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8.0-10.154

CR-163171

LANDSAT TECHNOLOGY TRANSFER USING COMMUNITY COLLEGES

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(E80-10154) LANDSAT TECHNOLOGY TRANSFER
USING COMMUNITY COLLEGES Progress Report,
Jan. - Apr. 1980 (Environmental Research
Inst. of Michigan) 48 p HC A03/MF A01

N80-26737

Unclas

CSCL 05E G3/43 00154

May 1980

Type II Report for the Period of January through April 1980

Prepared for:

NASA HEADQUARTERS

Washington, D.C. 20546

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. 147200-4-P		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle Landsat Technology Transfer Using Community Colleges				5. Report Date May 1980	
				6. Performing Organization Code	
7. Author(s) Robert H. Rogers				8. Performing Organization Report No. 147200-4-P	
9. Performing Organization Name and Address Environmental Research Institute of Michigan P.O. Box 8618 Ann Arbor, MI 48107				10. Work Unit No.	
				11. Contract or Grant No. NASW-3308	
12. Sponsoring Agency Name and Address NASA Headquarters (Code ETS-6) 600 Independence Ave., S.W. Washington, D.C. 20546				13. Type of Report and Period Covered Type II January - April 1980	
				14. Sponsoring Agency Code	
15. Supplementary Notes					
16. Abstract This paper reports on the results achieved during the first four months of the program to transfer Landsat technology to practicing professionals in the private sector and local agencies (grass roots) through Community Colleges and other institutions convenient to users. The approach offers "hands on" interactive analysis training and demonstrations through the use of color desk-top computer terminals communicating with a host computer by telephone line.					
17. Key Words Landsat Technology Transfer Training Data Processing			18. Distribution Statement		
19. Security Classif. (of this report) Unclassified		20. Security Classif. (of this page) Unclassified		21. No. of Pages	
				22. Price	

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1. INTRODUCTION AND SUMMARY

Since the initiation of the Landsat program, most government technology transfer efforts dealing with Landsat use have been focused primarily at the public sector — Federal agencies and state governments — and have not involved the private sector to any significant extent. The application of Landsat data in the private sector has been limited primarily to the private suppliers of Landsat data processing and analysis equipment and services — aerospace companies and a limited number of users in sectors such as the mineral and petroleum industry and timber companies. However, there are many other potential private users who have not yet incorporated Landsat as a tool in their array of services; some examples are architectural and engineering firms, computer data processing firms, energy and environmental companies, and other consultants providing services in land planning and development. Lack of greater involvement by these potential users has retarded the growth of Landsat technology, since engineering firms do much of the land-use mapping for both government and private industry.

Recent surveys show that a large number of potential users in the private sector and at local agencies are interested in becoming consumers or suppliers of Landsat-derived products and services. However, they have been prevented from entering this market by the high cost of analysis facilities and the difficulty of obtaining training in the new technology. The overall objective of this program is to demonstrate a way to bridge this gap by making Landsat technology readily available through local community colleges and universities.

The methodology gives users an opportunity to obtain "hands-on" training in data analysis techniques, using a desk-top, interactive "Remote Analysis Station" (RAS). The RAS communicates with a central computing facility via telephone line, and provides access to

deliverable, land cover maps and data products via remote command.

To achieve the desired objective — the successful transfer of Landsat technology — the 12-month program is working towards the following specific objectives:

1. Develop plans and select initial program participants for a network which will effectively transfer Landsat technology to the private sector and local agencies at the "grass roots" level. (Section 2.1)*
2. Develop an operating methodology for the remote, interactive analysis of Landsat data and the generation of the output product.
3. Develop an implement technology transfer and training at "grass roots" level. (Section 2.3)
4. Develop a plan for expanding the technology transfer program, preferably on a self-sustaining pay-as-you-go basis for users, with seed money for community college training grants only. (Section 2.4)

1.1 TECHNICAL APPROACH

To accomplish the program objectives, ERIM is developing and evaluating a model network (refer to Figure 1) where the basic partners are NASA, a university or research institute (ERIM in this case), and community colleges. In this investigation, a portion of the network is represented by the Southeastern Michigan Technical Assistance Program (SEMTAP) composed of ERIM and 13 community colleges. SEMTAP is a consortium of institutions dedicated to the development of a

*To review methods used and results achieved towards specific objectives, please refer to indicated sections.

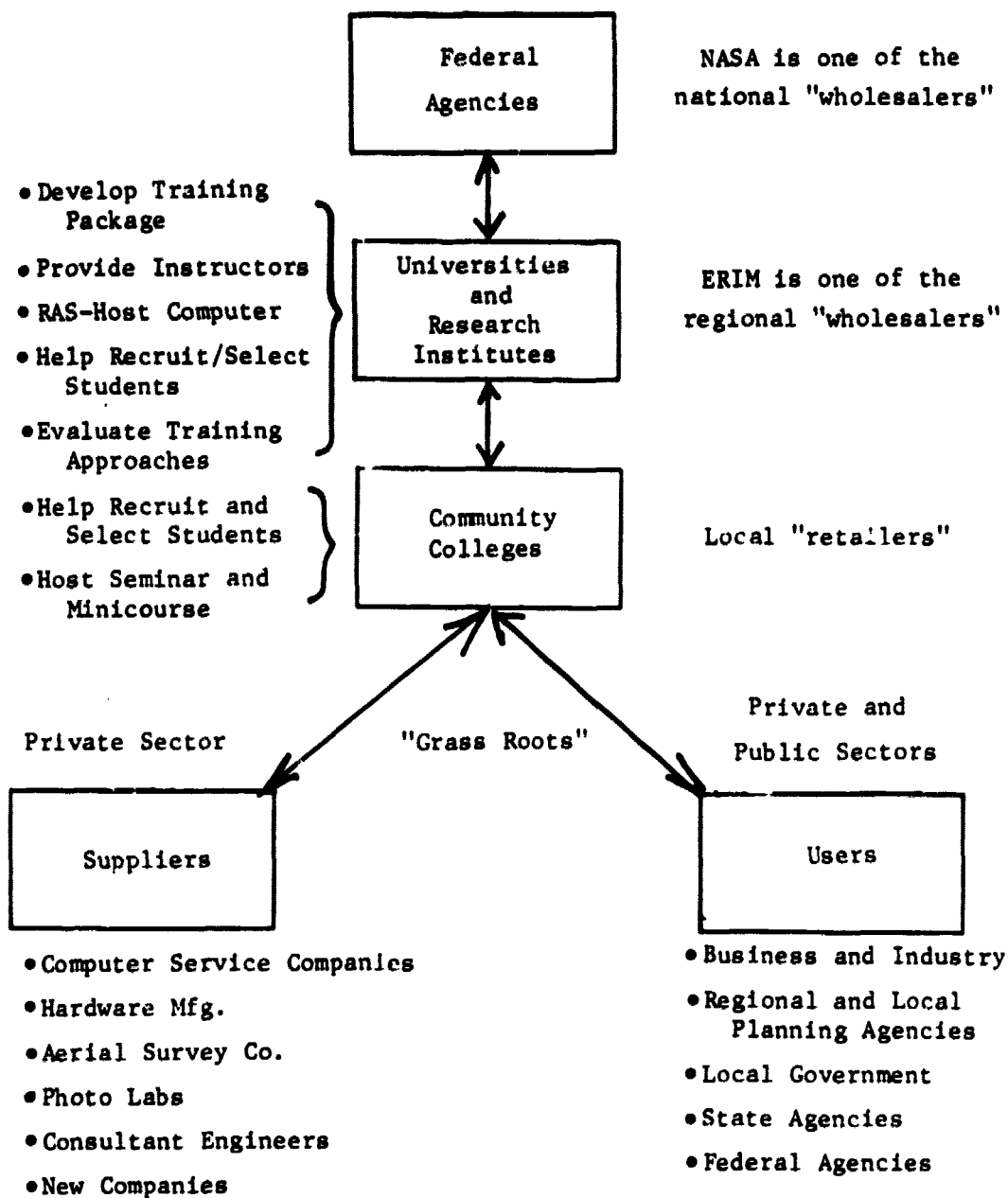


Figure 1. TECHNOLOGY TRANSFER NETWORK FOR PHASE I



a cost-effective, technology transfer network for the State of Michigan and the nation.

The role of the university or research institute is to provide host computer services for the Remote Analysis System (RAS), develop training packages and programs, and to deliver and support seminars, minicourses, and workshops staged at the community colleges. For their part, the community colleges will classify and organize business and industry in their neighborhoods in accordance with technical or information needs (via a user needs survey), organize and host seminars for potential users and suppliers of data products, provide facilities for Landsat exhibits and RAS demonstrations, and also serve as local contact points for technical assistance in accordance with their community service objectives.

Thus the university or research institute, acting as the "wholesaler" of Landsat technology, provides backup to the community colleges, helping link the creative resources of NASA with local organizations. The community colleges, or "retailers," identify local needs and develop transfer activities geared to those needs in both the private and public sectors. This concept for training and education utilizes existing organizations; one of its greatest strengths is that the various people and organizations occupy roles for which the required positioning and motivation have already been established. This is particularly important with respect to the rapport that exists between community colleges and people and organizations at the local level. The establishment of this productive rapport is the most important and difficult problem associated with technology transfer.

Through the work with SEMTAP, the program will determine the best procedures for working with community colleges in the transfer of Landsat technology to local users. This experience will provide a solid basis for developing plans to activate the resources of other

colleges as part of a national delivery system for Landsat technology. There are 1,240 community colleges and technical institutes in the United States located in 426 of the 435 congressional districts (1977 data); each of these institutions has close connections with various public and private local organizations that could benefit from the use of Landsat data — or more directly, from the information it provides. The close relationship between the community colleges and the local communities makes the former ideal for transferring remote sensing technology.

1.2 SUMMARY OF RESULTS AND PLANS

Section 2.1 reviews the program efforts to select colleges and local users to participate in the demonstration network. Activities have included meetings with community college presidents and local engineering organizations as well as announcements and articles in several publications. An analysis of questionnaires completed as a result of these contacts will be available for review with NASA at the end of May when the first participants will be selected to obtain training and RAS support for demonstration projects.

The three RAS terminals which will support these activities are described in Section 2.2. The terminals are all operational, with some software limitations which will be corrected before the first formal training activities begin on 1 July.

The training materials to be used with RAS (Section 2.3) will be reviewed by NASA and local academic institutions at a workshop in Ann Arbor in late May or early June. This workshop will also be the first step in preparing potential instructors, and should result in constructive comments on the training program. The training package has been designed to train practicing professionals in the use of RAS for the computer-assisted interpretation of Landsat data and in the use of the data for planning and management of earth resources. The pack-

age will support 45 hours of training, which can be delivered either as a minicourse or as a regular semester program. Of the 45 hours, 10 to 15 will be devoted to "hands-on" experience using the RAS terminals. The program will evaluate different methods of delivering the training activity to determine which works best. One method that looks promising for large organizations (i.e., those that can provide 6 to 10 trainees) is on-site training using the trainees' facility (in-plant training). Another approach is to use the community college or another convenient facility (e.g., a local high school, one of the users plants, etc.) for one week of group sessions followed by a second week where some trainees use RAS on-site at their organizations for additional training and in-plant demonstrations. The program will also evaluate the concept of using the community college or university as a service center where trainees schedule the use of the RAS to conduct their demonstration projects.

To introduce the technology to local organizations, tentative plans are to conduct two or three workshops and minicourses between July and November at local community colleges and universities, and to support three or four local users (mainly consulting engineering organizations) for more intensive demonstration projects.

The program is on schedule and meeting the planned objectives, with only two problems identified (Section 3). One is the weight and size of the RAS. Although the RAS terminal meets cost (under \$20K) and functional performance objectives, its size and weight are greater than anticipated. This will make mobility for on-site training and demonstration somewhat difficult. Two people are required to carry the monitor or desk, and the desk will not fit into the back of most station wagons. The other problem is a lack of a geo-based system capability in the RAS host computer, to permit land cover data derived from Landsat to be manipulated with other digital files (such as soils,

topography, etc.)). A larger number of potential users could be attracted if geo-based system applications were included in the training and demonstration efforts.

An updated schedule is included in Section 4, which summarizes major accomplishments during the first four months and reviews plans for the remaining eight months of the project.

1.3 CONCLUSION

Expressions of interest from the private sector and academic institutions and encouragement to move faster with this technology transfer effort indicate that the program is on track. We anticipate that this investigation will demonstrate that recent developments in computer technology now make it possible for the private sector to provide high-quality Landsat products and services, using a desk-top computer terminal, at the low cost investment of about \$20K. It will also show that community colleges and small universities, readily available to the local user community, can deliver the needed training in the use of the terminals and the application of Landsat technology. In addition, this approach will permit a gradual expansion of the initial low-cost user facility as confidence and available capital increase, and as the system shows potential for easily merging other sources of data (soils, topography, etc.) into the Landsat analysis process.

2.0 WORK TOWARDS FOUR PROGRAM OBJECTIVES

This section reports on the methods used and results achieved towards transferring Landsat technology to the private sector and local agencies (grass roots). To facilitate comparison between the work accomplished and the four (4) specific program objectives, the following sections have the same titles and are listed in the same order as the program objectives.

2.1 ESTABLISH NETWORK PARTICIPANTS AND PLANS

This objective requires development of plans and selection of initial participants for a network which will effectively transfer Landsat technology to the private sector and local agencies (grass roots). Work towards this objective includes the following efforts:

1. Provide user awareness publications, workshops, and user requirements analysis needed to identify potential participants and to establish their role in the technology transfer process.
2. Apply criterion in the selection of academic institutions and local user. The criterion to be used in selecting these participants will include: expressed interest in remote sensing and Landsat analysis, and in case of the private user, a viable application and market for use of Landsat products. Another important criteria is the willingness and likelihood that the private participant will invest his own money in continuing the use or providing Landsat products and services after completion of this training program. Organizations already committed to an in-house Landsat processing capability will not be considered for this program unless the program can significantly enhance or speed up acquisition of the in-house capability by several years.



The community college or other academic institutions selected for the demonstrations will be expected to integrate the RAS into classroom instruction and use trainees from the private sector and local agencies as well as college staff to carry out projects(s). One of the colleges will also act as a host later in the program for a user-oriented seminar or workshop where the college demonstrates its capability to bring together potential users of Landsat products with the potential supplier of the products and services.

3. Develop a plan for a program of trainings and demonstration projects to be carried out by one or more community colleges and small universities and three or more local users (mainly drawn from engineering consulting firms). Plans will provide names of initial participants and schedules showing how various demonstrations and training efforts are phased in over approximately a six month period to maximize resources.

Work towards these subtasks has included the following user awareness publication and meetings needed to inform community colleges and local agencies of opportunities to participate in Landsat technology transfer efforts.

1. Workshop at ERIM, March 21, 1980, for community colleges, presidents, and staff (refer to Appendix A).
2. Announcement of technology transfer program in the March regional newsletter of American Society of Photogrammetry (ASP).
3. Landsat workshop at ERIM, April 9, 1980, for approximately 30 attendees from local engineering organizations and public agencies. The workshop provided an opportunity to obtain inputs from the local community on Landsat technology transfer plans. Please see Appendix B for letter announcing

meeting, description of proposed training program, attendance list and questionnaire used by attendees to express views on technology transfer efforts.

4. Landsat false color image of Detroit and article on Landsat technology transfer program published in the April issue of Detroit Engineer Newsletter. This article has generated requests from over 100 engineers for free calendars with Landsat pictures as well as inquiries regarding training program. See Appendix C for copy of article.

Contacts made, as a result of these user awareness activities, are being followed up by questionnaires to obtain information which can be used as a basis for selecting the initial program participants and to determine user preferences regarding training methods, location for classes, and Landsat applications. Most questionnaires will be available and analyzed by the end of May. At that time, or in early June, ERIM will meet with NASA to develop a plan which includes names of the colleges and local users who will obtain training and RAS support for demonstration projects. Current plans indicate two or three workshops (1-day) and minicourses (1-week) to be held (during July through November) at community colleges and local universities. Trainees from one or two organizations could be selected from each minicourse to undertake further work of their choice using RAS at the college of their choice or on-site at their own organization.

2.2 DEVELOP OPERATING METHODOLOGY

This specific objective requires the assembly of equipment and techniques by which private sector users can obtain the capability to develop Landsat products and services through community colleges and small universities with the aid of a remote analysis station. The development of this methodology includes the following intermediate goals:



1. Assembly and test of three desk-top RAS computer terminals which will be connected to a central computing facility by telephone lines. The three remote stations will comprise the key means to perform user training and to conduct technology demonstration projects.
2. Integration and test of the RAS, including modification and development of new software where needed to permit individualized RAS operation at the sites of the participating colleges or private users.
3. Develop specifications and cost estimates of RAS and host computer operations and products preferred by users. This will evolve from experience and user comments gained from the operational support of training and demonstration projects.

Work towards these goals has included: assembly and test of two RAS units to complement a breadboard model (purchased prior to this program by ERIM for development activity), and integration and test of RAS with ERDC including modifications of ERDC software and development of new software as needed. The three RAS terminals were assembled from readily available hardware for less than \$20,000 each.

The breadboard model will be used for demonstrations and basic training as well as for continued software and operating technique development. The other two terminals will be shared by the colleges and four or five engineering consulting firms.

The three terminals are all operational, with some software limitations, and are being used to support demonstrations and technique development as planned software development activities. Scheduled software development should be completed by 1 July when formal training and demonstrations begin.

The following Sections 2.2.1 and 2.2.2 review the characteristics

of the RAS terminals and their host computer, the PDP11/70 in the Earth Resources Data Center (ERDC), respectively. Section 2.3 reviews plans for their use to support training and demonstration programs.

2.2.1 REMOTE ANALYSIS STATIONS (RAS)

The RAS, as shown in Figure 2, consists of a color CRT imagery display with alphanumeric overwrite and keyboard. Display resolution is 256 x 256 picture elements which allows for viewing of up to 115 square miles at one time. The station contains a Z80 microcomputer which controls the display refresh memory, that consists of 3 bits per color (red, green, and blue) with a resolution of 256 pixels by 256 lines plus one bit of graphics overwrite, and controls remote station processing. The station can communicate via modem and dial-up telephone with a host computer at 1200 baud or hardwired (twisted pair) to a host computer at 9600 baud. Although the display refresh memory is capable of 256 x 256 resolution, display resolutions of 128 x 128 and 64 x 64 can also be selected to fill the display faster during the training set selection process. Data can be displayed as three band false color imagery, one band color sliced imagery, or as processed imagery.

The slowest filling of the display would be for three-band false color imagery. False color display fill rates for the various resolutions and baud rates are shown in the following table. The single band color sliced and categorized images (with less than 16 categories) will fill the display at twice the indicated false color rates.

The interactive operating techniques developed for RAS permit most of the interaction to be performed at lower resolutions and faster display fill rates, with the high resolution capability used for viewing the final processed data. A key to the relatively rapid fill rate is that the data being transmitted to the RAS by the host computer are



FIGURE 2. REMOTE ANALYSIS STATION (RAS)

ORIGINAL PAGE IS
OF POOR QUALITY



APPROXIMATE FALSE COLOR DISPLAY FILL RATE AND RESOLUTION

Modem Baud Rate	Display Resolution-Pixels		
	<u>64 x 64</u>	<u>128 x 128</u>	<u>256 x 256</u>
1200 (Dial Line)	32 sec.	120 sec.	8.5 min.
9600 (Local Line)	4 sec.	15 sec.	64 sec.

already scaled to the 3 bits per color display resolution for the 3 CRT guns (red, green, and blue) prior to transmission.

The RAS features the following functions:

- Dial-up image coverage from host computer, with selectable trade-off between image loading speed and quality
- Display selected portions of image scene by specifying particular image fields
- Use menu-driven, interactive control language
- Select training sets for data classification via cursor
- Invoke categorization of selected data
- Display categorized image data
- Display categorization performance statistics
- Input ground control information for geometric image corrections
- Requests subsequent processed image generation

2.1.2 INTEGRATION AND TEST OF RAS WITH ERDC (See Figure 3)

During this program, the host computer for RAS is the PDP11/70 computer in the ERIM Earth Resources Data Center (ERDC). The PDP11/70 peripherals consists of the following:

- 1000K bytes of memory
- Three 176 megabyte disks
- Two 2.5 megabyte program disks
- Four 9-track computer tape transports
- Two interactive terminals
- One 16-channel terminal multiplexer
- Two telephone modems
- Datagrid digitizer table
- Optronics drum film recorder
- Two hardwired high-speed maximum likelihood processors

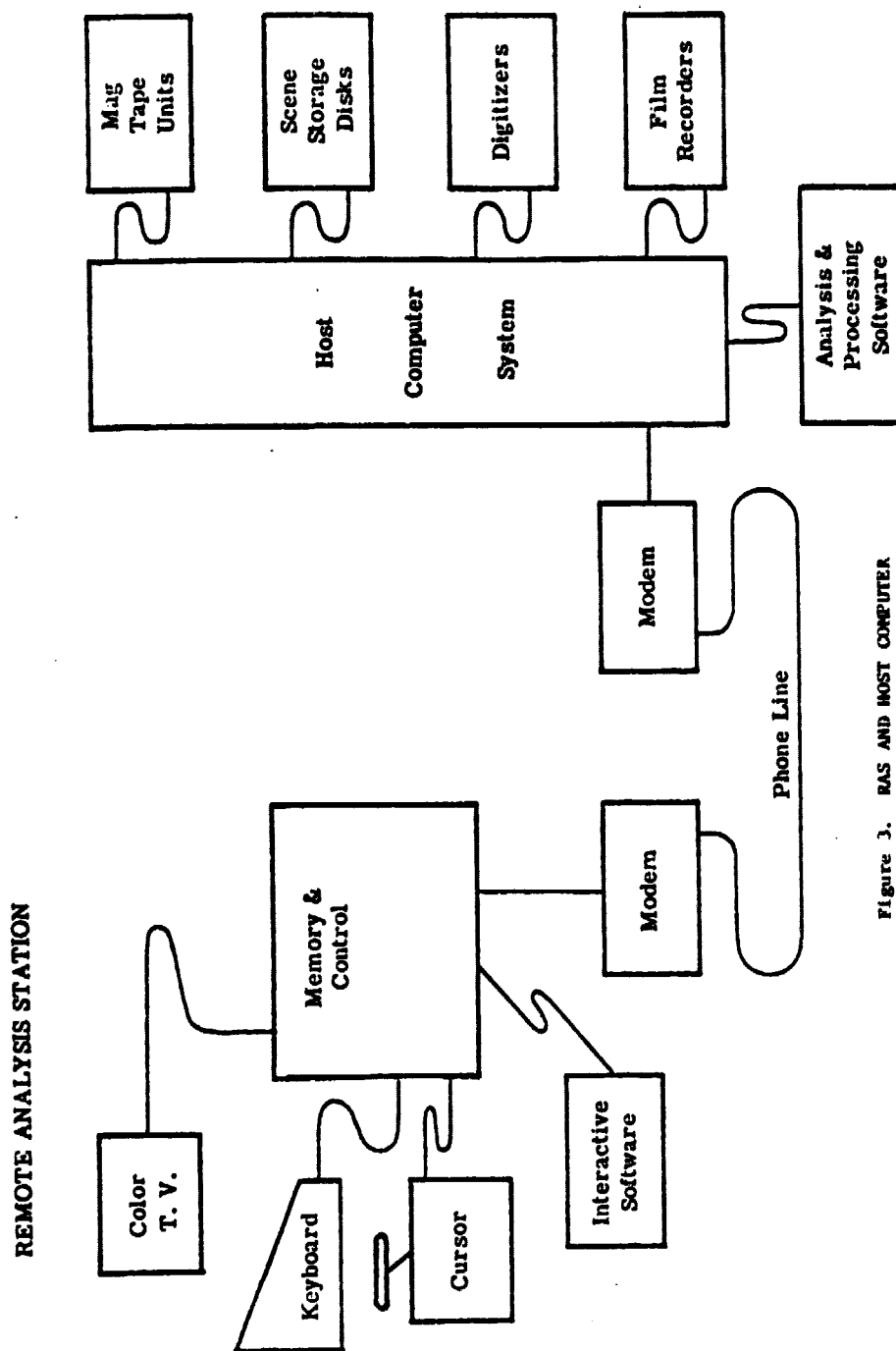


Figure 3. RAS AND HOST COMPUTER



An analysis has been made of the remote terminal "carrying capacity" of this facility, and 20-25 users could be supported under the following assumptions:

- For remote stations linked to ERDC, connect time duty cycle will average 10% and peak at 25%.
- If a user is linked to ERDC he/she will actually be using the ERDC CPU 10% of the time, with the remainder spent viewing the display or deciding what action to take next.
- Each user will require, on the average, 1/4 scene of Landsat data storage on disk at ERDC. This storage requirement will exist whether user is connected or not.
- No online task utilized more than 64K bytes of core memory.
- There are no more than four commercial telephone lines connected to the ERDC terminal modem/multiplexer.

Work accomplished during this period also included modification of existing ERDC software to operate with RAS and generation of new software peculiar to the RAS. Software modifications were primarily changeover of ERDC software, which was controlled by a combination of function switches and keyboard commands, to RAS control which is entirely by keyboard. The ERDC color displays, which are 320 pixels by 240 lines, 3 bits per color, with graphics overlay bit, are very similar to RAS. New software was primarily command and control software for the Z-80 microprocessor in the RAS

The presently envisioned operating methodology for use of RAS-ERDC is the following sequence of events:

- a. The user sends his Landsat scene to the host computer facility and requests a "mount" at a specified date. At that time, the user's test area is read onto disc into the user's assigned file. The user will have a RAS User's Manual, and may

request histograms and a color composite print of the study area as well.

- b. The user "dials up" the ERDC computer. Two outside lines have been established for this project.
- c. The user calls up a display full of data from his desk area by scan line and pixel number. After general familiarization with the RAS 10-Option menu, the user should perform a contrast stretch.
- d. Once map categories have been established and potential training set areas have been identified the user begins to select training sets. More than one training set can be selected from the display without moving to another Landsat location. Training sets are selected using a cursor, and the cursor coordinates along with training set identification and color codes are transmitted to the host computer.
- e. The user proceeds to interactive analysis after initial training sets are selected. Typically in ERDC, the first analysis is performed after 6-8 training sets are selected. Categorized data on the display, together with statistical printouts (as overwrite) are reviewed, and then training sets refined and additional training sets selected until the desired results for up to 50 categories are available. Typically in ERDC, 35-40 training sets for 25-30 categories are selected. The categories are then aggregated down to the desired number of final map categories.
- f. Statistical displays such as categorization accuracy tables, category separability analysis, etc. can be requested and displayed. Since the RAS has no hard copy capability, the display must be photographed if the display information is to be retrieved before hard copy from the host computer arrives.

- g. Presuming the categorization is satisfactory, the user can request categorization of the entire file and then review the categorization at high resolution, moving through the area.
- h. Returning to the false color display, the user types in the latitude and longitude of map derived ground control points (GCP). The host computer converts the points from latitude and longitude into rough Landsat coordinates and places a blinking cursor point on the displayed image at the estimated point in the image corresponding to the GCP. The user moves the cursor to the image control point, which transmits the image control point location to the host computer. With a sufficient number of such properly located points, the host computer calculates the geometric correction matrix. Residual errors are transmitted to the user for his review.
- i. The user selects theme colors, map products (scale and projection), digital files, etc. and transmits the order to the host computer.
- j. The products are generated off line and sent to the user. Analysis of demonstration projects performed by ERDC shows that demonstration test sites vary from 1,000 square miles to 8,000 square miles with the average site as 2,500-3,000 square miles. This average area is approximately 1/4 of a Landsat scene. One of three 176 megabyte disks in ERDC can store approximately 25 such areas.)

All of these steps are presently performed in ERDC in the manner described above, with the exception of entering ground control points which are entered directly from maps on a digitizing table instead of typed in on the terminal keyboard.

Using the above approach, a knowledgeable RAS operator should be able to converge on a set of land cover themes with a categorization accuracy of 85% or better in 6-12 hours of interaction. When modification of ERDC software is completed, the RAS user will be able to generate the full range of Landsat products, e.g., color maps and overlays, land cover tabulations, and digital land cover files, now only available from ERDC operation. The ERDC output products have a high degree of user acceptance and can be provided at most any desired map scale in any common map projection.

2.3 DEVELOP AND IMPLEMENT TECHNOLOGY TRANSFER AND TRAINING AT THE GRASS ROOTS LEVEL

The objective requires the development and delivery of a program of training and demonstrations designed to stimulate the market and encourage private users to become consumers and suppliers of Landsat products. Work towards this objective includes the following subtasks:

1. Develop a training program containing workbooks, RAS operator's manual, and other material needed to instruct users in Landsat data processing and applications.
2. Provide two or three minicourses or workshops through local community colleges and universities. For this activity, RAS will be integrated into classroom instruction and used by trainees to carry out projects. The trainees and college staff will assess the utility of RAS as a technology transfer medium and will determine the feasibility of using the college as a local technology transfer center as well as a clearinghouse for remote sensing information.
3. Support three or four demonstration projects by private engineering consulting firms to produce Landsat products for use in on-going projects, to generate user awareness material, to train staff, and to evaluate the RAS as an initial low-cost operational Landsat data analysis capability.



Work towards these goals has been directed at developing the training program. (See Appendix B for course description). The objective of the course is to train practicing professionals in the computer-assisted interpretation of Landsat data; in the generation of digital data bases from Landsat, aerial photography and map sources; and, in the use of these data bases for planning and management of the environment, natural resources, and land use. This training can be delivered as a minicourse or regular semester program. Approximately 15 hours of lecture and 15 hours of work book exercises are anticipated. Another 8 to 16 hours covering remote sensing fundamentals could be available as an optional portion of the training. For the minicourse, this option could be provided as an exercise to complete before the first class session or some mix of lecture and exercise.

The laboratory portion will provide instruction in the use and "hands-on" experience of RAS computer terminals for processing Landsat data and interacting with other digital data bases. To support this activity, the training will contain 10 to 15 hours of exercise designed to train the attendees to use RAS.

*Various methods of program delivery will be evaluated during the investigation to determine what works best. One method will be a minicourse where trainees meet as a group at the community college or other facility convenient to trainees during the first week and then trainees use the RAS on-site in their own organization during following week(s) to obtain additional experience as well as to support in-plant training and demonstrations.

Work accomplished regarding the training program has included a review of available training material from the NASA Regional Centers, and various academic institutions, as well as establishment of an agreement with Eastern Michigan University (EMU) to develop additional training aids. EMU was selected to assist with this activity due to



their previous experience in using the ERIM Earth Resources Data Center (ERDC) to provide an off-campus, graduate course (GEO 505) in Landsat data processing. Experience and material generated during the EMU course and materials obtained from NASA and EROS provide much of the materials being used to assemble the new training package.

This investigation will host a workshop for 10 to 15 people during the last week in May or early June to obtain a critical review of the training material. Representatives from the following organizations will be invited to the workshop: NASA, local universities and colleges teaching remote sensing courses, private sector and local agency staff who have expressed interest in teaching the program, as well as representatives from community colleges. This workshop will be the first step in preparing potential instructors to use RAS and training material, and will provide the program an opportunity to obtain additional inputs for upgrading the materials before use with trainees at the colleges.

Tentative plans are to use one RAS to conduct two or three seminars and minicourses during July through November 1980 at local community colleges and universities. During the same period, the second RAS will be used to support the demonstration projects. Selection of participants for these activities are awaiting analysis of questionnaires and meeting with NASA in late May or early June.

2.4 DEVELOP PLANS FOR EXPANSION OF LANDSAT TECHNOLOGY

This objective requires the development of a plan for the continued and expansion of the use of Landsat technology at additional community colleges and including more local users. Emphasis in the plan will be placed upon:

1. Prospective users procuring their own remote analysis stations once a successful demonstration project is completed.

2. Community colleges and small universities providing self-support of training courses with minimal NASA grant support.
3. Involvement of commercial concerns (computer time-share firms, hardware packaging firms) on an investment basis.

Work towards development of this plan will start (about mid-August) when this investigation has successfully demonstrated the feasibility and methods of working with the Southeast Michigan Community College network (SEMTAP) to transfer Landsat technology. There are many emerging state networks such as SEMTAP which could become part of a national delivery system for Landsat and other remote sensing technology. The state of Ohio, for example, has recently formed OTTA (Ohio Technology Transfer Organization) consisting of Ohio State University and Ohio Community College.

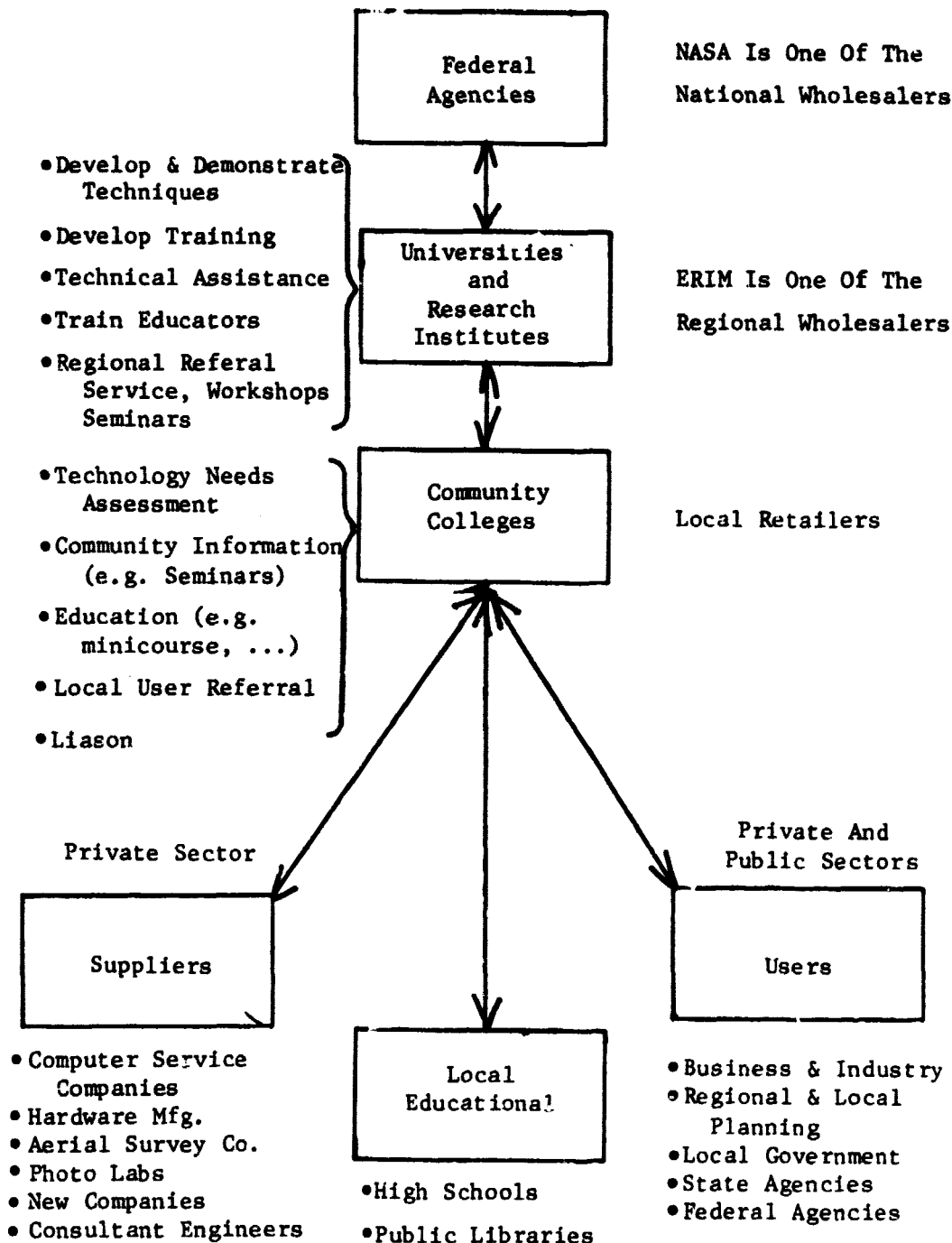
One approach to putting these emerging community college networks into action nationwide may be to duplicate activities of this investigation in one or two other states. It is believed that if a model extension network can be successfully demonstrated in Michigan and in a few other states, other colleges would follow nationwide. The basic partners in a model or national technology transfer effort would be NASA, community colleges, research institutes, and university research centers. However, it should be noted that approximately one-half of the research and development activity in this country is undertaken by the private sector. A maturing technology transfer program should, therefore, involve private sector organizations as well.

The universities and research institutes in the model or demonstration networks would be funded to develop the necessary training material, conduct early user awareness activities, and to assist the community colleges in developing their role as the extension agency. Funding to the community colleges in the model network program would demonstrate the colleges' capability to provide:

- a. Technology needs assessment (identify potential users and data needs).
- b. Community information (seminars -- to bring public attention to the technology).
- c. Technology transfer education (e.g., mini-course in digital data processing using remote analysis stations connected to university or research host computers by telephone line).
- d. Career education (e.g., computer, photo processing, etc).
- e. Local user referral service (technology data bank service which matches user needs with government and private industry data or services).
- f. Technical assistance.
- g. Liaison with community research institutions, universities, and Federal government.

A national technology extension network, patterned loosely after the USDA Cooperative Extension Service, can be envisioned. The different partners and their roles in the network are identified in Figure 4. Such a network could stimulate the market and mobilize local private sector's initiatives to offer remote sensing products and services. A technology extension network, with support to community colleges paralleling present-day vocational education funding, might be a legislative goal.

Figure 4. FUTURE NETWORK TO EXTEND LANDSAT TECHNOLOGY TO THE PRIVATE SECTOR



3.0 PROBLEMS

3.1 RAS WIEGHT AND SIZE

RAS terminals are low cost (under \$20K) and meet operational performance specifications, but weight and size of the monitor and desk purchased from Ramtek is greater than anticipated. The larger weight and size will make set-up and moving for 1-day workshops and in-plant demonstrations more difficult than anticipated. Ramtek and other hardware organizations will be encouraged to review Landsat technology transfer program needs and develop specification and cost for alternative RAS configurations.

3.2 NEED FOR GEO-BASED INFORMATION SYSTEM CAPABILITY

Many potential users of Landsat data have applications that are best solved with the aid of systems which can integrate and manipulate digital land cover files (derived from Landsat) with files derived from other data sources (e.g. soils and topographic maps, etc.). The ERDC host computer does not have this geo-based system capability at this time. Suggestions and recommendations are sought on how to obtain additional capability so that this important application for Landsat data can be integrated into training and demonstration activities.

4. SUMMARY OF RESULTS AND SCHEDULE

The 12 month program is on schedule and meeting planned objectives. This section summarizes major accomplishments during the first quarter of activity and reviews plans for the remaining three quarters. Plans are also reflected in the following schedule (Figure 5) which shows the time phase relationship between remaining activities.

4.1 ESTABLISHING NETWORK PARTICIPANTS

Most questionnaires will be available and analyzed by the end of May, and at that time or in early June ERIM will meet with NASA to develop plans providing names of colleges and local users who will obtain initial training and RAS support for demonstration projects. The plan will also show to the degree possible how ERIM intends to phase in the various demonstrations and training efforts over the July through December period.

4.2 ESTABLISHING OPERATING METHODOLOGY

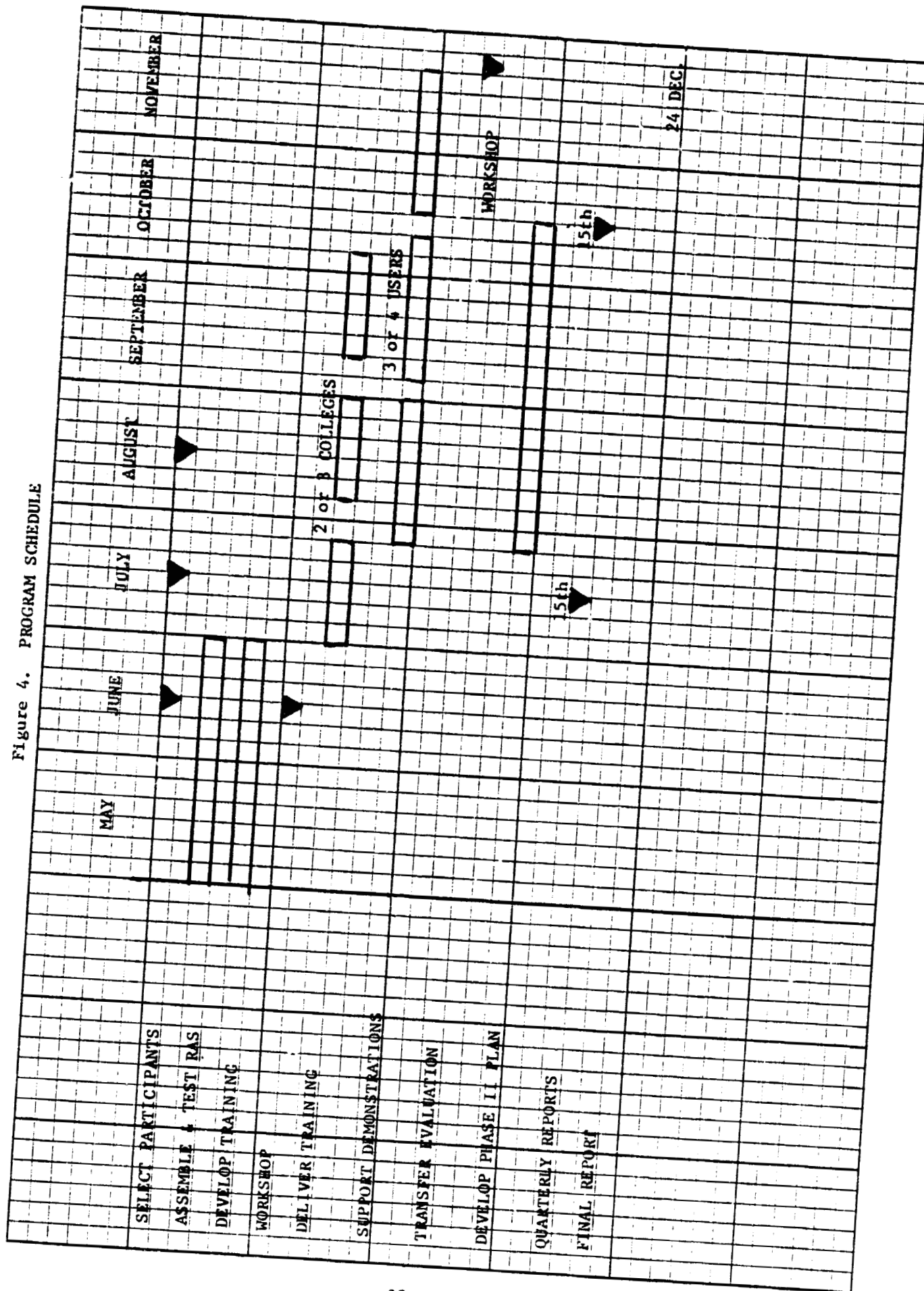
The three (3) RAS terminals are in limited use for technique development and demonstrations, as planned software development will continue until about July when the first formal training activity starts.

4.3 DEVELOP AND IMPLEMENT TRAINING AND TECHNOLOGY TRANSFER

First draft of the training program (i.e., operator's handbook, exercise workbooks, etc.) is nearing completion. Plans are to conduct a workshop in Ann Arbor in late May or early June with NASA and academic institutions to critique the training material and RAS operations. Comments from this workshop will be incorporated into the training program (to the extent possible) before the first workshop tentatively scheduled for July.

Eastern Michigan University, Western Michigan University,
Central Michigan University, Michigan State University, and other

Figure 4. PROGRAM SCHEDULE



academic institutions have expressed interest in attending a workshop to review the training program. These institutions are investigating methods of upgrading their remote sensing courses to include digital analysis capability.

Several members from the private sector, who provide some Landsat products or services, have also expressed interest in attending a workshop and in being considered for instructors in Landsat training activity at the community colleges. Staff from these organizations will be encouraged to become instructors, since it provides their organization an opportunity to be identified as a potential source for Landsat services.

To introduce the technology to local organizations, plans are to use one RAS to conduct two or three seminars and minicourses between July and November at local community colleges and universities. One method of delivery to be evaluated will be a minicourse followed by some trainees using RAS on-site at their organizations. As part of the in-plant effort, the program will assist the trainee with a workshop for other employees, if desired. Need for in-plant support is expressed by a number of returning questionnaires showing that some large utility, engineering, and regional planning organizations may provide 6 to 15 additional trainees if their facilities were used. In-plant activity may also attract others in the organization who can influence the decision to adopt Landsat technology.

The second RAS will be used during the same period (July through November) to support more intensive demonstration projects by local users where the results will be used in on-going projects to generate user awareness materials, to train staff, and to evaluate RAS as an initial low-cost, operational data analysis capability.



4.4 TRANSFER EVALUATION WORKSHOP

A workshop is planned for late November with NASA, ERIM, community colleges, universities, and local user participation to assess the effectiveness of the training and demonstration programs as well as the ability of the users to apply the resultant products in operational activities. Based upon workshop results, refinements in the program will be suggested to NASA for implementation. As part of the workshop, interested hardware manufacturers and computer time-share firms will be asked to participate for an assessment of market interest on their part.

4.5 PHASE II PLAN

Planning for Phase II will begin after completion of the first series of seminars and workshops (early August) and will continue to mid October when a recommendation will be presented to NASA for continuation and expansion of the program involving more community colleges and local users.



APPENDIX A BRIEFING FOR SEMTAP COLLEGE PRESIDENTS

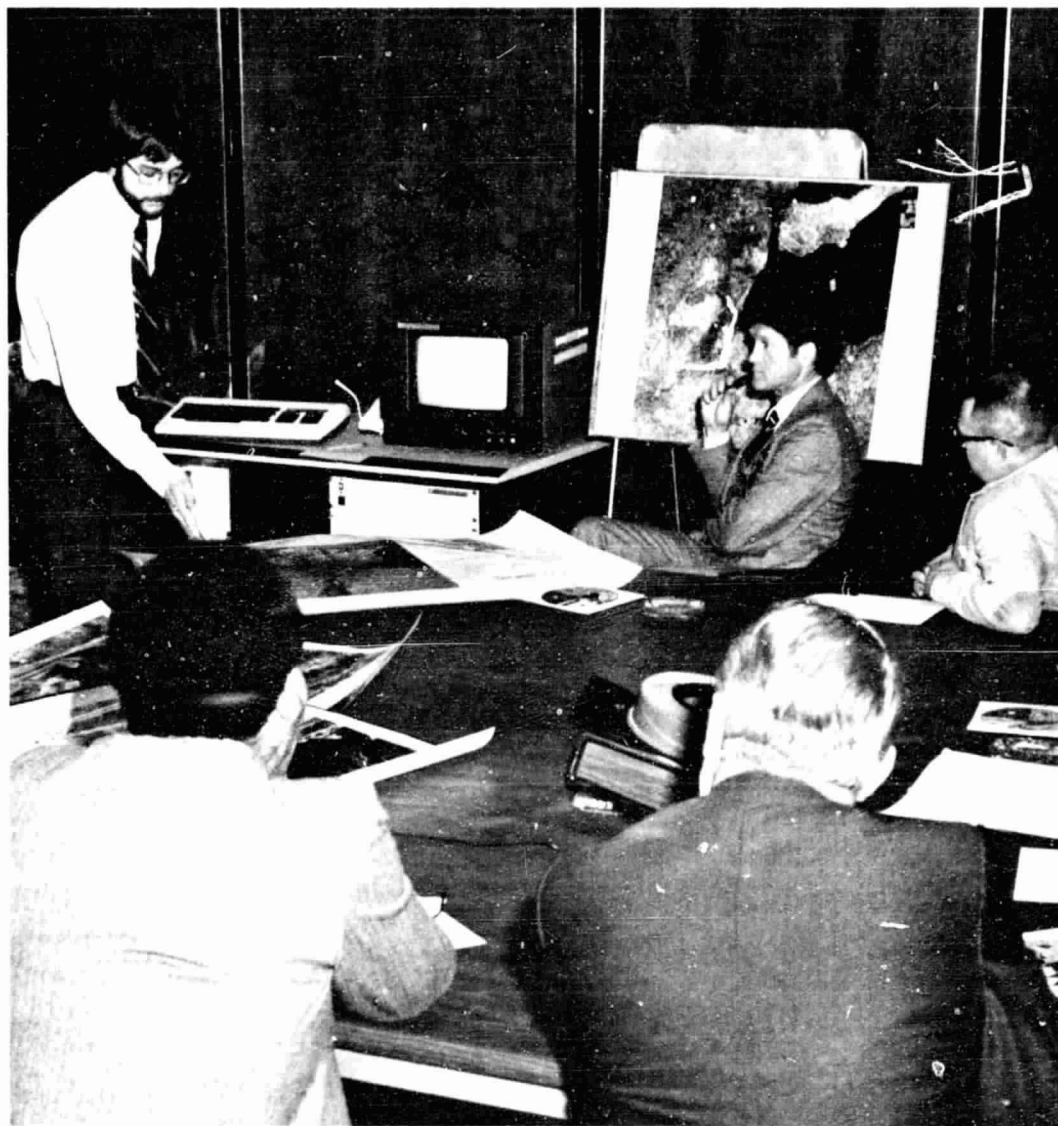
To review plans for transferring Landsat technology using community colleges, the ERIM staff met with the Southeastern Michigan Technical Assistance Program (SEMTAP) college presidents and staff on March 21, 1980.

To begin the meeting, Donald Lowe (Vice President and Director of ERIM's Applications Division) gave an overview of Landsat technology; he was followed by Charles Mathews (ERIM Trustee) who summarized current U.S. plans for an operational, Landsat remote sensing system for civilian uses.

George Peace (Assistant to the President of ERIM) then gave a report on the current status of SEMTAP. ERIM helped initiate this network several years ago to transfer energy technology to local businesses and industries, government agencies, and individual homeowners. Focus was on the continuing viability of SEMTAP as a technology transfer network.

Robert Rogers (ERIM Applications Scientist) followed with a discussion of the NASA-sponsored, Technology Transfer Program, for which he is Principal Investigator. Emphasis was on NASA's mandate to transfer all practical uses of Landsat technology to the general public at the "grassroots" level. Finally, Charles Wilson (Head of the Earth Resources Data Center) and Roger Reinhold (Research Scientist) gave a demonstration of the RAS (see following figure).

The general discussion at the end of the meeting focussed on the elements of the local community that could and would make use of the technology if it were available to them. Consulting engineering and architectural firms and local government agencies were two readily evident users. It was pointed out that other users could become apparent as the pilot program unfolded, and that one of the purposes of



REVIEWING LANDSAT TECHNOLOGY TRANSFER PROGRAM
WITH COMMUNITY COLLEGE PRESIDENTS AND STAFF



the program is to assess the demand for Landsat technology in the local community at the present time.

Current plans for establishing the community colleges as the technology transfer mechanism include:

1. choosing two or three colleges, based on interest and resources, at which to begin offering seminars and courses this summer and fall.
2. holding a one-day seminar in June and July to introduce the technology and to gather additional information via a questionnaire.
3. holding a two-week minicourse in July for 6-15 trainees, who will be carefully selected based on their interest and on the immediate use to which they could put the Landsat technology.
4. providing individual, working-demonstrations of RAS on-site at "trainees" organizations.

APPENDIX B
LANDSAT WORKSHOP AT ERIM APRIL 9

Appendix B Contents:

1. Announcement, 9 April 1980, Landsat workshop.
2. Description of training program.
3. Questionnaire
4. Attendance lists.



P.O. BOX 8618 • ANN ARBOR • MICHIGAN • 48107

PHONE (313) 994-1200

LANDSAT (SATELLITE) WORKSHOP AT ERIM APRIL 9

Recent surveys have shown that a large number of potential users in the private sector (such as consulting engineering firms) and at local agencies are interested in becoming consumers or suppliers of Landsat-derived products and services. However, they have been prevented from entering this market by the high cost of analysis facilities, the difficulty of obtaining training in the new technology, and concerns for the continuity of satellite data. The presidential decision announced in November 1979 to establish operational land remote sensing satellites and recent developments in computer technology which make it possible to generate high quality Landsat products from low cost (under \$20K) desk-top computer terminals, signal the need to take a "new look" at this technology.

To help bridge the gap between the private sector and the technology, NASA has requested ERIM to develop a program of training and demonstrations which will stimulate the market and encourage private users to become consumers and suppliers of Landsat products. To introduce this technology to local organizations, ERIM will conduct two or three seminars and minicourses during June through November of this year at local community colleges and universities. The program will provide practicing professionals an opportunity to obtain data analysis training, using color, interactive computer terminals. These Remote Analysis Systems (RAS) will be linked with ERIM's Earth Resources Data Center (ERDC) via telephone lines. The terminals will also make it possible for a few attendees to undertake demonstration projects of their choice in their own organizations. Enclosed is a brief description of RAS and the proposed training course.

Knowing of your interest in this technology, we feel that it would be beneficial for you to attend a working meeting at ERIM, Wednesday morning (9:00 am) April 9 for a preview of our plans. We will even provide a buffet luncheon at no charge if you will bring the enclosed completed questionnaire. We sincerely want your inputs early in this program. During your visit to ERIM we will share ideas on content of training course, demonstration projects which may interest your organization, and potential sites for workshops and training. ERIM will also provide you with a demonstration on RAS and a review of recent applications of Landsat data.

If you have questions on the meeting or the training program, please contact me, on ext. 319, or George Peace, on ext. 220, anytime. If you call Lisa Cool, on ext. 320, and inform her of your plans to attend the meeting, we can better plan the buffet and have your badge ready. If you can't make the meeting, but have interest in a workshop or training opportunity in your community "cast your ballot" by returning the questionnaire.

Sincerely,

Robert H. Rogers
Applications Scientist

DESCRIPTION OF TRAINING PROGRAM

REMOTE SENSING TRAINING: LANDSAT TECHNOLOGY

COURSE DESCRIPTION: The objective of the course is to train practicing professionals in the computer assisted interpretation of Landsat (satellite) data, generation of digital data bases from Landsat, aerial photography and map sources; and to use these data bases for planning and management of the environment, natural resources, and land use.

The course will consist of classroom training and a "hands-on" experience using a color, interactive remote analysis station (RAS) connected by the telephone line to ERIM's Earth Resources Data Center (ERDC).

Sessions will include information on basic concepts of remote sensing, Landsat characteristics, computer assisted interpretation of Landsat data, construction of digital files from Landsat, aerial photography, and map sources (e.g., topography, soils, etc.), selection of data sources considering factors such as cost and detail, development of program plans and specifications for obtaining and processing data, and applications. Applications examined will be tailored to attendees interest and can include land use analysis, pollution monitoring, wildlife habitat, agriculture and forestry. Approximately 15 hours of lecture and 15 hours of work book exercises are anticipated. Another 8 to 16 hours covering remote sensing fundamentals could be available as an optional portion of the training. This option could be provided as an exercise to complete before the first class session or some mix of lecture and exercise.

The laboratory portion will provide instruction in the use and "hands-on" experience of RAS computer terminals for processing Landsat data and interacting with other digital data bases. To support this activity the training will contain 10 to 15 hours of exercises designed to train the attendees to use RAS.

INTENDED AUDIENCE/PREREQUISITES

Practicing professionals will be recruited from the private sector, (e.g. consultant engineering organizations, educational institutions), local governmental organizations (e.g. regional and local planning agencies) and computer service companies and hardware manufactures. Their background will be varied but will include; geographers, physical scientists, photo interpreters, programmers, educators, and managers who desire a comprehensive understanding at a basic level of the pertinent concepts, potentials, problems, and trade-offs associated with the practical and operational aspects of collecting, interpreting, and merging Landsat data with other data sources and applications for these data. No formal prerequisites are required.

LOCATION OF TRAINING

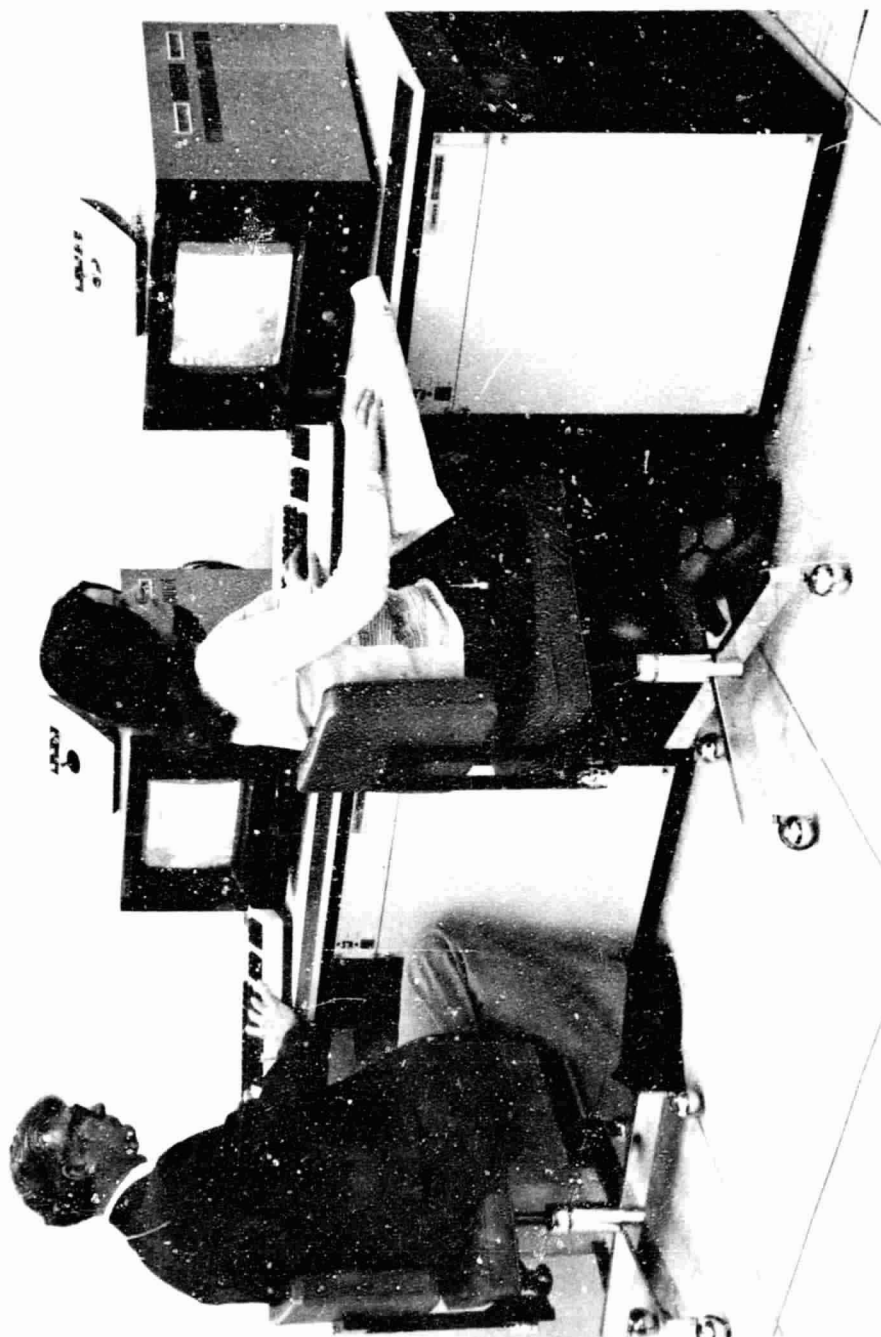
Training will be delivered at Community Colleges, Universities, High Schools and at other institutions, and facilities convenient to the majority of attendees. Some training and demonstrations may be provided to the user in his own facility.

TEXT

The training package will be completely self contained and not require additional text.

CLASS SIZE

Assumes availability of one RAS (6 to 10 trainees).



Date: _____

QUESTIONNAIRE

Landsat Technology Transfer Project

1. Name _____
2. Business Address _____

3. Business Phone _____
4. Present Occupation Position (Brief description of duties)

5. Home is in what city/county? _____
6. What method of training would most interest you (minicourse for 2 weeks, semester program, correspondence, workshop, demonstration, other)? _____

7. What Community College or other location would be most convenient to you? What time (day or night)? _____

8. If part of training or demonstration is on-site at your facility, how many others may want to take part? _____

9. What applications for Landsat data would you like to investigate? _____

10. If training or demonstration (item #9) established utility of the technology, can you say at this time how your organization or agency would use or may benefit from the technology?

11. If training and demonstrations are limited to 2 or 3 communities, can you state why NASA may want to select your community for this technology transfer effort?

12. Other comments: _____

Please Return Questionnaire To:

Robert H. Rogers
The Environmental Research Institute of Michigan
P.O. Box 8618
Ann Arbor, Michigan 48107
Phone (313) 994-1200, ext. 319

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Landsat Workshop 9 April 1980

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APPENDIX C

Reprint of Landsat Article Published by Detroit Engineer
Newsletter, April 1980.

Robert H. Rogers
is an applications scientist with the
Environmental Research Institute of
Michigan (ERIM), earth resources data
center, Ann Arbor. A native of Fort Worth,
Dr. Rogers earned his PhD in electrical
engineering from Michigan State U. He is
president of eastern Great Lakes region of
the American Society of Photogrammetry,
and author of more than 40 papers on the
application of remote sensing data. His
activities include working with user
organizations to identify those natural and
cultural features that can be monitored
through remote sensing.



Landsat orbits the earth in a north-south polar orbit at an altitude of 575 miles and views most of the planet every 18 days, imaging each 115 x 115 square mile area (13,225 square miles) in 25 seconds. This perspective of the earth and its changes has been recorded by a multispectral scanner and a return beam vidicon camera on a precise schedule since 1972. The chief instrument, the multispectral scanner, observes the earth in 4 spectral bands (or "colors"): green, red, and 2 invisible, reflective infrared bands. The video signals of each of these bands are digitized and transmitted to earth where they are recorded on computer compatible tapes from which a wide range of data products is then derived.

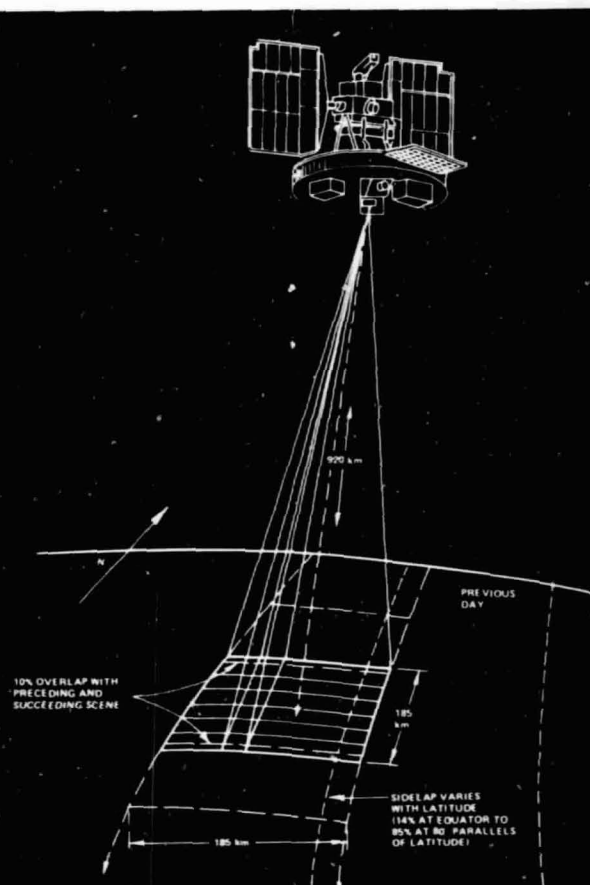
False color-enhanced Landsat images—as shown on this month's cover of *Detroit Engineer*—are generated from computer compatible tapes by assigning and filming 3 of the 4 Landsat bands as blue, green, and red. Additional processing options, such as edge enhancement, precise geometric correction, and image scale, are selected to tailor the image to specific users' needs. The most common image format looks like a high altitude color infrared photograph.

Since the Landsat 1 satellite was launched in 1972, many impressive applications were found for these space-acquired

images. Geologic features, for example, are traced without interruption for hundreds of miles in one or a few images. Landsat imagery reveals geologic faults and even helps prospect for uranium, copper, oil, and other minerals and fossil fuels. It is valuable in making and correcting maps, especially of inaccessible areas. Some foreign governments use false-color "photomaps" with geometric accuracy approaching 40 meters root mean square in place of conventional maps. Computer-derived land cover/land use maps are accurate, and relatively inexpensive to produce and, since they are available in digital form, they lead naturally to computerized data banks for modeling studies. Landsat images help update navigation charts, detect oil slicks at sea, and even locate shrimp fishing pounds.

Recent surveys point out that many potential users in the private sector—such as consulting engineering firms—want to become consumers or suppliers of Landsat-derived products and services. They are prevented, however, from entering this market by the high cost of analysis facilities and the difficulty of obtaining training in this new technology. This has seriously retarded its growth, since engineering firms do most of the land use mapping for both government and private industry.

The technology exists to



Spreading NASA's wealth

Satellite-derived information comes down the technology tube to benefit planners, economists, farmers, geologists

by Dr. Robert H. Rogers

How Landsat does its work

The multispectral scanner scans west to east on a 115-mile path in 33 milliseconds and digitizes 4 different wavelengths of earth radiation. NASA receiving stations at Fairbanks, Alaska, Goldstone, California, and Greenbelt, Maryland copy streams of numbers sent by the satellite. When beyond receiving station range, Landsat stores data for later delivery.

perform computer-assisted interpretation of Landsat data to generate cartographically accurate, digital data bases by combining Landsat data, aerial photography, and map sources. These data bases can be used for planning and management of the environment, natural resources, and land use.

Data graphics are generated using the computer, which transforms reflected light recorded in the 4 multispectral scanner bands into interpreted land cover codes for each 56 x 79 meter picture element (pixel). This interpretation process is a fast, inexpensive way to identify general cover types such as

A 1980 calendar illustrating 12 Landsat images in color is available at no charge. Write Dr. Rogers at ERIM's Applications div., Earth Resources Data Center, Box 8618, Ann Arbor, MI 48107.

cropland, grassland, barren land, forest, and water. Additional detail is obtained from aerial photographs and maps and merged with the Landsat interpretations. The digital files resulting from this processing then are used as direct computer input for analysis and compositing with other data sources. They also are a source for color maps and land cover tabulations. Common map scales range from

1:50,000 to 1:1,000,000. The tabulations list the area in acres occupied by each land use type within defined boundaries, such as drainage areas, counties, and townships.

To help bridge the gap between the private sector and the technology, the national aeronautics & space administration requested the Environmental Research Institute of Michigan (ERIM) to develop a program of training and demonstrations. The goal is to stimulate the market and encourage private users to become consumers and suppliers of Landsat products. To introduce this technology to private industry, ERIM plans to conduct 2 or 3 seminars and minicourses during the summer and fall of 1980 in concert with local community colleges and universities. The program will provide hands-on, interactive, Landsat data analysis training, using color, interactive computer terminals. These terminals will be linked with ERIM's earth resources data center via telephone lines. The terminals also will make it possible for a few students to undertake demonstration projects in their own organizations.

For additional information on Landsat technology or on ERIM's new training project, call me at ERIM's earth resources data center in Ann Arbor: (994-1200) x 319.

COMPUTER-
GRAPHICS