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ON THE ACCESS TO AN EARTH RESOURCES DATA PROCESSING SYSTEM

TERRY L. PHILLIPS
SUSAN K. SCHWINGENDORF

The Laboratory for Applications of Remote Sensing

Purdue University, West Lafayette, Indiana

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Terry L. Phillips
Susan K. Schwingendorf

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Laboratory for Applications of Remote Sensing
Purdue University

ABSTRACT

The Purdue/LARS Earth Resources Data
Processing System is briefly described. The
considerations to which an organization would
want to give attention before obtaining a remote
terminal to this system are discussed. The
support of such a terminal which Purdue/LARS
is willing to propose is described.

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Terry L. Phillips
Susan K. Schwingendorf

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Purdue University

INTRODUCTION

The Laboratory for Applications of Remote Sensing at Purdue University (Purdue/LARS) has developed an Earth Resources Data Processing System which is being used by both LARS personnel and remote terminal users. This system is unique in that it offers immediate access to advanced technology for a relatively low cost. The facility consists of LARSYS, a multispectral data bank, and a general purpose computer. LARSYS is a fully-documented multi-image data analysis software system designed to provide for advanced research, development, and applications of remote sensing concepts and systems. The multispectral data bank is available to all users of LARSYS and serves as its primary data base. The implementation of LARSYS on a general purpose computer with time sharing and remote terminal capabilities increases the system's value to a large group of users. The resulting Earth Resources Data Processing System provides: (1) full user access, at the user's location, to both the data and the processing capability; (2) centralization and sharing of the expensive portions of the processing hardware at considerable cost advantage; (3) centralization of software maintenance, with additional cost advantage and updating flexibility; and (4) ease of training users and sharing experiences through standard data formats, terminology, and simplicity of communication.

This Earth Resources Data Processing System is briefly described in this information note. A complete description of the considerations to which an organization would want to give attention is the subject of the largest section in this report. Although careful attention has been given in this section to price information, the prices used are subject to change by the companies offering the products. The last section of this information note is entitled Purdue/LARS Support and includes

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a description of the support which Purdue/LARS is willing to
propose to an organization considering a remote terminal.
Specific proposals for a particular organization must be re-
quested before use of the system by an outside organization
can be considered.

DESCRIPTION OF FACILITY

The general purpose computer provides an optimal facility to test concepts and applications. Inherently the digital processing system offers the capability to duplicate data and results without concern for deterioration of the copied results or quantitative changes in results. A general purpose digital system offers flexibility in system design for those users requiring flexibility and at the same time allows the operation of a stable system (one which does not change often) for those users requiring this characteristic. These and other advantages of the general purpose digital computer make it the choice of research and development personnel in the early design and applications stages of technology development. Therefore the general purpose digital computer is used for the implementation of LARSYS.

The multispectral data bank provides the primary data base of LARSYS and is shared by all terminal users. At the present time the data base consists of approximately 800 data runs. The procedures for remote terminal users to enter new runs into the data bank are well defined and have been thoroughly tested and successfully used. In addition, personnel at LARS are well acquainted with the technology of converting data from its collection format to the format required by the multispectral data bank.

The technology available in LARSYS is a result of several years of research at Purdue. New capabilities from currently active terminal sites are beginning to be implemented. All algorithms incorporated into the base system are thoroughly tested and documented. Thus constant access to state-of-the-science developments which have proven usefulness is achieved. This provides each terminal site with an opportunity to evaluate techniques before expensive implementation on an inhouse facility.

The techniques implemented in LARSYS are easily accessible. Considerable attention has been given to simplicity of requesting and controlling the implemented algorithms. A generally free-form control language using English-like statements with a few simple rules of syntax and punctuation greatly simplifies usage. In addition, extensive error checking of inputs is provided to inform the user of control problems as soon as possible. In most cases interface problems can be corrected on line or in check out runs before expensive processing takes place.

As a result of the commonality of data format, terminology, and usage, standard training materials geared to the specific system have been developed. A LARSYS Educational Package has been created which makes the system easy to learn and use. By

relying on these training materials, the amount of teacher time
per pupil has been greatly reduced. The results of using the
educational package with the data processing system has dem-
onstrated that these tools are superior in their ability to
train personnel in general remote sensing concepts.

LARSYS is modular and implemented in a system design which
allows substitution or addition of new capabilities by pro-
gramming personnel at the user's site. Thus new algorithms
can be tested in concert with the total system at a terminal
location. The system also provides for the sharing and
further testing of new techniques between terminal sites. This
ability to quickly share technology further speeds progress
in the development of data processing concepts for remote
sensing.

The Purdue/LARS Earth Resources Data Processing System is
totally dedicated to remote sensing data processing. The
use of this facility for a single purpose enhances each user's
ability to concentrate on his particular aspect of a problem
without redesign of the total system. This concentration can
take place at any time due to the total dedication of the system
and the multiple user access. All personnel having access to the
system share similar concerns and therefore benefit from all
other users of the facility. The system serves as a catalyst
for transfer of technology between terminal sites, enhances
the solution of mutual problems, and speeds progress of the
development of remote sensing.

AVAILABILITY OF REMOTE TERMINALS

A limited number of remote terminals can be connected to the Earth Resources Data Processing System described above. In order to chart a course toward successful use of a terminal and contribute to the development of technology transfer concepts, the potential remote site participant must agree that it is prepared to:

(a) Arrange for the installation of the hardware and communication lines necessary to install a terminal in his facility, and pay for the CPU time used by that organization.

(b) Arrange for the coordination of the installation of hardware equipment and corresponding upgrades to the central computer.

(c) Provide tapes at the Purdue/LARS site for use by terminal personnel.

(d) Provide an adequate facility for the installation of a terminal.

(e) Designate two individuals by name to serve as systems specialist and analysis specialist and make them available for training with an available education package.

(f) Provide instruction and documentation for terminal users.

(g) Arrange for reformatting and programming support if desired.

A. Hardware Requirements

A remote user's equipment needs fall into 4 basic categories:

(1) Rental of terminal equipment for the remote terminal site

(2) Purchase or lease of two modems (one to be located at the terminal site and one at Purdue/LARS)

(3) Lease of communications lines

(4) Use of Central Computer Facility

1. Terminal Hardware

Existing training materials were developed for an IBM 2741 typewriter and 2780 terminal consisting of a page printer and a card read/punch. Use of these particular terminals is not mandatory but strongly suggested as this equipment is currently supported by the system. The remote site will be expected to take most of the responsibility for installing and operating other equipment. The terminals recommended and their monthly rental charges are:

IBM 2741 Model 1 Communications Terminal	$96.00
Feature 4708 Receive Interrupt	2.50
Feature 7900 Transmit Interrupt	8.00
Feature 9120 External Modem Attachment	N/C
TOTAL FOR 2741 TERMINAL	$106.50/month

IBM 2780 Model 2 Data Transmissions Terminal	$989.00
Feature 5820 120 character line	83.00
Feature 5010 Multi-record transmission	15.00
Feature 8030 EBCDIC Transparency	15.00
TOTAL FOR 2780 TERMINAL	$1,102.00/month

The remote site organization should also consider terminal transportation costs to and from the factory. The terminals are shipped from Raleigh, North Carolina. IBM can be contacted with respect to questions of terminal costs, shipping charges, and other questions concerning attachment to the Purdue/LARS system. IBM is supporting the Purdue computer site under their "Host Computer Concept". Under this agreement, IBM will help coordinate the ordering, shipping and maintenance of the 2741 and 2780 terminals.

2. Modems

A modem is required at the remote terminal site and at the Purdue computer site to service the 2780. Two Codex 7200 Data Modems with an alternate Voice/Data feature are recommended. The modem for the Purdue computer site should have the Rack Mounting feature. This is optional for the remote site. The cost of the recommended Codex modems is $16,650 purchase and $465.00/ month for a two year lease. Installation of each Codex modem is $100.00 per site with delivery charges of $25.00 each east of the Mississippi River and $50.00 west.

The Codex Modem is recommended because it can service the 2780 and 2741 with one phone line and Codex offers lease or purchase arrangements. The Codex Modem has proven to be reliable

on a currently operating remote terminal. With a 7200 BPS modem, the 2780 can operate at 4800 BPS, leaving the remainder of the bandwidth for one or more typewriter terminals. The alternate voice/data option is strongly suggested to allow either voice or data usage of the telephone circuit. This greatly facilitates communication between LARS personnel and terminal personnel in the event of system problems.

The Codex Corporation has a 2-year lease minimum. The modems can be used for less than 2 years by signing a 2-year lease. If the modems are used less than 2 years then the organization is back-billed for a higher monthly rate of the return of the modems. Further details on a Codex contract are available from the Codex Corporation.

Increased access to the system can be achieved through the use of two Codex 800 Model 810 Time Division Multiplexers, one installed at the terminal site and one at Purdue/LARS. These units, along with additional 2741 terminals, can service several users at the remote site through sharing of the 2780 and the unused bandwidths of the phone lines and modems. The two Codex 800 Time Division Multiplexers can be purchased for $2875.00 plus $400.00 per 2741 terminal channel or leased for $123.00/month plus $18.00 per terminal channel.

3. Communication Lines

Each terminal requires a leased four-wire (full duplex) channel. ATT 3002 or Western Union Class G lines are suitable, and require C2 conditioning.

Specific price quotes can be obtained by contacting the telephone company, but an estimate can be made by figuring the approximate distance from the remote site to LARS and using the rates shown in Table 1. The rates shown in Table 1 are for leased 4-wire, full duplex voice-grade channels, AT&T type 3002, with C2 conditioning. This information was obtained from: "Getting the Most from Data Links", page 26, August 1973, The Datacomm Planner. Examples of monthly phone line charges to 8 major cities in the United States are calculated in Table 2.

4. Computer Time

Use of the computer is essentially unlimited; the organization acquiring a terminal must agree to purchase computer time at the rate of approximately $250/hour. Included in this rate is the cost of the hardware needed to install ports on the 3705 communications

Table 1. Common Carrier Line Charges

BASIC LINE CHARGE (per month)	SERVICE TERMINAL CHARGE (per month)	C2 CONDITIONING (per month)
25 miles and under		
$3.30/mile	$16.50/location	$19.00/line/ location
	(locations are LARS and the remote terminal site)	
26-100 miles		
$82.50 + $2.31/mile over 25 miles		
101-250 miles		
$255.75 + $1.65/mile over 100 miles		
251-500 miles		
$503.25 + $1.155/mile over 250 miles		
Over 500 miles		
$792.00 + $0.825/mile over 500 miles		

Location	Air Miles to Lafayette	3002 Channel Line Charge	Service Terminal Charge	C2 Conditioning Charge	Total Monthly Rental
Austin, Texas	924	$1,141.80	$33.00	$38.00	$1,212.80
Berkeley, California	1891	$1,939.57	$33.00	$38.00	$2,010.57
Denver, Colorado	957	$1,169.02	$33.00	$38.00	$1,240.02
Sioux Falls, South Dakota	549	$ 832.42	$33.00	$38.00	$ 903.42
Ann Arbor, Michigan	207	$ 432.30	$33.00	$38.00	$ 503.30
Boston, Massachusetts	829	$1,063.42	$33.00	$38.00	$1,134.42
Washington, D. C.	534	$ 802.05	$33.00	$38.00	$ 891.05
Miami, Florida	1076	$1,267.20	$33.00	$38.00	$1,338.20

Table 2. Estimated Common Carrier Monthly Charges

controller to accept new remote terminals, maintenance of the terminal site's portion of the tape library, rental of the shared hardware at the Purdue computer facility, maintenance of the installed computer software (CP-67, CMS, and LARSYS), computer operations, and other facility support. A minimum of 5 hours CPU time will be billed each month to provide a minimum of support costs. A typical ratio between CPU time and terminal connect time for remote LARSYS users is 1:10 based on experience to date.

B. Installation Support

The installation of a terminal requires upgrading the CP-67, 3705, and CMS software at Purdue to accept the new terminals. Arrangements for Purdue/LARS support of the terminal installation to the extent of changing this software is required. Purdue/LARS also offers support in ordering equipment, coordinating delivery and installation dates, and communicating this information to the system specialist at the remote site. It is suggested that Purdue/LARS support the remote terminal organization in all these tasks, but the organization has the option to handle some of these tasks.

C. Tapes

The remote terminal organization must arrange for tapes to be placed in the library at the central computer site. These tapes are for the personal use of the remote terminal users, and belong to that organization. If desired, the tapes can be returned when the remote terminals are disconnected. A reasonable number of tapes for this purpose is 30.

D. Facility

The remote site organization must designate a room which has adequate space for working at the terminal, reviewing output, and storing manuals. It must also have the proper receptacles and power requirements for the hardware equipment. These are specified below for the recommended hardware:

    2780:   208 volts, 15 amp circuit (1.8KVA)
            single phase, 3 wire

            Russell and Stoll FS3743 receptacle (wall plug)
            or FS3913 (connector to put on cable)

2741:   115 volt, 15 amp circuit (.76KVA)
        single phase, 3 wire
        standard grounded wire receptacle

Codex Modem: 115 volt, 15 amp circuit
               single phase, 3 wire
               standard grounded wire receptacle

Communications Lines: (Power for conditioning equipment,
                         test equipment, etc)
                        115 volt, 15 amp circuit
                        single phase, 3 wire
                        standard grounded wire receptacle
                        (at least two receptacles needed)

A good wired earth or building ground must be used in the installation of this equipment. Conduit does not provide a satisfactory ground. All receptacles must be within 10 feet of units.

E.   Responsible Personnel

To provide for open communications between the remote site and LARS, the remote terminal site must arrange for a minimum of 5% time of a system specialist and 5% time of an analysis specialist at Purdue. This will allow routine hardware and communication line problems to be promptly handled, as well as questions about possible software and analysis problems.

Also, the organization must designate two employees at the remote site to serve as system specialist and analysis specialist. These assignments should require 25% to 50% of the designated person's time, depending on the use of the terminal. These two people must complete the LARSYS Analysis for Instructors course at Purdue. A brief description of their duties follows:

i)   System specialist

This person has three main tasks. First, approximately 3 months before the target installation date, the designated facility should be checked out to be sure it will meet the requirements stated in the previous section. Second, coordination with the LARS system specialist as to delivery and installation dates is required for efficient supervision of the equipment installation.

Finally this person should be available to all users at the terminal site to sort out and handle problems with the phone lines or terminals, and apparent software bugs. Any problems which can't be resolved should be reported to the LARS system specialist.

ii) Analysis specialist

This person's first responsibility is to assist the terminal users in the completion of the LARSYS Educational Package. He should then be available at the terminal site to consult with users on the use of LARSYS, setting up job decks, and analyzing output. If more help is desired, or problems arise, contact with the Purdue/LARS analysis specialist should be made.

Note that users at a remote site must contact the remote site specialist, rather than contact Purdue/LARS personnel.

F.   Instruction and Documentation

Since every user is encouraged to complete the training course, the remote site should acquire one copy of the LARSYS Educational Package. There is also a Supplementary Analysis Seminar which can be given at the remote site after user instruction has been completed. Experience has demonstrated that users having access to available training and documentation significantly increase their effective use of remote sensing concepts and the terminal. The requirement to train users and provide adequate access to the documentation is important.

G.   Other Considerations

1.   Reformatting:

A specific format is required for data tapes which are stored in the tape library at the Purdue computer site. If researchers wish to add their own data tapes to the tape library for analysis, the tapes can be put into the proper format before delivery to Purdue, or arrangements can be made to have them formatted at Purdue.

2.   LARSYS Programming Support:

If remote site users wish to exercise programming options, e.g.,

add to or change the existing LARSYS software for the remote site, arrangements can be made for LARSYS documentation, LARSYS System Software Orientation, a CMS course, and CMS capabilities to be made available.

PURDUE/LARS SUPPORT

Purdue/LARS provides the central system resources for
the remote terminal network. These resources include the computer
hardware, maintenance of the software system and data library,
educational materials, all applicable documentation, and most
importantly personnel experienced in the installation and
continued use of the system. In this section the specifics of
this support are described to provide useful information for
planning a terminal installation. Specific proposals can be
obtained from Purdue/LARS for a specific site.

This section contains three subsections. The subsection on
hardware/software support discusses terminal installation
support available and continued hardware/software arrangements
which can be made. The second subsection discusses support of the
LARSYS or remote sensing analysis aspects of the system. Finally
the third subsection describes support of the programming aspects
of LARSYS. This third type of support is of interest only to
those sites desiring to make changes or additions to the installed
LARSYS system or implementing all or parts of the installed
LARSYS software on another hardware system.

A.   Hardware/Software Support

1.   Terminal Hardware Installation

The responsibility for ordering and coordinating the
delivery of a 2741 and a 2780 terminal with the specified
features can be delegated to Purdue. The remote site system
specialist will be informed of the installation date so that
he can supervise the terminal's installation at the remote site.
If Purdue/LARS assumes responsibility for installation of the
phone lines and modems (see below), then simultaneous installation
of all equipment will be coordinated. This support includes
monthly rental of the appropriate 2741 and 2780, terminal trans-
portation costs, and the Purdue designated system specialist
who will assume the responsibility for terminal hardware
installation.

2.   Phone Lines - Modem Installation

The coordination for ordering and delivering the modems
and phone line can also be delegated to Purdue. The system
specialist at Purdue will coordinate the delivery of the specified
modems and phone lines with that of the terminals as requested
by the remote site. The remote site system specialist will be

informed of installation dates so that he can supervise the physical installation. This service includes coordination, personnel, modem lease, and phone line lease. The phone line lease will vary according to the location of the remote site.

3. Software Installation

The 3705, CP-67 and CMS programs are changed to recognize the new terminal(s) and automatically distribute appropriate outputs to the new hardware. Also a software system to support the new 2780 will be installed and tested.

4. Tape Library

This support includes the purchase of 30 tapes. These tapes will be entered into the tape library for the remote terminal site's use according to instructions from the terminal site system specialist. If desired, the tapes will be shipped back at the terminal site's expense when the terminal is disconnected from the system.

5. Computational Facility

It is expected that Purdue will support the central processing facility for a remote terminal system on a continuing basis. This support includes rental of the hardware required for the 3705 communications controller, maintenance of the terminal site's portion of the tape library, rental of the shared hardware at the central computer facility, maintenance of the installed computer software (CP67, CMS, and LARSYS), computer operations, and other facility support.

Each remote terminal site is expected to provide financial support for this facility in proportion to its share of usage. Usage of the facility is measured in CPU hours. The total cost of the Purdue/LARS support has been prorated over the total number of hours the system can be expected to provide. At the present time, this cost is estimated to be $250 per CPU hour. The remote site participant is expected to contract for a minimum of 5 hours of CPU time per month to cover a minimum of support requirements for the terminal site. Additional hours are also available provided a reasonable range of CPU hours per month is agreed to in advance of the expected usage.

B. <u>LARSYS Support</u>

1. LARSYS Analysis for Instructors

The purpose of the LARSYS Analysis for Instructors Course is to train the designated remote site specialists to become qualified instructors prior to terminal installation. Current analysis techniques, operation of LARSYS Version 3, and familiarity with the LARSYS educational materials will be taught. The two weeks of instruction at LARS includes practice using LARSYS on a terminal identical to the one proposed for the remote site and assistance in understanding the use of analysis algorithms and the evaluation of their output. The course is designed for two participants; however, additional personnel will be welcome if arrangements are made at the time of agreements to connect to the system.

2. LARSYS Educational Package

The LARSYS Educational Package is a set of instructional materials that was developed to train people to analyze remotely sensed multispectral data using LARSYS. A high priority was placed on designing the materials for individual study as it was felt that this would be the most likely situation in practice. Essential to the effective use of the educational package is the concept of a "LARSYS expert" or "site expert". Each student should be assigned to one or two persons experienced with LARSYS who can serve as instructor-consultants. Initial "site experts" would be the recipients of the LARSYS Analysis for Instructors course at Purdue. As other terminal users improve their skills, they could be expected to serve as consultants also. Students would be starting at random times and, depending on their backgrounds and other duties, would progress at different rates.

To meet these educational challenges, a series of mini-courses has been prepared. A mini-course is a set of instructional materials designed to take a student from an initial point, defined by the mini-course prerequisites, to an end point, defined by its instructional objectives. Each mini-course provides informational materials, an opportunity for the student to practice or study the skills or ideas presented, and a problem or test situation to help him determine whether he has met the objectives of the mini-course.

A variety of media has been used in the educational package, the selection dependent on the nature of the material

and the defined instructional objectives of each mini-course.
Reinforcement of certain concepts is interwoven throughout
the mini-courses: examples are the multispectral concept,
the multidimensional statistical approach, and the reality that
some ground cover types, while of economic interest, may not
necessarily be spectrally distinct.

The LARSYS Educational Package consists of six mini-courses
or modules. A flow chart of the materials is shown on the
next page.

Students begin with a background manual entitled Remote
Sensing Analysis: A Basic Preparation. This is an introduction
to remote sensing stressing the role of pattern recognition
in numerically-oriented remote sensing systems. Its specific
purpose is to provide a common background and orientation for
those who expect to make use of the LARSYS data analysis
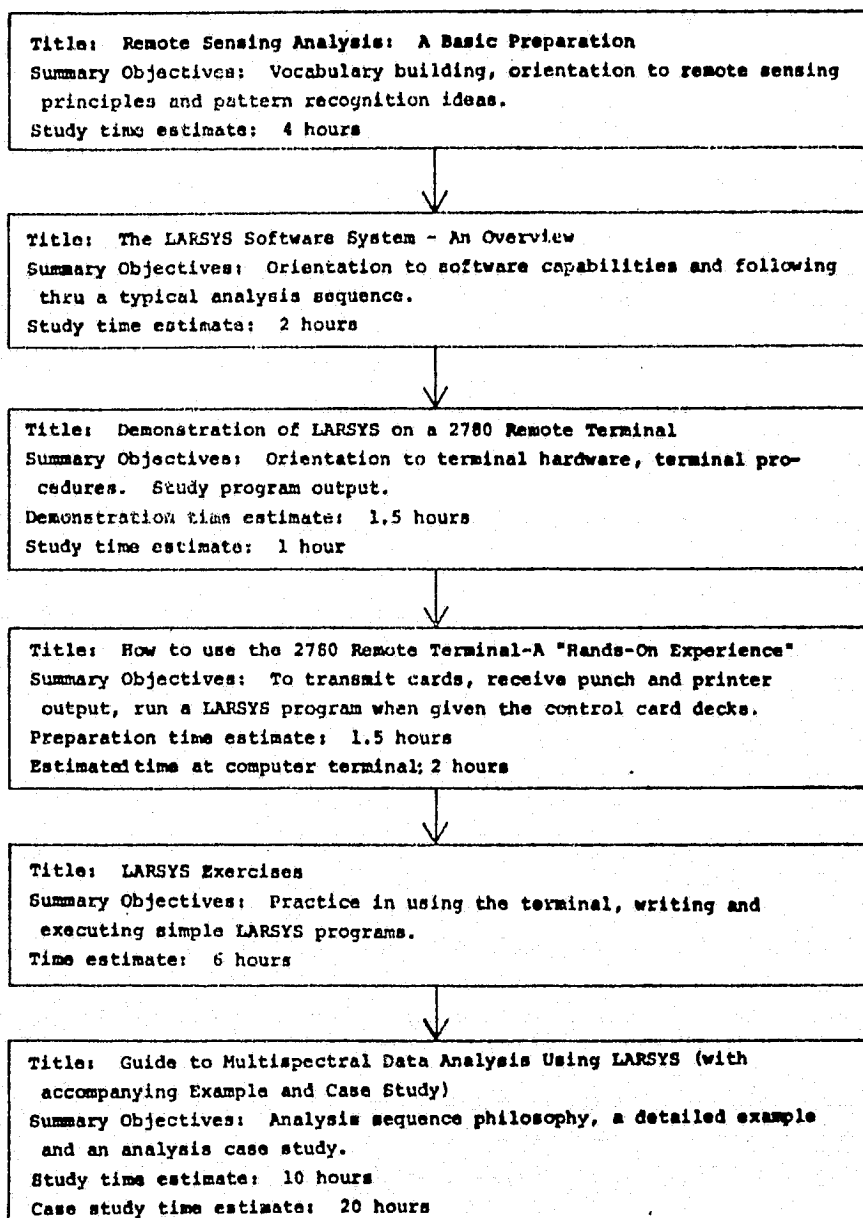computer software system.

The second module entitled The LARSYS Software System -
An Overview consists of a recorded tape which accompanies a
set of slides or a notebook of illustrations. It takes the
viewer through a typical remote sensing data analysis sequence
and illustrates the commonly used features of the LARSYS set
of processing functions.

An introduction to the computer terminal follows next. The
unit Demonstration of LARSYS on a 2780 Remote Terminal provides
the student with an introduction to the data processing hardware
he will be working with and provides him an opportunity to be
introduced to some aspect of the LARSYS software system. He
will see several LARSYS jobs run at the 2780 remote terminal.

Students are instructed in the use of the terminal by means
of an audio-tutorial lesson How to Use the 2780 Remote Terminal:
A Hands-On Experience. The student is guided by an audio tape on
how to use the terminal off-line as a card lister, login to the
computer and initiate the LARSYS system, run sample LARSYS jobs
and transmit data to and receive data from the main computer.
The audio tape is supported by a set of written notes.

LARSYS Exercises are short problems which the student
solves by using the computer terminal and LARSYS processing
functions. The purpose of these problems is to increase the
student's experience in the use of LARSYS processing functions
for multispectral scanner data analysis and to help him develop
an appreciation for the capabilities and limitations of the
LARSYS software system package. The mini-course consists
of a set of notes for the instructor and a set of problem state-
ments for the student.

The LARSYS Educational Package

```
Title:  Remote Sensing Analysis:  A Basic Preparation
Summary Objectives:  Vocabulary building, orientation to remote sensing
  principles and pattern recognition ideas.
Study time estimate:  4 hours
```

↓

```
Title:  The LARSYS Software System - An Overview
Summary Objectives:  Orientation to software capabilities and following
  thru a typical analysis sequence.
Study time estimate:  2 hours
```

↓

```
Title:  Demonstration of LARSYS on a 2780 Remote Terminal
Summary Objectives:  Orientation to terminal hardware, terminal pro-
  cedures.  Study program output.
Demonstration time estimate:  1.5 hours
Study time estimate:  1 hour
```

↓

```
Title:  How to use the 2780 Remote Terminal-A "Hands-On Experience"
Summary Objectives:  To transmit cards, receive punch and printer
  output, run a LARSYS program when given the control card decks.
Preparation time estimate:  1.5 hours
Estimated time at computer terminal: 2 hours
```

↓

```
Title:  LARSYS Exercises
Summary Objectives:  Practice in using the terminal, writing and
  executing simple LARSYS programs.
Time estimate:  6 hours
```

↓

```
Title:  Guide to Multispectral Data Analysis Using LARSYS (with
  accompanying Example and Case Study)
Summary Objectives:  Analysis sequence philosophy, a detailed example
  and an analysis case study.
Study time estimate:  10 hours
Case study time estimate:  20 hours
```

**A flow chart of the LARSYS Educational Package
giving the title, summary objectives and time requirement
estimate for each unit.**

The Guide to Multispectral Data Analysis Using LARSYS
gives a detailed breakdown of the philosophy of the analysis
methods describing steps in the analysis, why they are necessary
and how they are carried out. A detailed example parallels the
description, and in addition students have an opportunity to
carry out an analysis of their own by means of a case study.

The flow chart summarizes the objectives of each mini-
course and gives a time estimate for completing each unit.

In addition to the mini-courses, the Educational Package
includes a Site Library containing LARSYS annual reports,
selected LARS Information Notes, the LARSYS User's Manual,
"One Man's Analysis of Run 71053900" (an analysis example),
and copies of Focus. The Site Library also contains a listing
of available LARS publications.

Two documents in particular are referenced frequently
in the LARSYS Educational Package. They are the LARSYS User's
Manual edited by T. L. Phillips, and Pattern Recognition: A
Basis for Remote Sensing Data Analysis by P. H. Swain. The
former document provides a detailed documentation of the LARSYS
system from the user's viewpoint; the latter provides a theoretical
framework for the algorithms used in the LARSYS processing functions.

3. Student and Instructor Notes

The Educational Package contains 25 sets of Student Notes
and 5 sets of Instructor's Notes in addition to the previously
mentioned materials. Since these notes are expendable in the
course of using the LARSYS Educational Package, additional
copies are available. The packages can be obtained containing
25 copies of the Student Notes and 2 copies of the Instructors
Notes. This amounts to about 7000 pages of materials.

4. LARSYS User's Manual

The LARSYS User's Manual contains a comprehensive description
of the organization of the LARSYS system and the processing
functions available. It also describes how these functions are
used and controlled. Users, analysts and programmers should
have a good knowledge of the contents of this manual before
working with the LARSYS system.

Three copies of the LARSYS User's Manual are included in
the LARSYS Educational Package. It is suggested that they be
given to the system and analysis specialists and the third
copy used at the terminal. Extra copies may be purchased. It
is recommended that any person making heavy or daily use of the
system have his own copy.

5. Analysis Specialist

A Purdue/LARS employee will be designated to serve as an
analysis specialist for remote users. He will be available
to users for 5% of his time (or increments of 5%) to answer
questions on data analysis techniques, LARSYS output interpretation,
control card errors, and setting up decks to run LARSYS programs.

6. System Specialist

A Purdue/LARS employee will be designated to serve in this
capacity. The organization must arrange for at least 5% of
his time to facilitate communication and maintain smooth operation
of the terminal. Hardware and software problems should be
brought to his attention promptly. Suggestions for changes
or additions to LARSYS should also be sent to this individual,
and will be welcome. In addition, the system specialist will
place data runs in the LARS tape library for remote users.

7. Supplementary Analysis Seminar

After users have been trained by the remote site instructors,
Purdue/LARS offers a three-day seminar at the remote site to
allow users to discuss the system and its use with someone
who has experience running LARSYS programs and knows the LARSYS
algorithms. The format includes group seminars, handouts and
small group discussions conducted by the Purdue/LARS analysis
specialist.

8. Reformatting and Preprocessing Services

A data reformatting and preprocessing service is available
to remote terminal users for the purpose of entering data into
the LARSYS Multispectral Image Storage Tape library. A basic
reformatting task would be to enter a LARSYS-formatted, user-
generated data run into the LARSYS data library. The process
involves rewriting the run into 1600 BPI with an edited run
identification record which supplies needed information, cataloging
the run in the computer data storage and retrieval directory,
and generation of run log sheets for the LARSYS data log books.
Other reformatting tasks include converting data from other
formats, such as ERIM aircraft scanner data and ERTS satellite
system corrected tapes, to LARSYS format for entry into the
data library. Preprocessing tasks such as angle correction,
geometric correction, data registration and principle components
transformations can also be performed.

C.   LARSYS Programmer's Support

     If users at the remote site are interested in developing
new programs or experimenting with changes to parts of LARSYS,
they will be interested in some or all of the following:

1.   LARSYS Documentation

     The complete LARSYS documentation package consists of
a copy of the LARSYS User's Manual, LARSYS System Manual,
LARSYS program abstracts, LARSYS Test Procedures Manual and
a tape containing all the LARSYS Version 3 source coding.

     The LARSYS System Manual contains detailed information
on the hardware and software framework of the system, techniques
used in implementing the system, and the organization of the
data files.   It is directed to programmers and analysts.

2.   System Software Orientation Course

     This course is designed to take one person as far into
the understanding of how LARSYS is programmed as is possible.
Its contents are variable depending on the knowledge and
proficiency of the person taking the course.   If he knows very
little about LARSYS, the first days will be spent learning how
to use it.   Then several days will be spent in discussing the
documentation.   Preferably, the student has completed the LARSYS
Analysis for Instructors or its equivalent prior to taking the
course.   Then the entire time can be spent going over documentation,
delving into the modules of interest, and interacting with the
LARSYS system.   Initial plans should be made on changing LARSYS
from the remote site, or on installing LARSYS on his own
computer during the course.

3.   CMS Course

     CMS provides excellent facilities for writing and editing
programs at the terminal without the use of cards.   A person
can type in all or part of a program at one terminal session,
leave it stored on his personal disk, and return to delete
or add lines, correct typing errors, etc., and then compile and
execute the program, all with commands issued at the terminal.

     This CMS course involves 2 days of instruction, exercises
and assistance in the use of CMS at the remote site.   Notes
listing basic CMS commands will be made available.   The appropriate
CMS manuals can be purchased from IBM.

The CP/CMS Short Course introduces the user to many of the commands used in the following three environments: CP, CMS, and EDIT. CP is the Control Program for the time-sharing system; CMS runs under CP and allows the user to create and manipulate his disk files and initiate editing; EDIT then can be used for creating disk files at the terminal or editing existing ones.

The commands that are presented are all included in the IBM CP-67/CMS Manual (GH20-0859). Since the manual contains over 600 pages, the course is designed to include just those commands that are most useful and to present examples of how they are used. Having taken the course, the user should then be able to readily look up any additional information in the manual. Written material used in the course includes:

1) Short course notes -- includes all commands presented in the course,
2) A diagram of all the CP and CMS environments and how to transfer from one to the other,
3) A set of exercises.

The course is divided into the following four sessions:

1) general introduction to CP-67/CMS;
2) some CP functions, some CMS commands, EDIT commands;
3) more CMS and CP commands;
4) CMS commands for compiling, assembling, link-editing, and executing Fortran and Assembly language programs; CMS EXEC files.

Each session takes approximately two hours to complete. The 2 days of instruction include the formal sessions, exercises, and assistance in the use of CMS at the remote site.