

Systematically Disseminating Technological Information To Potential Users

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How can technological information be quickly disseminated to potential users in a rapidly expanding field of research? Historically, there has been a significant time lag between technological breakthroughs and the widespread use of new technology. The Laboratory for Applications of Remote Sensing (LARS) at Purdue University is faced with the problem in the remote sensing field.

Remote sensing is the science of acquiring information about distant objects from measurements made without coming into contact with the objects. The sensors, which may be cameras or other energy-measuring instruments, record the energy reflected or emitted from objects on the earth. The sensors can be mounted in field-based units, aircraft or satellites. One application of remote sensing technology is the identification and mapping of agricultural crops. Remote sensing can also be used to distinguish the types of trees in a forest and identify areas of diseased trees. Land-use maps, helpful in urban planning, can also be produced from remotely sensed data.

LARS is a research facility within the structure of Purdue University. The overall objective of the laboratory is to attack, in an interdisciplinary environment, specific remote sensing problems of current national and world interest in the area of earth resources. A multidisciplinary staff of over 100 professionals and graduate students from 22 departments within the university conducts research, develops computer analysis techniques, explores applications and trains people in the area of numerically oriented remote sensing systems.

Currently one of the major efforts at LARS is to share an understanding of the technology with those addressing natural resources and environmental questions. To train users, a Technology Transfer program area has been established. The staff which handles these educational functions includes experienced educators, training

specialists, and instructional developers. The team is responsible for developing educational materials and conducting training programs to transfer remote sensing technology from the research arena to the applications arena.

Remote sensing is a rapidly expanding field of research and technology. Consequently, there is a growing need to provide training for graduate and undergraduate students as well as the continuing education of scientists, engineers and users of this technology. The scientists and engineers range from those untrained in remote sensing to those already in the field but needing to expand their specialized knowledge and learn about new technological developments. The potential users of the technology are associated with federal, state, city and county agencies as well as business and industry. The needs of the "students" differ greatly in terms of subject matter, depth and approach because of diverse backgrounds and present needs.

Rapid technological developments in remote sensing and the broadening of its use have created a need for educational materials that are relevant and up-to-date. Since remote sensing is an interdisciplinary field, the scope of the content to be disseminated is very broad. It ranges from information about the electromagnetic spectrum (physics), numerical analysis techniques (mathematics) and spectral characteristics of vegetation (biology) to specific applications of the technology in fields such as geology, geography, urban planning and agriculture. The types of instructional strategies developed must be diverse in both format and content to meet this need. LARS has developed materials and programs which range from short tutorial brochures to post-doctoral research programs which may span several years. To organize both the content and the instructional techniques, a matrix of instructional materials has been conceptualized (see Figure 1). Each row in the matrix represents

a subject area in remote sensing and each column in the matrix represents a different type media or instructional strategy.

The simplest material in the matrix is the FOCUS series which explains basic information important in remote sensing. Each pamphlet in the series presents a single concept through one page of concisely written text supported by illustrations. Care is taken to minimize the use of technical terms in the description and to include definitions where confusion might occur. A two-page pamphlet format is used because of portability and flexibility. The pamphlets format also makes them relatively inexpensive to produce and yet attractive to the potential reader. A student typically spends 5 to 10 minutes on these materials.

A second type of material deals with the fundamental principles of remote sensing. Formats used at this level include films and minicourses. Each minicourse includes an audio tape, color slides and a study guide. Videotapes with viewing notes have also been developed. Printed information notes and monographs in text format can be used and are easily distributed. Units at the fundamental principles level are designed to take one to one and a half hours of student time.

Simulation exercises have been designed to lead the student through the professional thought and decision-making processes typical of those required by remote sensing researchers. These units, requiring 3 to 5 hours to complete, illustrate and explain the rationale, decisions and procedures of the professional remote sensing analyst.

Case studies require the student to make his own decisions, specify analysis techniques and interpret analysis results. The case studies usually involve the student using hardware, such as stereoscopic viewers, computers, etc. Intermediate results can be reviewed with a tutor or instructor. Case studies usually require on the order of 10-40 hours to complete.

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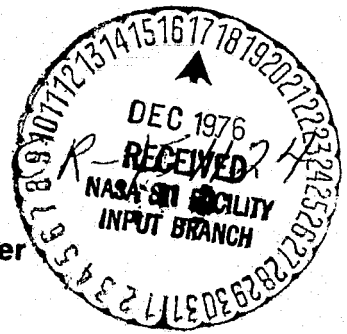
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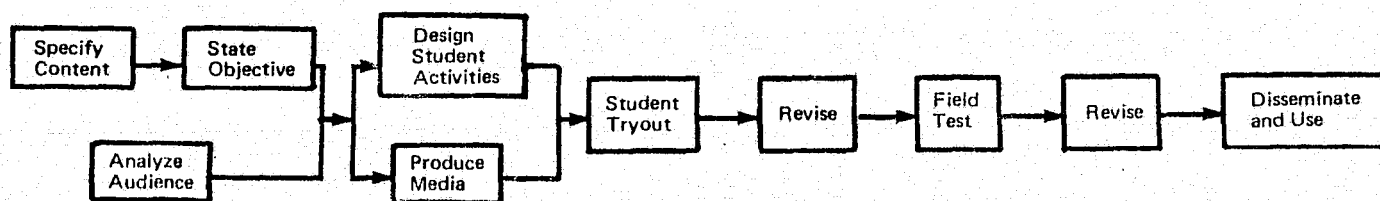
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		Focus Series	Films	Minicourses	Videotapes	Simulations	Case Studies
Introduction to Remote Sensing							
Electromagnetic Spectrum							
Spectral Response of Surface Features							
Systems	Photographic						
	Aircraft						
	Satellite						
	Mission Planning						
	Image-Oriented						
	Numerically-Oriented						
Instrumentation	Optical Mechanical Scanners						
	Side-Looking Radar						
Data Analysis	Interpretation of MSS Data						
	Pattern Recognition						
	The LARSYS Computer System						
Applications	Agronomy						
	Forestry						
	Geology						
	Land Use Planning						

Matrix of Instructional Materials
Figure 1



LARS Instructional Development Sequence
Figure 2

individual training programs can be synthesized. Typically a larger number of units is selected from the left columns with fewer units being selected as the student moves to the right on the matrix. An instructional program can be designed to meet the needs and interests of each individual. When possible, students with the same needs are brought together in small groups of six to eight so that a coordinator of training can encourage group interaction and facilitate discussion of newly learned concepts, principles and procedures.

Materials designed by the Technology Transfer team at LARS undergo systematic instructional development procedures. As shown in Figure 2, the content is specified by a group of subject matter specialists in that area of remote sensing. Then with the help of an instructional technologist, a set of objectives is written. Simultaneously a description of the potential audience is developed. The audience analysis includes general characteristics (technical background, relevant experiences, present employment, etc.) and specific entry behaviours (knowledge of remote sensing techniques, technical vocabulary, ability to interpret remotely sensed data, etc.)

The next step is to design the student activities. The challenge in preparing material for a technological field is to present a complex topic in a way that is neither unnecessarily complicated nor misleading for a person who has had no prior experience with the material. Following the principle that students learn by doing, instructional activities are built into the material whenever possible. These activities might include responding to pertinent questions, manipulating equipment, solving mathematical problems, programming a computer, or analyzing computer output.

The student activities incorporated are determined by the objectives for a particular unit. At the same time, the appropriate media (printed materials, slides, audio tapes, diagrams, videotapes, etc.) are designed or selected based upon the objectives. Production of media is initially done in a rough form since revisions usually occur during the next steps.

To help insure both the educational and technical accuracy of materials, each unit of instruction is subjected to rigorous in-house review by remote sensing specialists, technicians, and instructional technologists.

Evaluation is continuous during the development and use of instructional materials at LARS. The materials are used with individual students and their reaction to the material is solicited. On the basis of this feedback, the materials are revised and tested with additional individuals. The

materials are then ready for use "in the field" with large groups of students and away from the direct control of the developers. Similar student reaction data is gathered. The materials are further refined. Usually only minor modifications are necessary at this point in the development sequence and then the materials are now ready for dissemination and use.

One example of the materials developed using this approach is an educational package developed to train people to analyze remotely sensed data using LARSYS, a computer software system. The materials were designed for independent study since organizations getting started in the analysis of remotely sensed data usually have only two or three people making initial use of LARSYS. As their experience and skills improve, other workers can be trained by them. The individuals usually start at different times and progress at different rates depending upon their background and other duties. Essential to the effective use of the educational package is a tutor with computer analysis experience. Therefore, two persons from an organization come to LARS for training and they in turn train other people within their organization and they train additional staff, etc.

A variety of media and instructional strategies is used in the educational package. The first unit is a programmed textbook. An audio tape, a display book and student notes accompany the second unit. Unit III, a demonstration of a remote terminal, requires an instructor who is familiar with the computer hardware. An outline and suggestions to the instructor are provided along with a set of student notes. During Unit IV, the student gets hands-on experience with the terminal and then completes simple analysis problems in the following unit. The initial training requires about 15 to 17 student hours and prepares the student to tackle one of the case studies requiring 40 to 50 hours. These case studies provide a detailed explanation of the philosophy of the analysis methods with an example that parallels the analysis he is to do.

A very effective instructional strategy for training individuals from business, industry and government has proven to be a week-long short course. The short course which is limited to eight to fifteen participants, combines many of the instructional materials already described. For example, videotapes allow the fundamental content to be presented by an expert in the field and at the same time free him from having to repeat the same basic presentation each time the course is offered. However, during the short course the expert is usually available for questions and discussions following the videotape.

About one fourth of the short course is devoted to a simulation in which the participants learn the basics of computer-oriented techniques used to analyze remotely sensed data. No prior computer experience is required to gain an understanding of the processes involved. The simulation presents the process in a step-wise sequence and allows the participants to actually make the same decisions an analyst has to make when analyzing remotely sensed data. Computer output is supplied and the results of the participant's decisions are discussed with the teaching staff.

To enable scientists to study remote sensing in depth at the Laboratory for Applications of Remote Sensing, a Visiting Scientist Program has been established. This program provides an opportunity for personalized study at the laboratory during a period of residence which may vary from several days to many months. The instructional portion of the program incorporates the media and techniques described earlier in this article. In addition, the participants can interact on a one-to-one basis with remote sensing specialists at LARS. The experience is a "reverse consulting" arrangement. Rather than have one consultant come to the person's home institution, the person goes to LARS and has a variety of "experts" available to him along with the supporting hardware (computer, digital display, etc.). The cost of the program is comparable to a daily consulting fee for the first few days of the visit with the daily cost decreasing as the length of the visit increases.

Summary

By working with individuals or small groups, training coordinators at LARS are able to establish objectives for each "student" and to structure the learning program to begin where he is and continue from that point to meet each individual's needs and interests. The Technology Transfer staff has found that systematically designing instructional materials and activities using the matrix as an organizer has proven to be very effective in meeting the needs of students, scientists and users in a rapidly expanding technology.

