have provided consultation and input regarding system configuration and cost where these inputs were appropriate.

Special projects, like the Knabb Application Test which is reported on in Section 2.3 are also monitored in this task. Special projects involve either a test of the technology, as in the Knabb situation, or the development of improvements. The ratio classification scheme is an example of an improvement to the utility of Landsat MSS data.

The concept behind the ratio classification approach involves using the IR to visible ratio as an index to pine development. The ratio is calculated by simply dividing the sum of the response in the infrared bands by the sum of the response in the visible bands. The resulting dimensionless number is then related to the age of the pine operating area, information which is available from the inventory data. The ratio of reflectance values is not directly related to the age of the pine stands but rather is an index of site occupancy, which is exhibited by crown closure. As the pines mature, their crowns occupy more of a given site. As the crowns be in to dominate the site the infrared reflectance of that site increases, as does the ratio value. Therefore, indirectly the ratio value relates to age or maturity level. This appears to be especially true for managed pine plantations.

We propose to utilize the ratio value in a regression estimation equation to estimate the age range of pine. To date we have applied this technique and the results have been very encouraging. The R^2 value for age prediction in Fargo was .88 . We are proposing to use this technique on the Knabb tract to see if we can improve upon the per point Lnadsat classification.

Another project we have embarked on involves the evaluation of Landsat 3 data. The new Landsat 3 data is provided by EDC to the user in a geometrically corrected but non-rotated format. The availability of geometrically corrected data has the potential to save the user both time and computer resources since this step may be eliminated from the preprocessing sequence. However, this data is not rotated and therefore not corrected for north orientation. Since one of the uses of the Landsat data in FRIS will be to provide updated maps, the rotation of the data is an important consideration.

The test we are proposing involves classifying the Landsat 3 data in the geometrically corrected but unrotated format. The raster classification results would then be converted to vector format. This classification would be rotated in vector form and the appropriate transformations performed to overlay and register the Landsat results to the ownership boundary. Maps and tabular results produced from the combination of the two files would be assessed to determin if this product meets the FRIS requirements for cartographic output.

Using this approach all the preprocessing activities with the exception of Landsat data tape reformatting would be eliminated. Only the reformatting, image processing and possibly the raster to vector conversion would be performed on the mainframe. The remaining activities could be accomplished on a mini-computer with suitable geo-referencing software. Savings would occur primarily in the reduction of time necessary to prepare the data. Two important assumptions are necessary to enable this approach to work:

1) The Landsat rotation and overlay can be suitable performed on a mini-computer, and
2) EDC will operationally be capable of providing geometrically corrected data.

In order to address the first assumption we will contact the Harvard Computer Graphics Laboratory for assistance in conducting the rotation and overlay test. A Landsat 3 data set from the Picayune Test Site, figure 4, will be classified and sent to Harvard along with the digitized ownership boundaries. Output products from Harvard's ODYSSEY software will be evaluated to assess the suitability of this approach.

Only time will allow us to evaluate the assumption that EDC will be able to provide geometrically corrected Landsat data on an operational basis. Recent literature from EDC indicates this capability will be in place by 1 February 1980.

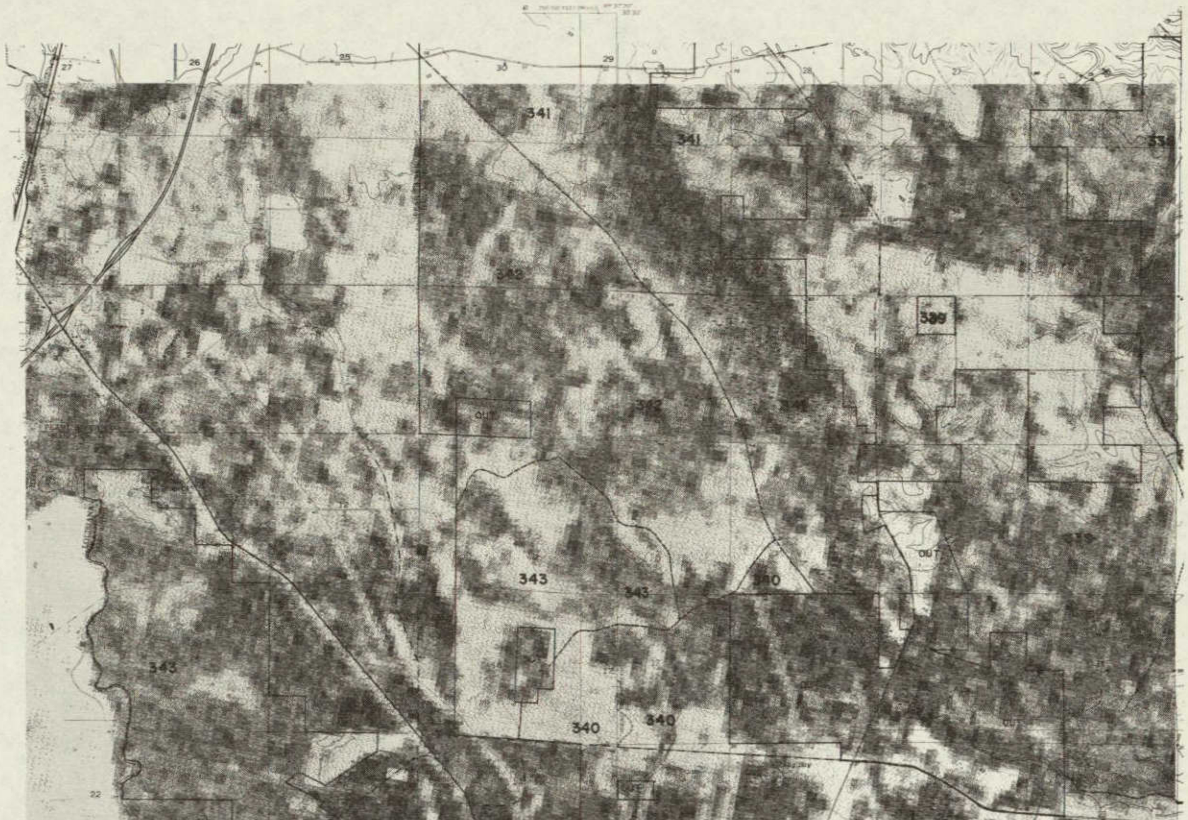


Figure 4. Landsat 3, geometrically corrected data from the Picayune, Mississippi test site has been overlaid with photographically reduced ownership maps to indicate the visual correlation of this new data type.

Appendix A

The document that follows was prepared by LARS staff as an interim users manual for the Jacksonville remote terminal operations. The purpose of this manual was to provide reference concerning LARSYS operations to St. Regis staff involved in image processing.

A document similar in format and content will be prepared for LARSYS operations through the St. Regis National Computer Center in Dallas. This interim manual will be a model for that document.

15

Interim Draft Classification Documentation

A BEGINNING GUIDE TO OPERATING LARSYS

July 1979

Developed for

St. Regis Paper Company
Southern Timberlands Division
Jacksonville, Florida

by

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Prepared for

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TABLE OF CONTENTS

INTRODUCTION

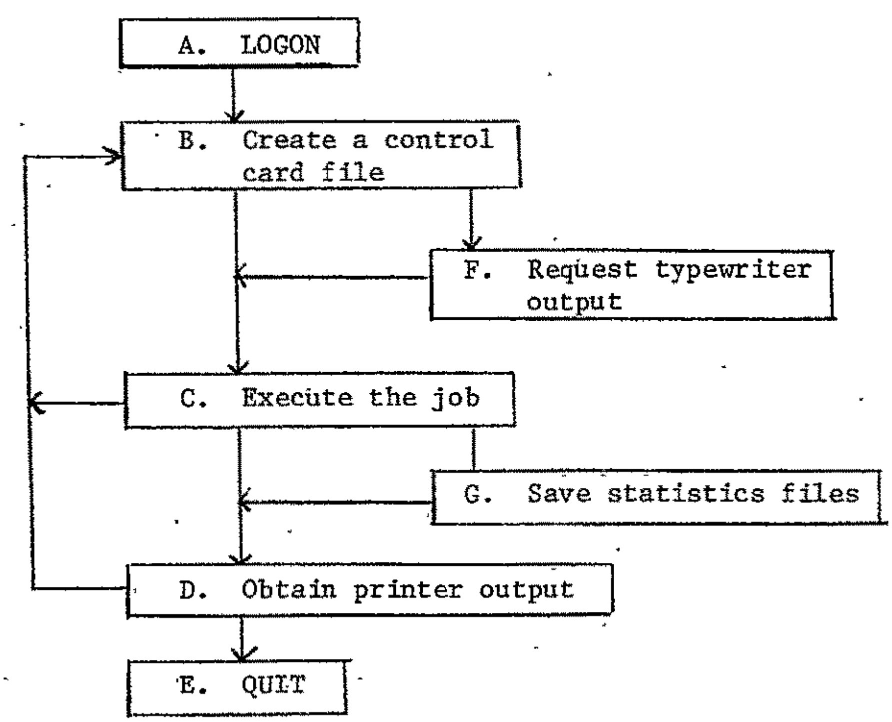
This guide is intended to serve as a handy reference for new (or infrequent) users of the LARSYS software available at Purdue/LARS, and has been divided into two sections. The first section describes the sequence of commands required to access the Purdue/LARS computer, create input files for the LARSYS processors, execute the LARSYS job and receive printer output. Section II briefly discusses the LARSYS processors used in an analysis sequence, with examples of setting up the control card files and executing the jobs.

Before using this guide, the new LARSYS user should witness a demonstration of the terminal equipment, the procedure for accessing the Purdue/LARS computer and the steps involved in executing a LARSYS function. This person should also know who is available at his location to answer questions and assist with unexpected problems.

The new analyst should also have some background in remote sensing, such as is presented in the monthly LARS Short Course on "Numerical Analysis of Remote Sensing Data" or minimally, by reading the LARS Information Note 110474, "An Introduction to Quantitative Remote Sensing."

This may be followed by an overview of the LARSYS processors and their capabilities. Brief descriptions can be found in the "LARSYS User's Manual," Volume 1; Sections 1, and 2.1 through 2.4. More detailed descriptions of each processor are located in Volume 2 of the "LARSYS User's Manual" and may be reviewed as the processor is used in the analysis sequence.

The general steps required to access the Purdue/LARS computer and execute a LARSYS processor are flowcharted below. The letters refer to the part in Section I where that step is discussed, not the required sequence.



Section I

Procedures for Accessing LARSYS

A. LOGON AND INITIATE THE LARSYS SYSTEM

In order to access the LARSYS system, it is necessary to have a computer ID and a password. If you do not know what computer ID you are to use, check with ________________. The initial procedure for accessing the computer at Purdue/LARS from a typewriter terminal is called "logging-on" which is illustrated below. Before logging on locate the Attention(ATTN) or Break (BRK or BREAK) key on your terminal. Pressing this key signals to the computer you are ready to gain access to the system. Also locate the RETURN (or CR) key, which you will press each time you have completed typing a line. The command "i lsdv370" initiates the LARSYS system.

Lines to be entered by the user are outlined with boxes. The > means the keyboard is unlocked and waiting for user input.

```
VM/370 ONLINE  <------------  (Press BREAK key)
!
[>logon jax]   <------------  (Substitute your ID for 'jax')
ENTER PASSWORD:
[>XXXXXXXX]
ENTER NAME:[>schwingendorf]
LOGMSG - 08:37:18 EST MONDAY 07/09/79
* YOUR OPERATORS THIS MORNING ARE ROSS AIKEN AND GREG RICHARDSON
LOGON AT 09:48:54 EST MONDAY 07/09/79
[>i lsdv370]
DEVELOPMENTAL LARSYS READY:
  SYSTEM IS BEING INITIALIZED...

... LARSYS IS READY FOR YOUR FIRST COMMAND
T=0.40/1.07 09:49:48
```

At this point (after a message beginning with "T=" and a ">") the system will accept any of the LARSYS commands listed in the reference file listing at the back of this notebook. We will discuss the ones you will use most often.

Note: <u>Character delete</u> - If you happen to make a typing error, you can type the @ to "erase" the previous character(s)

e.g. i lad@@sdv370

would be interpreted by the computer as

i lsdv370

<u>Line delete</u> - If you need to "erase" an entire line, use the [and the computer will ignore what you have already typed on that line.

<u>CP begin</u> - If the letters CP are typed unexpectedly, you will need to type "begin". This can happen if you try to type a command before the ">" appears or if there is noise on the line.

B. PREPARE CONTROL CARD FILES

To use LARSYS, a person must first decide which LARSYS processor is to be executed, and then create a control card file containing the necessary information for that processor. To help the user know what to put into a control card file, LARSYS maintains lists or menus (called REFERENCE Files) of all the possible control parameters for each processor. A composite list of all processors, including initialization functions and control commands, also exists. For your convenience the list has been printed and included in this notebook. These control card files are "shown" to the LARSYS software system on cards, from disk files, or interactively from a typewriter terminal. In these examples, we will make use of disk files.

Associated with your computer ID is a private disk area on which you can store one or more files of information, such as control card files. Before discussing the usual processors used in an analysis project, we will look at how you can enter a control card file onto your disk storage area. You will repeat this process for each LARSYS processor you run.

A typical sequence, then, might be as follows: 1) determine the desired function, such as wanting to produce a grayscale map, 2) from experience or by reviewing the function of each processor in the "LARSYS User's Manual", determine the processor that can perform the desired function, (for example PICTUREPRINT will produce a grayscale map), 3) by reviewing the control card list (provided at the back of the notebook) for the selected processor, write out the keywords and control parameters necessary to execute the processor, and 4) enter the keywords and control parameters into a disk file. Now let's look at how to obtain and enter parameters into a control card file.

GET

Having completed the steps from Section I for logging-on, we select the LARSYS processor IDPRINT, to execute. This processor produces a one-page listing of identification information for your data. Use the GET command and the first three letters of the processor's name, (in this case IDP) to obtain a skeleton control file for IDPRINT.

```
>get idp
THE FILE -- IDP CC -- HAS BEEN COPIED TO YOUR PRIVATE DISK.
IT'S CONTENTS ARE:

-RUNTABLE
DATA
RUN(XX), TAPE(YY), FILE(ZZ)
END
*IDPRINT
PRINT RUN(XX)
END

EDIT:
```

(A file has two names - only the first was needed for the GET command. See Note at end of this section.)

EDIT As you can see from the above messages, the file named IDP CC is copied onto your disk storage area, its contents are typed, and your computer ID enters the Edit environment. This means that you can enter a variety of Edit commands which will add, change or delete lines from this control card file.

In order to make changes to the file, the user must move to the line to be changed. Four Edit commands help you position yourself in the file. These are:

TOP	*(point to the Top of the file)*
BOTTOM	*(point to the last line of the file)*
UP n	*(move up 'n' lines in the file)*
NEXT n	*(move down 'n' lines in the file)*

TOP points you to the place before the first line of the file, BOTTOM moves the pointer to the last line of the file and UP and NEXT move the pointer one or more lines within the file. When Edit is first entered, you are at the spot just before the first line of the file. If you type NEXT you will be at the first line of the file. Note that the computer types out the line you are on.

```
>next
-RUNTABLE
>next 2
RUN(XX), TAPE(YY), FILE(ZZ)
>up 2
-RUNTABLE
```

Now let's look at some commands to make changes to the file. Four commands you can use are:

DELETE n	*(delete 'n' lines from the file)*
CHANGE .XXX.YYY.	*(Change the letters 'XXX' to the letters 'YYY' in current line)*
REPLACE 'new line'	*(replace current line with 'new line')*
INPUT 'new line'	*(insert 'new line' after the current line)*

One other command, TYPE allows us to verify which line we are on.

TYPE	*(type the current line of the file)*

Remember that we are currently at the first line of the file, which is the line -RUNTABLE. We decide that the first four lines of the file are not needed and type DELETE 4. Using the TYPE command reassures us we are no longer at the line -RUNTABLE (because it was removed from the file) and are at the new first line of the file, *IDPRINT.

```
>delete 4
>type
*IDPRINT
```

We proceed to the next line of the file and use the CHANGE command to supply a run number in place of 'XX'.

```
>next
PRINT RUN(XX)
>change .xx.76020106.
PRINT RUN(76020106)
```

We decide to input a comment line at the beginning (TOP) of the file using the INPUT command. (TOF stands for Top Of File)

```
>top
TOF:
>input  -comment test comment line
```

To replace this entire line with a new comment, the REPLACE command can be used.

```
>replace -comment print id record for fargo data
```

Now we can check the contents of the file by going back to the top and typing all the lines.

```
>top
TOF:
>type 10
TOF:
-COMMENT PRINT ID RECORD FOR FARGO DATA
*IDPRINT
PRINT RUN(76020106)
END
EOF:
```

When the Edit session has been completed there are two Edit commands for returning to LARSYS. They are FILE and QUIT.

FILE	*(save the current file on disk)*
FILE 'name'	*(save the current file on disk with the new name 'name')*
QUIT	*(don't save the changes made during the current Edit session)*

To save our IDPRINT control card file, we can type

```
>file
T=0.50/4.79 10:09:18
```

and the file IDP CC will be stored on our computer ID with all the changes which have been made. This completes the Edit session and returns us to the LARSYS Environment. If we wanted to make further changes to this same file in the future the EDIT command should be used instead of the GET command. The format of this command is:

EDIT name1 name2

```
>edit idp cc
        (Issue any Edit commands to make changes desired)
>file
T=0.10/0.45 11:06:40
```

Note on disk files: All files which you store on your private disk have two names which identify the file to the computer. (In the above example the file was IDP CC). You must remember this name for later commands. It is generally easier to remember the names if you establish a naming pattern (such as always making the second name of a control card file CC or DECK, and making the first name an abbreviation of the analysis area location or processor name). The names may consist of up to 8 alphanumeric characters.

A QUICK REFERENCE TO EDIT COMMANDS

Edit name1 name2	
Bottom	*(move to the last line of the file)*
Change /string1/string2/	*(change 'string1' to 'string2' in this line, where a string is a sequence of characters.)*
DELete n	*(delete 'n' lines from the file, starting with the current line. If 'n' is omitted, the current line is deleted.)*
Getfile name1 name2	*(insert the file 'name1 name2' after the current line)*
Input new-line	*(insert line 'new-line' after the current line)*
Next n	*(move down 'n' lines in the file. If 'n' is omitted, move to the next line.)*
Replace new-line	*(replace the current line with 'new-line')*
TOP	*(move to the top of the file)*
Type n	*(type 'n' lines, starting with the current line. If 'n' is omitted the current line is typed.)*
Up n	*(move up 'n' lines in the file. If 'n' is omitted, move up 1 line.)*
FILE	*(store the current file, with all changes made, on the private disk and return to LARSYS)*
QUIT	*(stop editting the current file without storing changes which have been made)*

Note: Once you are familiar with the Edit commands, it is usually faster to use the abbreviations for the commands. These are indicated above by the letters which are capitalized and underlined. Hence, the abbreviation for 'delete' is 'del' and the abbreviation for 'next' is 'n

C. EXECUTE THE LARSYS JOB

To run a LARSYS job, the control cards must be passed to the computer by reading them into a card reader or by telling the computer which disk file contains the needed control cards, using the CCINPUT command. The format of the CCINPUT command is

CCINPUT

CCINPUT name1 name2

```
>ccinput idp cc
T=0.11/0.60 10:09:32
```

You must know both names of your control card file, in this case IDP CC. In case you have forgotten the name(s) of your control card file(s), you may get a list of file names with the LISTFILE command.

```
>listfile * cc
```

This indicates you want to list all files on your private disk with a second name of "cc". If you have forgotten the contents of a file, use the TYPE command, supplying the two names of the file.

```
>type idp cc
```

Here, the contents of the file IDP CC will be typed.

RUN Next type:

```
>run
EXECUTION BEGINS...
 I0065  IDPRINT FUNCTION HAS BEEN REQUESTED.  (RUNSUP)
 I0114  IDPRINT FUNCTION COMPLETED.  (RUNSUP)
 I0103  CPU TIME USED WAS    6.148 SECONDS.  (LARSMN)

 I0004  END OF INPUT DECK - RUN COMPLETED  (LARSMN)
 I0050  TOTAL CPU TIME FOR THIS RUN WAS  6.288 SECONDS.  (LARSMN)
PRT FILE 6458 TO RSCS          COPY 01 NOHOLD
T=2.06/10.17  10:10:25
```

Notice that LARSYS prints a series of informational messages indicating when the function begins processing and ends. A print file is created as normal output from a LARSYS processor and procedures for obtaining the printer output from your site can be found in the next section.

You have now completed the general sequence for running a LARSYS job. The next step is to review your printer output and decide if you need to run any more LARSYS jobs. If so, go back to Section B, and create a new control card file. Then, using the name of this new file, enter the CCINPUT command and the RUN command. When you have executed the last LARSYS processor, proceed to Section E.

Note on halting execution: To terminate a job which is executing, press the BREAK key (computer types 'CP'), and type 'i lsdv370' to re-initiate the system.

D. OBTAIN PRINTER OUTPUT AT JACKSONVILLE

The steps for receiving printer output from LARS are as follows:

1. On the DECWRITER terminal type:

   m cp please start stregis

   (or call LARS computer room and ask them to check whether STREGIS is STARTED. Call: 317-749-2052 and ask for computer operator)

2. Flip the LARS/DALLAS switch to position A

Move to the IBM 3776 terminal for the following steps:

3. Flip the reset switch on the IBM 3776

4. Enter "local mode" (press "code" and "start job")

5. To get 8 Lines Per Inch (LPI), press "code" and "K"

6. Press: "start job", "s", "3", "0", "EOM"
   (NPR should display 320)

7. Put the SIGNON card in the reader and press START

8. Receive print files.

9. After all print files have been received, put the DRAIN card in the card reader, press START, and then flip the LARS/DALLAS switch back to B.

E. TERMINATE THE LARSYS SESSION

QUIT When you have completed your work for the current terminal session, the QUIT command is used to let the computer know you are finished.

```
>quit
YOU TYPED QUIT.  DO YOU NEED TO RETURN TO LARSYS TO SAVE ANY
STATISTICS OR HISTOGRAM FILES?
>no
CONNECT= 00:16:38 VIRTCPU= 000:17.75 TOTCPU= 000:33.58
LOGOFF AT 10:05:34 EST MONDAY 07/09/79
```

F. EXECUTE A LARSYS JOB, RECEIVING OUTPUT AT THE TYPEWRITER TERMINAL

PRINT If for some reason you would like to receive the printer output from a LARSYS job at your typewriter terminal, then there is a new LARSYS command to use called PRINT TYPEWRITER. Its format is:

PRINT TYPEWRITER linewidth

where "linewidth" is the number of characters which can be printed across your terminal. For the Decwriter terminal, use 120. This command must be entered shortly before the RUN command. For example, if a control card file called JAXPRI CC had been created, the following command sequence would execute the job and return the output for printing on the Decwriter.

```
>print typewriter 120
T=0.09/0.27 10:17:41
>ccinput jaxpri cc
T=0.11/0.20 10:19:22
>run
EXECUTION BEGINS...
 I0102  COMMENT - CLASSIFICATION RESULTS FROM RUN 76020106
 I0113  PRINTRESULTS FUNCTION REQUESTED   (PRISUP)

 I0071  PRINTRESULTS FUNCTION COMPLETED   (PRISUP)
 I0103  CPU TIME USED WAS  19.651 SECONDS.   (LARSMN)

 I0004  END OF INPUT DECK - RUN COMPLETED   (LARSMN)
 I0050  TOTAL CPU TIME FOR THIS RUN WAS  19.725 SECONDS.  (LARSMN)
TAPE 181 DETACHED
T=13.47/21.90 10:23:03
```

OUTPUT After the job completes execution, the print file is stored on a temporary disk file while you decide whether to print it out or run another LARSYS job. If you are ready to print the output, use the OUTPUT START command:

```
>output start
EXECUTION BEGINS...          (printer output is typed)
```

Warning: Do not try to print large outputs (such as all 4 channels in PICTUREPRINT) on the typewriter terminal, as it could take hours to print.

PRINT To shift the output from the typewriter to the printer, then use the command:

PRINT 'location'

to specify where the output should go.

```
>print stregis
T=0.09/0.27 10:35:01
>ccinput newprint cc
T=0.12/0.30 10:37:23
>run
EXECUTION BEGINS...
```

Note: The print location stays in effect for all jobs executed, until it is changed by another PRINT command.

G. SAVE STATISTICS FILES

One important data file which LARSYS creates and later uses as input to other processors is called the LARSYS Statistics File. When you execute a LARSYS processor which creates a Statistics File, it is important to save it on your computer ID's private disk storage after the job has finished executing. To do this, use the STATDECK command:

```
>statdeck save "name"
```

You should supply a name for the Statistics File which is meaningful to you. If you forget what names you have already assigned, use the command:

```
>statdeck status
```

to get a listing of all of your saved Statistics Files. Later, when you want to execute a LARSYS processor which requires the input of a Statistics File, use the command:

```
>statdeck use "name"
```

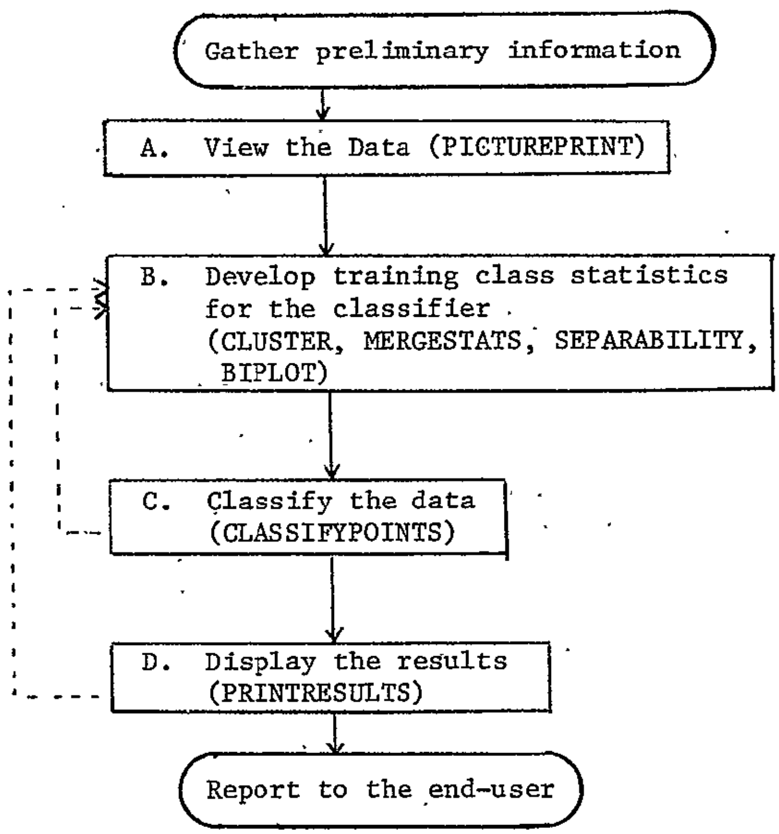
before typing the RUN command. Examples of these commands may be seen in the next section.

Section II

An Example LARSYS Analysis Sequence

Before beginning an analysis of remotely sensed data, you should be familiar with the names and general functions of the LARSYS processors, have a computer ID and password, know what data you will be analyzing, and collect the "ground truth" (any information you can get on the ground cover for parts of your analysis area, such as maps, photos, statistical reports, etc.) you will use. The digital data used by LARSYS is identified to the computer by a run number, which you should be informed of when the data is entered into the LARS Data Library. For the examples on the following pages the run number assigned to the data was 76020204. This data is over an area south-east of Columbus, Georgia.

The typical analysis sequence has been illustrated below.



A. OBTAIN A GRAYSCALE MAP OF THE DATA

PICTUREPRINT

The first step in the LARSYS Analysis sequence is to get a pictorial representation of the data to check data quality and geographically orient yourself in the data. The PICTUREPRINT function in LARSYS reads data from the LARSYS Multispectral Image Storage tape and produces alphanumeric pictorial printouts of the data for each channel that is specified. In this example maps of channels 2 and 4 (one visible and one infrared channel) will be printed. (Note: It is not a good idea to receive the output from PICTUREPRINT at the typewriter terminal unless you are looking at one channel of a small area.)

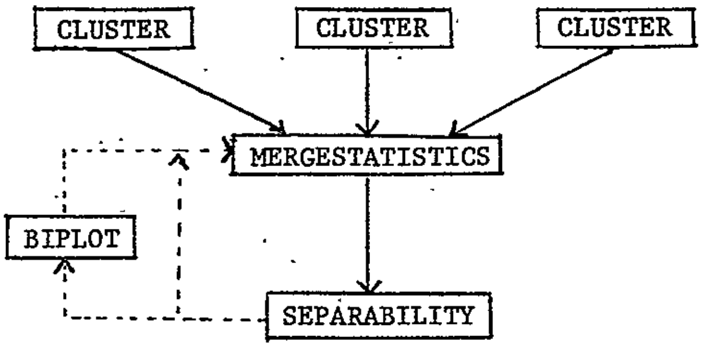
You should now turn to the control card reference page for PICTUREPRINT and write down the control cards you will need to use, checking the example which follows if necessary.

```
VM/370 ONLINE
!
>l stregis                                          (Logon procedure)
ENTER PASSWORD:
>XXXXXXXX
ENTER NAME: bud goodrick
LOGMSG - 08:01:17 EST TUESDAY 07/10/79
* YOUR OPERATOR THIS MORNING IS CINDY....
LOGON AT 08:44:35 EST TUESDAY 07/10/79
>i lsdv370
DEVELOPMENTAL LARSYS READY:
   SYSTEM IS BEING INITIALIZED....

... LARSYS IS READY FOR YOUR FIRST COMMAND
T=0.42/4.17 08:47:29
>get pic
THE FILE -- PIC CC -- IS READY TO BE EDITTED.
IT'S CONTENTS ARE:

-RUNTABLE
DATA                                                (Create the control
RUN(XX), TAPE(YY), FILE(ZZ)                          card file)
END
-COMMENT GRAYSCALE MAP OF RUN XX
*PICTUREPRINT
DISPLAY  RUN(XX), LINES(A,B,C), COL(I,J,K)
CHANNELS 2,4
BLOCK    RUN(XX), LINES(A,B,C), COL(I,J,K)
END

EDIT:
>next
-RUNTABLE
>delete 4
>type
-COMMENT GRAYSCALE MAP OF RUN XX
>change /xx/76020204/ * <----------------  (Note: the * causes this
-COMMENT GRAYSCALE MAP OF RUN 76020204        change to be made in
                                              every line)
```

```
DISPLAY  RUN(76020204), LINES(A,B,C), COL(I,J,K)
BLOCK    RUN(76020204), LINES(A,B,C), COL(I,J,K)
EOF:
>top
TOF:
>next
-COMMENT GRAYSCALE MAP OF RUN 76020204
>change /4/4 columbus, georgia test site/
-COMMENT GRAYSCALE MAP OF RUN 76020204 COLUMBUS, GEORGIA TEST SITE
>next 2
DISPLAY  RUN(76020204), LINES(A,B,C), COL(I,J,K)
>change /a,b,c/60,120,1  *
DISPLAY RUN(76020204), LINES(60,120,1), COL(I,J,K)
BLOCK  RUN(76020204), LINES(60,120,1), COL(I,J,K)
EOF:
>up
END
>up 3
DISPLAY RUN(76020204), LINES(60,120,1), COL(I,J,K)
>c /i,j,k/335,475,1/ *
DISPLAY RUN (76020204), LINES(60,120,1), COL(335,475,1)
BLOCK  RUN(76020204), LINES(60,120,1), COL(335,475,1)
>top
TOF:
>type 99
TOF:
-COMMENT GRAYSCALE MAP OF RUN 76020204  COLUMBUS, GEORGIA TEST SITE
*PICTUREPRINT
DISPLAY  RUN(76020204), LINES(60,120,1), COL(335,475,1)
CHANNELS 2,4
BLOCK    RUN(76020204), LINES(60,120,1), COL(335,475,1)
END
EOF:
>file
T=0.66/8.51 09:08:22

>ccinput pic cc                           (Execute the LARSYS
T=0.12/0.81 09:09:52                       PICTUREPRINT function)
>run
EXECUTION BEGINS....

 I0102  COMMENT - GRAYSCALE MAP OF RUN 76020204  COLUMBUS, GEORGIA TEST
SITE             (LARSMN)
 I0092  PICTUREPRINT FUNCTION REQUESTED        (PICSUP)
 I0237  ALL CONTROL CARDS FOR PICTUREPRINT HAVE BEEN READ     (PICRDR)
TAPE 182 ATTACHED
 I0002 TAPE 4523 HAS BEEN REQUESTED ON UNIT 182      (TAPMOUNT)
 I0003 TAPE READY...   EXECUTION CONTINUING     (TAPMOUNT)
 I0036  DESIRED RUN FOUND ... 76020204        (GADRUN)
 I0093  PICTUREPRINT FUNCTION COMPLETED        (PICSUP)
 I0103  CPU TIME USED WAS     36.012 SECONDS.      (LARSMN)

 I0004  END OF INPUT DECK - RUN COMPLETED       (LARSMN)
 I0050  TOTAL CPU TIME FOR THIS RUN WAS     36.197 SECONDS.     (LARSMN)
PRT FILE 6418  TO RSCS       COPY 01 NOHOLD
TAPE 182 DETACHED
T=11.74/41.47 09:21:16
```

B. DEVELOP TRAINING CLASS STATISTICS

This phase is the heart of the analysis process, and is a series of several steps, which may be re-iterated as needed. A general scheme of the order the processors may be used is illustrated below.



B1. CLUSTER - The cluster function implements an unsupervised classification (clustering) algorithm which groups data points into a user-specified number of clusters. The processor creates a LARSYS Statistics File of means and covariances which is needed as input to the classification processor and other LARSYS processors which use statistics information. The Statistics File must be saved on the user's private disk after the CLUSTER job has executed with the command 'STATDECK SAVE name', where 'name' is assigned by the user. Typically, the 'name' is chosen to be meaningful to the user, such as a location name. NOTE: The name must consist of only letters and numerals - no special characters are allowed.

Before setting up the control card file you need to select several training areas in the data containing points that represent all the cover types. Use your grayscale map from PICTUREPRINT to help you do this. Note the starting and ending lines and columns for each area. You will now execute a separate CLUSTER job on each training area.

Turn to the CLUSTER control card reference page and try to set up the first file you should use. The user-specified number of classes 'YY' is entered on the OPTIONS MAXCLAS(YY) card. In this example, 12 classes are requested for an area from line 50 to line 94 and column 420 to column 476 of the Columbus data.

```
>get clu
THE FILE -- CLU CC -- IS READY TO BE EDITTED.
IT'S CONTENTS ARE:

-RUNTABLE
DATA
RUN(XX), TAPE(YY), FILE(ZZ)
END
-COMMENT CLUSTER ON RUN XX
*CLUSTER
OPTIONS  MAXCLAS(YY), CONV(97.5)
PUNCH  STATS
CHANNELS 1.2.3.4
```

*(Create the control card file for *CLUSTER)*

(These lines are only needed if the data is copied to a user's tape.) [applies to -RUNTABLE, DATA, RUN(XX), TAPE(YY), FILE(ZZ), END]

```
DATA
RUN(XX), LINE(A,B,C), COL(I,J,K)
END

EDIT:
>next
-RUNTABLE
>delete 4
>type
-COMMENT CLUSTER ON RUN XX
CHANGE /XX/76020204/*
-COMMENT CLUSTER ON RUN 76020204
RUN(76020204), LINE(A,B,C), COL(I,J,K)
EOF:
>top
TOF:
>next
-COMMENT CLUSTER ON RUN 76020204
>next 2
OPTIONS MAXCLAS(YY), CONV(97.5)
>change .yy.12
OPTIONS MAXCLAS(12), CONV(97.5)
>change .7.9.
OPTIONS MAXCLAS(12), CONV(99.5)
>next
PUNCH    STATS
>delete
>next
DATA
>next
RUN(76020204), LINE(A,B,C), COL(I,J,K)
>change .a,b,c.50,94,1.
RUN(76020204, LINE(50,94,1), COL(I,J,K)
>change .i,j,k.420,276,1.
RUN(76020204), LINE(50,94,1), COL(420,476,1)
> top
TOF
> type 15
TOF:
-COMMENT CLUSTER ON RUN 76020204
*CLUSTER
OPTIONS  MAXCLAS(12), CONV(99.5)
CHANNELS 1,2,3,4
DATA
RUN(76020204), LINE(50,94,1), COL(420,476,1)
END
EOF:
>file
T=0.61/3.00 10:36:25
```

(These are the line and column coordinates for this training area)

```
>ccinput clu cc
T=0.08/0.61 10:08:16
>run
EXECUTION BEGINS...
 I0102  COMMENT - CLUSTER ON RUN 76020204
                  (LARSMN)
 I0165 CLUSTER FUNCTION REQUESTED.      (CLUSUP)
 I0034  ALL CONTROL AND DATA CARDS HAVE BEEN READ.     (CLURDR)
 I0002 TAPE 4523 HAS BEEN REQUESTED ON UNIT 182     (TAPMOUNT)
TAPE 182 ATTACHED
 I0003 TAPE READY...  EXECUTION CONTINUING      (TAPMOUNT)
 I0036  DESIRED RUN FOUND ... 76020204      (GADRUN)
TAPE 182 DETACHED
TIME IS 10:09:34 EST TUESDAY  07/10/79
CONNECT= 01:25:00 VIRTCPU= 000:19.08 TOTCPU= 001:17.41
TIME IS 10:27:41 EST TUESDAY 07/10/79
CONNECT=01:43:06 VIRTCPU= 003:22.61 TOTCPU= 004:37.44
 I0171  FLAG=  0 NOMOD=  12 INTOT=  2565 INTV=   1 ITER=  16 TIME=
05 SECS
         NCHAN=    4 CHAN=  1  2  3  4
 I0166  CLUSTER FUNCTION COMPLETED.  (CLUSUP)
 I0103  CPU TIME USED WAS  220.473 SECONDS.     (LARSMN)

 I0004  END OF INPUT DECK - RUN COMPLETED     (LARSMN)
 I0050  TOTAL CPU TIME FOR THIS RUN WAS  221.120 SECONDS.    (LARSMN)
PRT FILE 6457  TO RSCS    COPY 01 NOHOLD
T=194.37/226.23 10:32:38
```

*(Execute the *CLUSTER job)*

```
>statdeck save columbus
T=0.36/2.40 10:39:28
```

(Save the Statistics File)

```
>statdeck status
 I0007
```

(List all saved Statistics Files)

FILENAME	FILETYPE	FM	FORMAT		RECS	BLKS	DATE	TIME
COLUMBUS	STATDECK	A1	F	80	57	6	7/10/79	10:29
COMBO	STATDECK	A1	F	80	119	12	6/19/79	17:49
DEC76	STATDECK	A1	F	80	70	7	5/23/79	9:29
DEC77	STATDECK	A1	F	80	76	8	4/20/79	9:33
MOD	STATDECK	A1	F	80	74	8	6/19/79	14:39
MODNULL	STATDECK	A1	F	80	65	7	6/19/79	13:58
NONUL	STATDECK	A1	F	80	65	7	7/06/79	14:07
PICAMOD	STATDECK	A1	F	80	103	11	5/10/79	11:03

```
T=0.21/2.00 10:41:32
```

Now repeat the above procedure for each training area you selected, by creating another CLUSTER control card file with the lines and columns for the next training area. Then issue the CCINPUT and RUN commands. After execution save the Statistics File with the STATDECK SAVE command, being sure to use a different name. For this example we created two other control card files using the above file called CLU CC and the EDIT command to change the line and column numbers.

2nd CLUSTER job

```
>edit clu cc
EDIT:
>type 7
TOF:
-COMMENT CLUSTER ON RUN 76020204
*CLUSTER
OPTIONS  MAXCLAS(12), CONV(99.5)
CHANNELS 1,2,3,4
DATA
RUN(76020204), LINE(50,94,1), COL(420,476,1)
>change /50,94/79,113/
RUN(76020204), LINE(79,113,1), COL(420,476,1)
>change /420,476/333,364/
RUN(76020204), LINE(79,113,1), COL(333,364,1)
>file
T=0.23/4.72 07:32:47

>ccinput clu cc
T=0.12/1.01 07:33:16
>run
EXECUTION BEGINS...
```

(When execution is completed use the statdeck save command, using a different name than the first saved file)

3rd CLUSTER job

```
>edit clu cc
EDIT:
>type 7
TOF:
-COMMENT CLUSTER ON RUN 76020204
*CLUSTER
OPTIONS  MAXCLAS(12), CONV(99.5)
CHANNELS 1,2,3,4
DATA
RUN(76020204), LINE(79,113,1), COL(333,364,1)
>change /79,113/60,90/
RUN(76020204), LINE(60,90,1), COL(333,364,1)
>change /333,364/420,475/
RUN(76020204), LINE(60,90,1), COL(420,475,1)
>file
T=0.26/1.03 15:48:26
>ccinput clu cc
T=0.08/0.23 15:57:13
>run
EXECUTION BEGINS ...
```

(When execution is completed, use the statdeck save command, using a name different from the above two saved files

---

(If you are done for now, type QUIT.)

```
>quit
YOU TYPED QUIT.  DO YOU NEED TO RETURN TO LARSYS TO SAVE ANY
STATISTICS OR HISTOGRAM FILES?
>no
CONNECT= 02:00:04 VIRTCPU= 003:30.29 TOTCPU= 004:59.94
LOGOFF AT 10:44:41 EST TUESDAY 07/10/79
```

Obtain the print files for these CLUSTER jobs and compare the cluster maps in the output to any ground truth (maps or photos) you have. Give a name to as many of the cluster classes as possible in each of the three areas. Don't worry if you can't name all the classes, since we have several other programs to aid us.

Remember that you created three separate Statistics Files. It is very probable that there are statistical values in each Statistics File that represent the same cover type on the ground. To combine these classes and allow us to better compare the other classes, it is necessary to merge the Statistics Files.

B2. BMERGESTATISTICS - The mergestatistics processor provides the capability of combining several LARSYS Statistics Files or decks and editting the resulting new file. Classes from the input Statistics decks may be combined (pooled), deleted and renamed. This processor is frequently used in conjunction with the SEPARABILITY processor (discussed next) to identify redundant or unnecessary classes, and then combine or delete them as required. The 'Separability-Mergestatistics' processor combination may be repeated if the analyst feels class redundancy justifies its use.

The version of this program we use is called BMERGESTATISTICS, so we create our control card file and execute the job as follows:

```
>logon stregis                                      (Logon)
ENTER PASSWORD:
>XXXXXXXX
ENTER NAME:>bud goodrick
LOGMSG - 13:00:06 EST THURSDAY 07/19/79
* YOUR OPERATOR THIS AFTERNOON IS CINDY....
* NEXT SCHEDULED SHUTDOWN IS SATURDAY JULY 21 AT 17:00...
LOGON AT 13:00:58 EST THURSDAY 07/19/79
>i lsdv370
DEVELOPMENTAL LARSYS READY;
   SYSTEM IS BEING INITIALIZED....

... LARSYS IS READY FOR YOUR FIRST COMMAND
T=0.35/4.01 11:47:41                                 (If you have forgotten the names
>get bme cc                                           of your statistics files use the
THE FILE -- BME CC -- IS READY TO BE EDITTED.         STATDECK STATUS command before
IT'S CONTENTS ARE:                                    the GET command.)

*BMERGE                                              (Create the control card file).
OPTIONS NOFIELD, COSPEC
CLASSES ENTIRE(1,2)
SCALE SPCINT(1)
DISK READ
DATA  (USE GETFILE COMMAND TO INSERT YOUR STATDECK AFTER THIS CARD)
DATA  (USE GETFILE COMMAND TO INSERT YOUR STATDECK AFTER THIS CARD)
END

EDIT:
>next 3
CLASSES ENTIRE(1,2)
>change /2/2,3/
CLASSES ENTIRE(1,2,3)
>next
SCALE SPCINT(1)
>next
DISK READ
>delete
>type
DATA  (USE GETFILE COMMAND TO INSERT YOUR STATDECK AFTER THIS CARD)
>getfile csg statdeck
EOF REACHED
EOS                    *****     LAST CARD OF STATISTICS DECK     *****
```

```
>next
DATA     (USE GETFILE COMMAND TO INSERT YOUR STATDECK AFTER THIS CARD)
>getfile au49 statdeck
EOF REACHED
EOS                  *****     LAST CARD OF STATISTICS DECK     *****
>input data
>getfile columbus statdeck
EOF REACHED
EOS                  *****     LAST CARD OF STATISTICS DECK     *****
>next
END
>top
TOF:
>type 8
TOF:
*BMERGE
OPTIONS NOFIELD, COSPEC
CLASSES ENTIRE(1,2,3)
SCALE SPCINT(1)
DATA     (USE GETFILE COMMAND TO INSERT YOUR STATDECK AFTER THIS CARD)
LARSYS VERSION 3 STATISTICS FILE            0
CLASS TPL7601
>file
T=0.54/7.48 11:59:17
>ccinput bme cc
T=0.54/7.48 11:59:41
>run                                           (Execute the BMERGE job)
EXECUTION BEGINS...
 IOXXX  MERGESTATISTICS FUNCTION REQUESTED     (MERSUP)
 I0034  ALL CONTROL AND DATA CARDS HAVE BEEN READ     (MERSUP)
 IOXXX  STATISTICS BEING MERGED     (MERSTT)
 I0032  REDUCED STATISTICS COMPUTED.     (REDSAV)
 I0032  REDUCED STATISTICS COMPUTED      (REDSAV)
 I0032  REDUCED STATISTICS COMPUTED.     (REDSAV)
 I0209  COINCIDENT BI-SPECTRAL PLOT PRINTED.     (COSPEC)
 IOXXX  MERGESTATISTICS FUNCTION COMPLETED     (MERSUP)
 I0103  CPU TIME USED WAS     16.155 SECONDS.     (LARSMN)
 I0004  END OF INPUT DECK - RUN COMPLETED     (LARSMN)
 I0050  TOTAL CPU TIME FOR THIS RUN WAS   16.400 SECONDS.     (LARSMN)
PRT FILE 4952  TO RSCS     COPY 01 NOHOLD
T=9.96/22.11 12:03:14
>statdeck save csg3deck
T=0.61/1.96 12:12:01
```

B3. SEPARABILITY - The separability processor helps the user to decide how well the individual classes in a LARSYS Statistics File may be distinguished from one another. i.e. What is the "separability" between the classes. It is also used to select a subset of channels in a Statistics File which will produce an accurate classification. The first reason is why we will use the separability function now. We want to compare all of our cluster classes which have been combined into one Statistics File during the BMERGESTATISTICS job.

Now create your SEPARABILITY control card file. If you have forgotten the names of your Statistics Files, type 'statdeck status' before issuing the 'get' command.

```
>get sep
THE FILE -- SEP CC -- IS READY TO BE EDITTED.
IT'S CONTENTS ARE:

-COMMENT SEPARABILITY ON CLASSES FROM RUN XX
*SEPARABILITY
COMBINATIONS 4
SYMBOLS  A,B
CARD     READSTATS
CHANNELS 1,2,3,4
DATA
* PUT STATISTICS DECK HERE IF A CARDS READSTATS CARD IS ABOVE *
   DON'T FORGET TO DELETE THESE TWO LINES.
END

EDIT:
>next
-COMMENT SEPARABILITY ON CLASSES FROM RUN XX
>change /XX/76020204/
-COMMENT SEPARABILITY ON CLASSES FROM RUN 76020204
>next 3
SYMBOLS A,B
>delete 6
>up
COMBINATIONS 4   <--  (The 4 indicates we want to use all 4 channels
                       in computing class separabilities)
>input print div(1200)  <-- (Class pair separabilities are assigned a number
>top                        ≤ 2000, the higher the number, the more sep-
TOF:                        arable the classes. This line causes a table
>type 6                     to be printed of classes with separability less
TOF:                        than 1200 which are candidates for combining.)
-COMMENT
*SEPARABILITY
COMBINATIONS 4
DIV (1200)
END
>file
T=0.54/1.28 13:45:21
```

```
>statdeck use csg3deck
T=0.59/1.56 12:04:31
>ccinput sep cc
T=0.08/0.20 12:05:50
>run
EXECUTION BEGINS...
 I0111  SEPARABILITY FUNCTION REQUESTED    (SEPSUP)
 I0032  REDUCED STATISTICS COMPUTED.   (REDSAV)
 I0034  ALL CONTROL AND DATA CARDS HAVE BEEN READ     (SEPINT)
 I0022  DIVERGENCE CALCULATIONS COMPLETED--READY TO ORDER AND PRINT RESULTS
 I0011  SEPARABILITY FUNCTION COMPLETED    (SEPSUP)
 I0103  CPU TIME USED WAS   22.083 SECONDS.     (LARSMN)

 I0004  END OF INPUT DECK - RUN COMPLETED    (LARSMN)
 I0050  TOTAL CPU TIME FOR THIS RUN WAS   22.339 SECONDS.    (LARSMN)
PRT FILE 4954  TO RSCS    COPY 01 NOHOLD
T=13.49/27.30 12:10:34
```

After obtaining the printer output from this SEPARABILITY job, turn to the table of suggested class groupings. Compare this with the names you assigned to the classes in the CLUSTER output. Based on how well the grouped classes agree with respect to cover type, you should decide whether to combine or delete classes.

Your next step is to create another BMERGESTATISTICS control card file with the class combinations indicated on the POOL card, and then re-run the SEPARABILITY processor, changing the DIV value to 1400. Do this as many times as is necessary. Don't forget to save the Statistics File after BMERGESTATISTICS is executed.

After the 2nd BMERGESTATISTICS job has been executed, you may also choose to run the BIPLOT processor, as follows:

B4. BIPLOT - The Biplot processor provides the user with a graphic presentation of the relationships of the classes in a statistics deck. Two-channel plots of means, ellipsoids of concentration, and classification space for training classes may be requested. The plots are used to examine the spatial relationship of training classes in two channel space. Any two channel combinations may be plotted.

```
>get bip
THE FILE -- BIP CC -- IS READY TO BE EDITTED.
IT'S CONTENTS ARE:

-COMMENT BIPLOT OF CHANNELS X,Y
*BIPLOT
PLOT MEANS(X,Y),ELLIPSE(X,Y),CLASS(X,Y)
SCALE ORIG(X,0.0), ORIG(Y,0.0), UNIT(X,0.8), UNIT(Y,0.6)
END

EDIT:                    (issue Edit commands here to create a file
                          which looks like this:)
>type 5
TOF:
*BIPLOT
PLOT MEANS(3,2),CLASS(3,2)
SCALE ORIG(3,0.0),ORIG(2,0.0),UNIT(3,0.5),UNIT(2,0.5)
END
>file
T=0.09/1.17 17:05:12
>statdeck use csg             (our final Statistics File is named 'csg')
T=0.42/0.61 17:07:49
>run
EXECUTION BEGINS...
 I0000  BIPLOT FUNCTION SELECTED                  (BIPSUP)
 I0000  READ STATISTICS COMPLETED                 (BIPRDR)
 I0000  ALL CONTROL AND DATA CARDS HAVE BEEN READ (BIPSUP)
 I0000  DOING CLASSIFY PLOT OF  2 VS 3            (BIPLTR)
 I0000  DOING    MEANS PLOT OF  2 VS 3            (BIPLTR)
 I0000  BIPLOT FUNCTION COMPLETED                 (BIPSUP)
 I0103  CPU TIME USED WAS  12.108 SECONDS.        (LARSMN)

 I0004  END OF INPUT DECK - RUN COMPLETED       (LARSMN)
 I0050  TOTAL CPU TIME FOR THIS RUN WAS   12.228 SECONDS.    (LARSMN)
PRT FILE 5943 TO RSCS     COPY 01 NOHOLD
T=11.22/13.85 17:08:56
```

C. CLASSIFY THE DATA

Having completed the necessary iteration of steps in part B. to develop your training class statistics, you are ready to classify all the data points in your analysis area.

CLASSIFYPOINTS - The classifypoints processor uses the maximum likelihood classification rule which classifies multispectral data on a point-by-point basis. The processor assigns each data point to a class in the training set (LARSYS Statistics Files) for which the data values give the maximum likelihood for statistically correct classification. The classification file is written onto tape or disk.

Now create a control card file for CLASSIFYPOINTS and execute the job.

```
>get cla
THE FILE -- CLA CC -- IS READY TO BE EDITTED.
IT'S CONTENTS ARE:

-RUNTABLE
DATA
RUN(XX), TAPE(YY), FILE(ZZ)
END
-COMMENT PERPOINT CLASSIFICATION OF RUN XX
*CLASSIFYPOINTS
RESULTS  TAPE(X),FILE(Y)
CLASSES  MM(P1/C1,C2/)  <------ (The 'classes' card is not needed if
CHANNELS 1,2,3,4                 you have already combined your class-
DATA                             es in the BMERGE jobs)
RUN(XX), LINE(A,B,C), COL(I,J,K)
END

EDIT:                   <------ (Issue Edit commands here to get a
                                 file such as the one typed below)
*CLASSIFYPOINTS
RESULTS DISK  <------ (If you have a larger area, you will
CHANNELS 1,2,3,4       need to put it on tape instead of disk.
DATA
RUN(76020204),LINE(140,180,1),COL(60,200,1)
END
>file
T=0.15/0.49 14:51:35
>ccinput cla cc
T=0.09/0.18 14:52:03
>statdeck use csg
T=0.09/0.23 14:56:39
>run
EXECUTION BEGINS...
```

At this point the data has been classified and you can proceed to display the data.

D. DISPLAY THE RESULTS

PRINTRESULTS - The Printresults processor produces printed outputs describing the classification results, in the form of map images, tabular summaries, or both. The user can assign various symbols to the classes for the maps, and produce several types of tables. All output products are optional and various combinations of products may be produced, with multiple copies produced if requested.

If you choose to produce a map, then you must first select symbols to assign to each class. Many special symbols may be used, such as 'blank', ., /, +, =, -, etc. in addition to letters and numbers.

```
>get pri
THE FILE -- PRI CC -- IS READY TO BE EDITTED.
IT'S CONTENTS ARE:

-COMMENT CLASSIFICATION RESULTS FROM RUN XX
*PRINTRESULTS
RESULTS  TAPE(TT), FILE(FF) <-- (specify here where the classification was
PRINT    TEST(P)                 written)
SYMBOLS -,+,.  <---------------- (symbols are required for a map)
GROUP    GG(G1/P1,P2/)
DATA                            (data cards are needed if tables are requested)
TEST
RUN(XX), LINES(A,B,C), COL(I,J,K)
END

EDIT:  <------------------------ (Issue Edit commands here to create your file.
                                  The following file just requests map output.)
*PRINTRESULTS
RESULTS DISK
SYMBOLS  .,.,.,.,.,.,/,/,/,/,X,X,X,H,H,H,W
END
>file
```

Execute the job using the CCINPUT and RUN commands. Obtain your printer output and look for problem areas in the classification. It may be necessary to repeat several steps from part B to redefine the training class statistics. If no problems are apparent, then you have completed the analysis sequence and may produce various other maps or tables, grouping similar class types as desired.

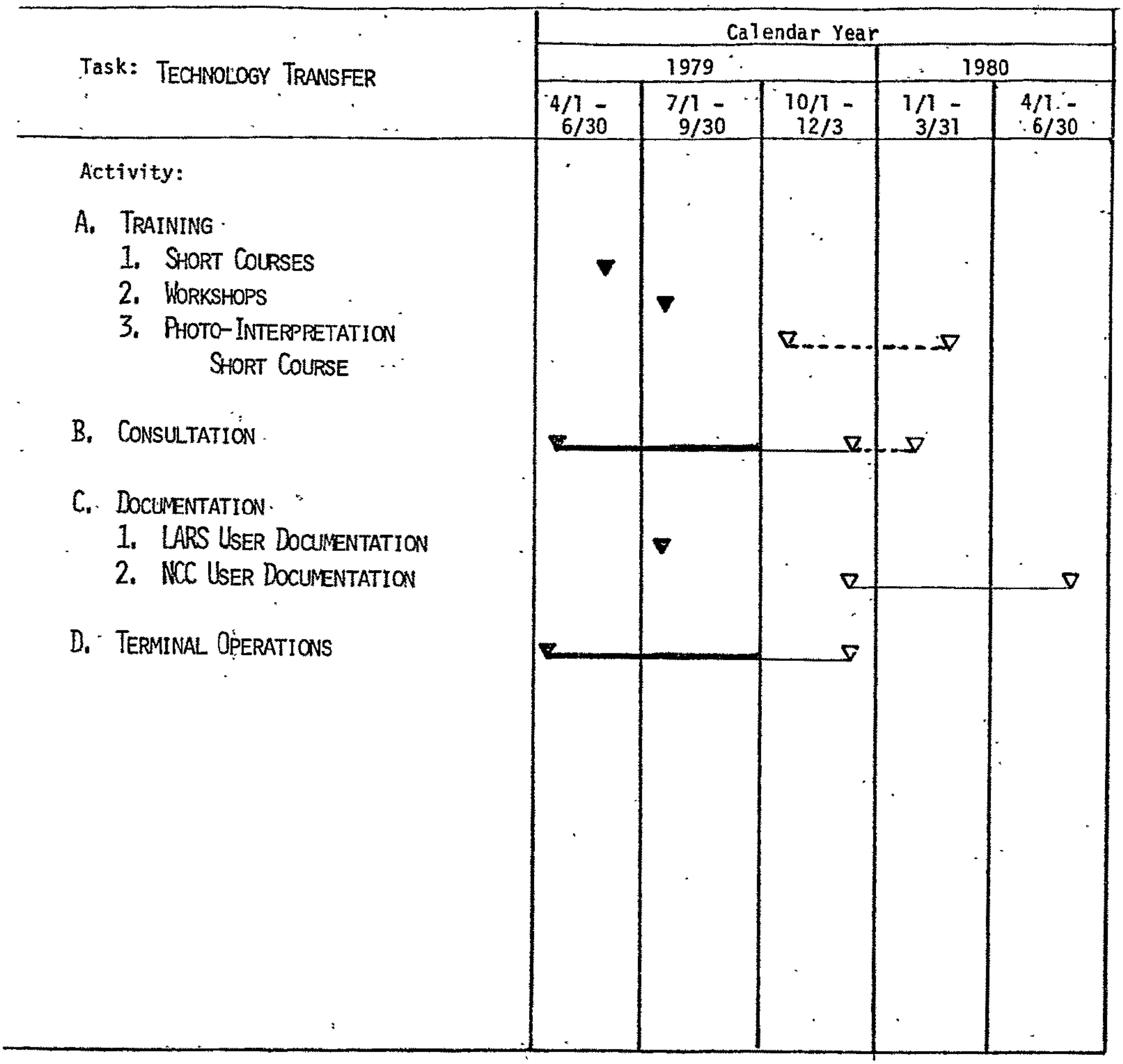
Appendix B

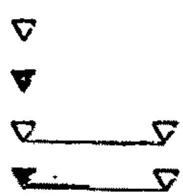
The Exhibits that appear in this Appendix are updated versions of the milestone and timeline charts that were published in the first Phase III quarterly report. The Exhibit numbers to the following Phase III task activities:

1. Technology Transfer
2. LARSYS Transfer
3. Preprocessing Transfer
4. Management

Exhibit 1

FRIS III Timeline Chart





planned start of activity

actual start of activity

duration of activity

progress toward activity completion

Exhibit 2

FRIS III Timeline Chart

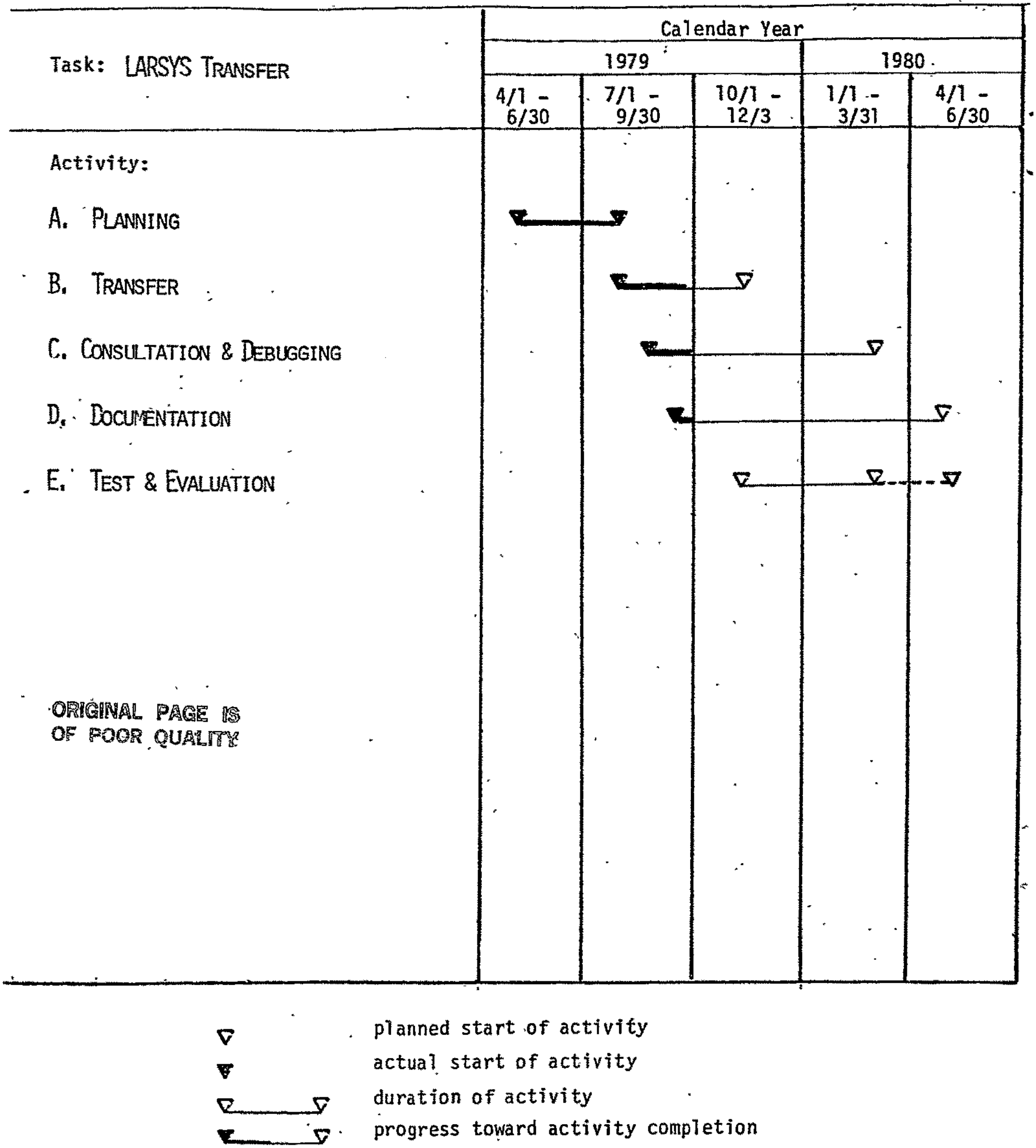


Exhibit 3

FRIS III Timeline Chart

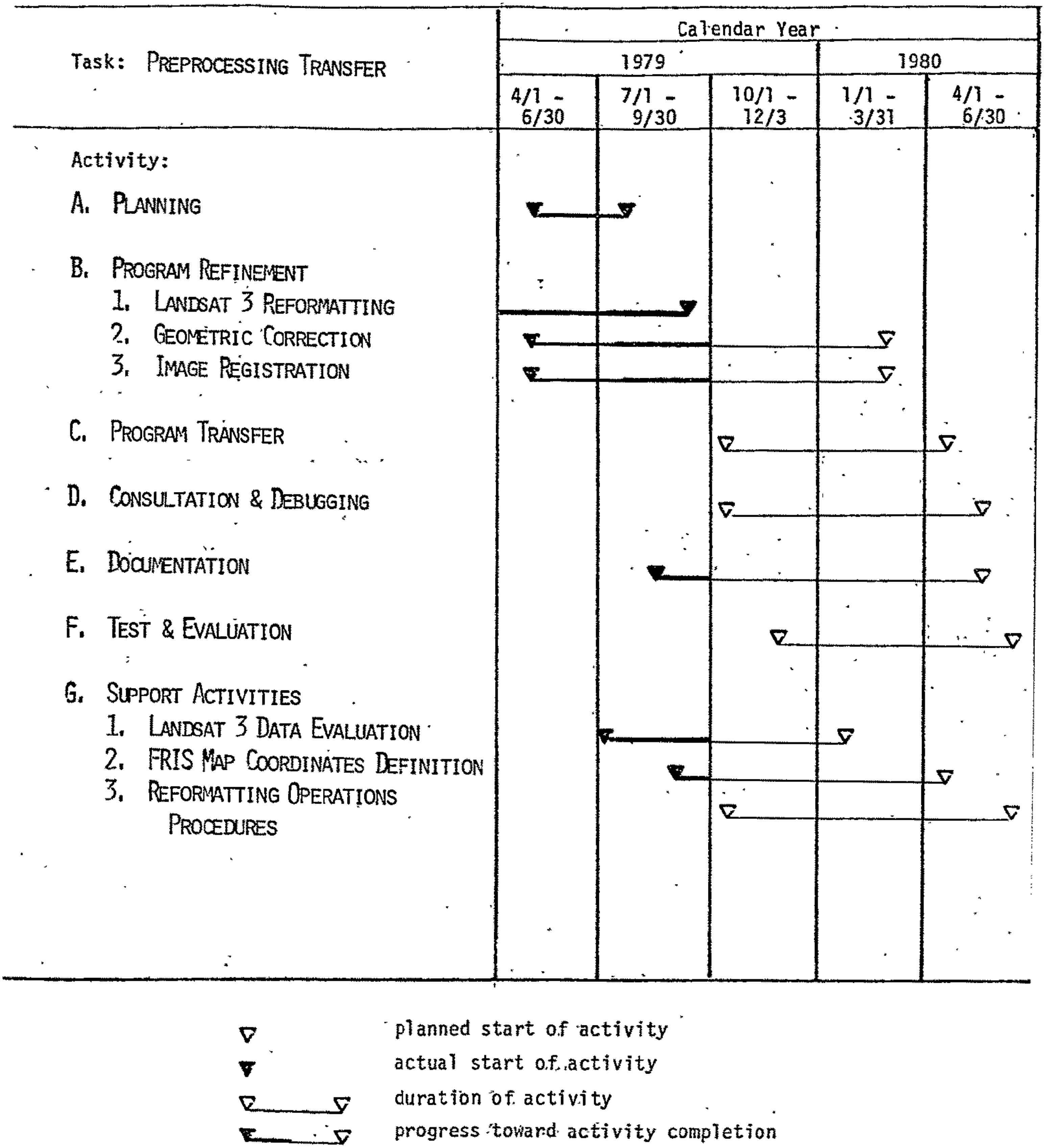
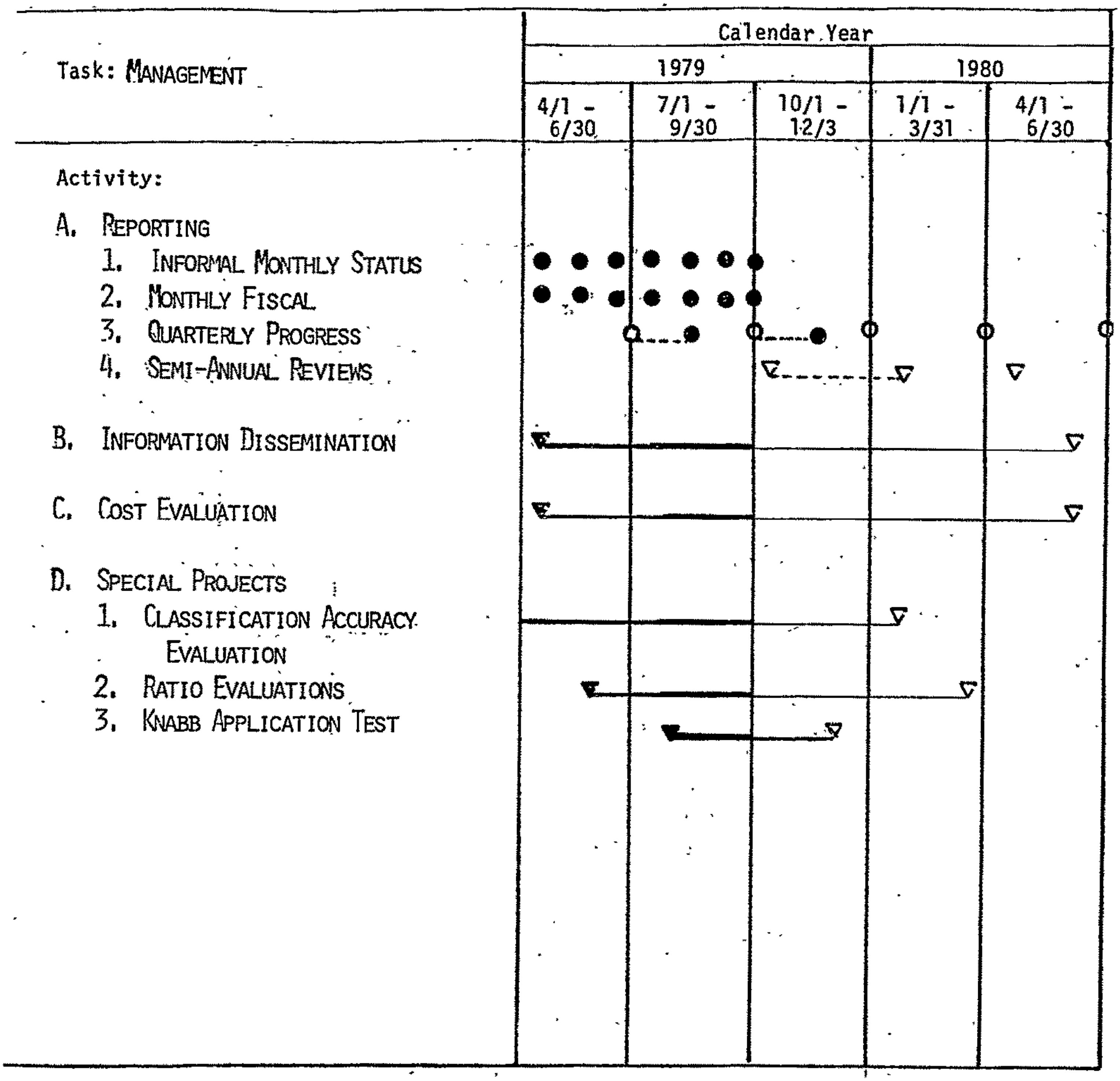
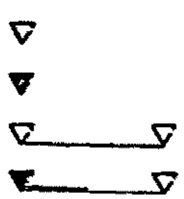


Exhibit 4

FRIS III Timeline Chart





planned start of activity

actual start of activity

duration of activity

progress toward activity completion

Appendix C

Lists of the Preprocessing and LARSYS software being transferred to NCC are included in this Appendix.

File	Program	File	Program
1	LNDSUP	31	LNDTRA
2	LNDINT	32	LNDWUP
3	CHAR	33	LNDSUM
4	LNDRDR	34	USAGE
5	LNDPAG	35	LNDRES
6	LNDPRM	36	DISK
7	CNDVAL	37	DISMAT
8	CTLCBC	38	EOT
9	CTLSPN	39	GCTROL
10	BINSRH	40	GEMCOR
11	SRTVAL	41	IDRITE
12	ERRPRT	42	LARS17
13	LNDERR	43	PAGLOC
14	LNDCTL	44	TAPMC
15	XMOUNT	45	ACCNT
16	LNDDIR	46	CPTIME
17	CASCII	47	DISKOP
18	LNDDMP	48	FILEOP
19	LNDARC	49	GETACT
20	LNDHED	50	BCDVAL
21	LNDANC	51	CTLWRD
22	LNDANN	52	GADRUN
23	LNDIMA	53	CPFUNC
24	LNDBIL	54	GTDATE
25	LNDLIP	55	IDNAME
26	CTOIAI	56	MOVBYT
27	JTOR	57	MOUNT
28	LNDMIL	58	TSTREQ
29	LNDCOR	59	TAPOP
30	LNDWRT		

Index to LARSYS and LARSYSDV

LARSYS

PICTUREPRINT
STATISTICS
IDPRINT
LISTRESULTS
PUNCHSTATISTICS
LINEGRAPH
COLUMNGRAPH
HISTOGRAM
GRAPHHISTOGRAM

LARSYSDV

1 BIPLOT
2 CHANGE
3 CLUSTER
4 SEPARABILITY
5 CLASSIFYPOINTS
6 PRINTRESULTS
7 DUPLICATERUN
8 COPYRESULTS
9 MERGE
10 BROWSE
11 RATIO
12 GDATA
13 GRESULTS
14 ECHO