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REMOTE SENSING EDUCATION: A SPECIAL REPORT ON THE CONFERENCE OF REMOTE SENSING EDUCATORS - CORSE-81

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I. ABSTRACT

CORSE-81, Conference On Remote Sensing Education, was held May 18-22, 1981, at Purdue University. Co-sponsored by NASA and NOAA, the conference was organized and conducted by the Purdue University Laboratory for Applications of Remote Sensing (LARS). Attended by approximately 200 educators from a broad range of disciplines, CORSE-81 represented the first national conference in the U.S. dealing solely with the topic of remote sensing education.

This paper is an attempt to summarize the major trends and issues in remote sensing education which crystallized from the presentations and discussions of CORSE-81. These include: 1) a profile (by discipline) of remote sensing courses taught throughout the U.S., 2) the manpower and skill requirements for students trained in remote sensing, 3) the impact of "low cost" digital image processing on the remote sensing education process, and 4) the concern of the educational community about the fundamental philosophy of design and implementation of an operational land remote sensing program.

II. CONFERENCE BACKGROUND/OBJECTIVES/FORMAT

A. BACKGROUND

CORSE-81 was a follow-on to a NASA-sponsored remote sensing educator's workshop held at Stanford University during June 26-30, 1978 (CORSE-78). CORSE-78 was regional in character, bringing together educators from across the 14 states included in NASA's Western Regional Application Program (WRAP). The intent of CORSE-78 was to stimulate exchange of class materials, curricula, course outlines, and ideas for teaching remote sensing. Workshops were organized around regional interests, data acquisition and reduction methods, audio-visual and multimedia techniques, and discipline interests. Panels discussed problems associated with remote sensing curriculum design, teaching methods and equipment, facilities and texts. Also discussed were the attributes of a well-trained remote sensing technician and technologist, problems in introducing new remote sensing courses, and multidepartmental approaches to teaching remote sensing. The format of CORSE-78 was two days dedicated to formal papers followed by three days of workshops, all of which are included in the proceedings for the conference.[1]

B. OBJECTIVES

The general objectives of CORSE-81 were akin to those of CORSE-78, but CORSE-81 was national in scope and was organized by a committee composed of educators from each of the three areas served by NASA's Regional Applications Centers, the respective NASA training director, and the conference co-chairmen from LARS/Purdue. This committee organized CORSE-81 to meet the goals of:

1. Bringing together remote sensing educators for exchange of information and ideas with each other and with federal agencies on setting up or improving remote sensing courses and curricula and on developing and utilizing the resources of their institutions for teaching and research activities.

2. Helping these educators keep abreast of current technological developments flowing from other universities, NASA, NOAA, other federal and state agencies, industry, and other segments of the user community.

3. Providing tutorial workshops to increase participants' levels of understanding of the fundamentals of the technology.

C. FORMAT

To meet the above objectives the conference consisted of 2½ days of plenary sessions, discipline-oriented discussion sessions (including submitted papers), panels, and poster presentations. Tutorial workshops were held for a day before and after the conference.

Overall, the conference program was designed to flow from definition of what remote sensing education is now, to what it needs to become. This was accomplished by presentations and discussions dealing with such topics as the current status of remote sensing courses nationwide, the expressed needs of potential employers of students trained in remote sensing, the strategies and resources available for teaching remote sensing (literature, multimedia methods, and computer hardware and software) in various disciplines, the future role of NASA and NOAA in remote sensing education, and the overall direction of remote sensing technology and education in the future. The remaining sections of this paper include some of the highlights of these discussions.

It should be noted here that this paper is one person's observation of "the bottom line" of the discussion of 200 individuals who interacted for the better part of a week in a range of settings--often in concurrent sessions. Accordingly, the author makes no claim of absolute completeness. Also, the reader should recognize the problem of trying to convey objectively any concensus of discussion of so many educators from such a broad range of backgrounds and institutional settings. (The details of virtually all of the many excellent conference presentations and discussions will be published in a conference report.)

III. NATIONWIDE PROFILE OF REMOTE SENSING COURSE OFFERINGS

Numerous attempts have been made to characterize the number and distribution of remote sensing courses taught across the country. This is a particularly challenging task in that by most standards the system of remote sensing education in the U.S. is complex, multidisciplinary, new, and in a state of growth and flux. Table 1 and Table 2 contain data included in a CORSE-81 paper presented by Dahlberg and Jensen ("Status and Content of Remote Sensing Education in the United States"). These data have been extracted from the Mapping Science Education Data Base, a USGS-supported effort aimed at inventorying mapping science courses nationwide. Course data in the data base have been extracted from institutional catalogs and a variety of directories. The hope is to maintain and publish such data periodically through the cooperation of the American Congress on Surveying and Mapping (ACSM) and the American Society of Photogrammetry (ASP). As the data base becomes operational it is planned to publish annually a "Directory of Courses and Programs in the Mapping Sciences" to provide current information to students and advisors. The data will also be useful for a variety of analytical purposes. For example, in the highly aggregated form presented here, these data show some interesting features about the profile of remote sensing courses offered in the U.S.

Among other observations, Dahlberg and Jensen pointed out that "The majority of remote sensing education is to be found in public supported institutions having strong graduate program orientations. Approximately 88 percent of remote sensing courses are offered by public institutions and over 90 percent of the courses are offered by institutions having graduate level programs (Table 1). It is evident from the data that much the same pattern obtains for the mapping sciences generally with the exception of surveying which is strongly concentrated in two-year colleges.

"The diversity of academic homes of remote sensing is evident from the summary data in Table 2. In terms of numbers of courses offered, the social sciences rank first with 37 percent of all courses, followed by the physical sciences with 25 percent, engineering with 19 percent, and agriculture and natural resources with 10 percent. Also evident from these data is the virtual absence of remote sensing in the technology programs in the two-year colleges....

"Of the nearly 700 courses offered, 34 percent could be classed as remote sensing, 33 percent as aerial photo interpretation, 12 percent as photogeology, 6 percent as sensor technology, and 4 percent as image interpretation. Courses in map and aerial photo interpretation have been classified under cartography and excluded from this discussion....

"Succinct characterization of programs of remote sensing education is especially difficult as much change is occurring at present and existing programs generally are not well articulated. Data on programs are available in highly preliminary form only. Two features of remote sensing programs that emerge clearly are a graduate level emphasis and the near absence of remote sensing in two-year colleges. There is also a taxonomic problem because remote sensing education tends to be imbedded in other programs and these lack external visibility....

"Even in a brief overview of remote sensing education such as this, one feels compelled to identify major gaps or deficiencies. One of the most glaring gaps is the near-absence of remote sensing technician training programs in American colleges. Such programs exist within the defense establishment but elsewhere commercial firms and government agencies must rely upon on-the-job training. Program specialization or vertical development is weak reflecting the well known "critical mass" problem of concentrating sufficient numbers of faculty, students and facilities to offer viable programs. The problem that the education system has of keeping abreast of technological developments in the remote sensing field grows progressively larger. The large number of short courses in remote sensing is clear evidence of a strong and expanding demand for education in this field. It is also symptomatic of the need for more formal training and of serious lags in technology transfer within the system. Lastly, one can note weakly developed linkages between remote sensing and other mapping sciences programs such as cartography and photogrammetry."

This author will take the liberty to present some additional interpretation of the Dahlberg and Jensen data. First, the role of the discipline of geography in remote sensing instruction is significant. Engineering and physical science courses are reasonably well represented. However, only 10 percent of all remote sensing courses offered in the U.S. are offered in a natural resource or agricultural context. Also, the "weak linkage" problem between remote sensing and other mapping science courses and programs warrants reiteration. Few are the institutions where true synthesis of coursework and/or research in the various mapping sciences exists. It appears our professional societies have similar linkage problems and we are all probably the worse for this condition. With all the glitter and glamour of our individual data acquisition technologies, it is reasonably shocking to note that only 23 courses exist in the country which deal with the specific subject of geographic information systems.

IV. MANPOWER AND SKILL REQUIREMENTS IN REMOTE SENSING

Employment opportunities and employee skill requirements were the subject of discussion at various points in the program of CORSE-81. A panel discussion was held on the subject with panel members representing the managerial perspective of various employing groups. These included a private consulting firm, a federal contracting corporation, a petroleum and mineral exploration group, an international development agency, and the U.S. Department of Agriculture. In general, the panel painted a rather bright picture for the future employment opportunities in remote sensing; particularly in such fields as mineral and petroleum exploration. However, it was also pointed out that employment prospects were somewhat ill-defined at the current time given an austere economic climate, and the rather uncertain technological and institutional environment surrounding the developing domestic operational satellite remote sensing program.

While the precise demand for students trained in remote sensing was somewhat difficult to measure from the discussions, the type of student employers are likely to hire was stated much more explicitly. Employers prefer to hire people solidly trained in a discipline first, and remote sensing second. A comment frequently reiterated during the discussion was "Remote sensing is a means, not an end."

A general preference for individuals with broad masters degree training (and/or experience) was expressed by most of the panel members. In addition to being well educated in a discipline, prospective employees were advised by the panel members to develop strong communication skills, an ability and desire to interact at a conceptual level with other specialists, and an overall adaptability to change. J. Robert Porter, President of Earth Satellite Corporation, summarized the characteristics of an ideal employee for his firm by presenting the following assessment of what an honest and realistic ad for a prospective employee might look like:

"WANTED: A specialist with strong academic background, preferably graduate training and two years experience in geology, agronomy, geography or computer science. Must be bright, self-confident and personable, adaptable to changing circumstances, able to manage and be managed, to take and to give criticism, to think and to do, to express himself or herself well and to listen, to assert himself persuasively and care about others, to enjoy travel and new experiences, to be intellectually curious and have an infectious enthusiasm, to be able to survive disappointment and withstand the ups and downs of a small company. Foreign language desirable, but not required. Minimum commitment by employee - 2 years, but subject to release at any time."

In terms of the remote sensing component of a prospective employee's formal education, the need for a balance between visual interpretation and digital image processing was stressed. While digital techniques are increasing in their application, conventional visual interpretation is still very much the mainstay of many agencies and likely will be for some time. In this respect, Merle P. Meyer, sitting on an educator's panel, indicated a concern over: "(a) the apparent, and increasing, tendency for some remote sensing educators and research scientists to "purify" the remote sensing subject matter field by purging it of what they perceive as being mundane, vocational and applied--i.e., aerial photography and aerial photo-interpretation; and (b) the increasing dearth of educational institutions which provide the professional forest and range management student with the type and level of remote sensing training essential to his/her needs in the job market...." Meyer further stated that the Society of American Foresters (SAF) Remote Sensing and Photogrammetry Working Group recently conducted a survey of the status of remote sensing training in the 43 accredited U.S. forestry schools and obtained some rather discouraging results. In short, fewer than 60 percent of accredited forestry schools require adequate training in aerial photo-interpretation. ("Adequate" in the eyes of the SAF Working Group means at least two quarter credits of material).

One final issue which surfaced in the context of remote sensing employment needs bears emphasis here. That is the paucity of individuals prepared to enter the field of remote sensing education. On the one hand, industry and government are attracting qualified educators out of the teaching field. At the same time, the ranks of the World War II-vintage interpretation specialists who entered the education field are being thinned by normal attrition. Many are the schools and disciplines who have had, and will have, problems finding suitable candidates for remote sensing faculty positions.

V. EDUCATIONAL IMPACT OF LOW COST DIGITAL IMAGE PROCESSING SYSTEMS

Numerous papers and discussion sessions during CORSE-81 dealt with the problems and potentials of integrating digital image processing in remote sensing courses and developing a digital image analysis research capability. A dramatic increase in instruction and research in this area is evolving in conjunction with the increasing availability and power of low cost microprocessor-based systems. While what constitutes "low cost" is predicated on one's institutional context, clearly hands-on digital image processing capabilities will become much more available to students of remote sensing. In fact, the potential impact of these systems for instructional systems is such that they might well be perceived in the not too distant future as fundamental to a basic image interpretation course as a supply of stereoscopes.

The increasing availability of image processing equipment in the classroom will indeed offer some new demands on the educational community. Much greater understanding of the fundamental theory which underlies the various quantitative image processing methodologies will be needed to avoid having instructors and students alike falling victim to the "black box." Because many of these needed fundamentals are quite abstract and complex, and students from diverse disciplinary and mathematical backbrounds are involved, the successful educator has a new set of challenges before him/her in terms of student motivation and understanding.

Reinforcing the instructor's need to understand and convey the fundamentals of the quantitative techniques he or she is called upon to teach, Philip H. Swain stated:

"Remote sensing is an inherently multidisciplinary technology, a fact which must be recognized, accepted and dealt with in teaching as well as in developing and applying the technology. We cannot afford to overlook the fundamental principles involved in the phenomena we are exploiting and the tools we are applying, be they the devices used to collect the remote sensing data, the methods used to extract information from the data once collected, or whatever. To do so is to handicap our students, at best leaving them unable to take full advantage of the information available through quantitative remote sensing; at worst making them vulnerable to costly errors in misuse of the methods available ....

"The instructor must have a solid grounding in the fundamentals he or she is trying to teach. Now, it is no easier for a computer scientist or an electrical engineer to learn, say, the physics of geology than it is for an agronomist to learn the principles of digital image processing. But it can be done and it is done regularly in the multidisciplinary research and education programs which have grown up with the technology. An apprenticeship with such a program is probably the most effective way to prepare oneself to be an effective educator in the field of modern remote sensing technology and its applications."

With or without an apprenticeship as described above, most remote sensing educators (and students) are probably well-advised to improve their knowledge and skills in such areas as basic radiation physics, multivariate statistics, etc. Much more communication with faculty colleagues in these areas will characterize the future if we are to adequately prepare our students in digital image processing.

VI. EVOLUTION OF AN OPERATIONAL REMOTE SENSING PROGRAM

One day of CORSE-81 was devoted to discussion of the role of NASA and NOAA in remote sensing education as we enter the transition period resulting from issuance of Presidential Directive 54 in late 1979. The impact of this directive is the transfer of responsibility for many of the functions in operating the Landsat program from NASA to NOAA. Both NOAA and the civilian sector are expected to assume major roles in providing future earth resources data to the national and international user communities. While the detailed plan and schedule for this transition are subject to continuous change, it is important to reiterate the essence of the program as indicated in a NOAA planning document dated June, 1980.[3] The highlights of the plan as specified therein are:

1. Continuity of the Landsat Program through the transitional period in the 1980's will be assured, although it is possible that there may be gaps in data coverage at any one period, especially if a satellite should fail prematurely.

2. A Fully Operational System, under private sector ownership and operation, could be on-line by 1990.

3. An Initial Operational System, under NOAA management, will be implemented during most of the 1980's. This will consist primarily of a series of Landsat-D's. These will include the MSS and the Thematic Mapper (TM), an advanced sensor (unless the TM is not ready for the first launch in mid-1982).

4. Sometime in 1983 NOAA will begin taking over NASA's responsibility for controlling the Initial System, after launch of Landsat-D and checkout of the TDRSS data relay and ground data processing systems.

5. Requirements for future satellite design and systems operation will be sought from major sections of the worldwide user community (primarily, those concerned with agriculture, mineral extraction, and land use/cover applications) in developing the Fully Operational System.

6. The private sector will be encouraged to seek eventual ownership and management of the operational system before the end of the decade. As a possible scenario, one or more profit-making organizations could be chartered by federal legislation to invest in the system, thus assuming a significant fraction of the financial risk. The resulting institution must agree to abide by certain regulations (e.g., comply with the Outer Space Treaty provisions; foster non-discriminatory dissemination of data to all public users; protect possible classified information) specified by the federal government. Any eventual private sector operator will manage the Operational System under federal regulation.

7. NOAA will retain or expand current policies favoring international participation in the U.S. remote sensing program. This will include satisfactory scheduling of satellite operation over areas specified by user nations and continued transmission of data to foreign Ground Receiving Stations.

8. The United States, through its State Department and other agencies, will work cooperatively with foreign organizations or countries that elect to compete in an open international market by building and operating civilian remote sensing satellites to provide Earth resources data. A principle of complementarity is proposed to encourage the United States and foreign satellites to have complementary coverage patterns and orbital repeat cycles and to adopt compatible data handling systems.

9. Pricing of data products and other output will be set at a high enough level to assure acceptable recovery of systems costs in accord with public needs. Some federal underwriting of costs will likely be needed prior to self-financing by the private sector in order to maintain affordability.

10. As the transition to NOAA operation progresses, the primary NASA role will shift to emphasize various R&D functions, including development of new sensor and platform systems and specialized processing and applications activities.

Updates on the above plan and the respective roles of the federal agencies involved were given by representatives from NASA, NOAA, and Interior. Immediately thereafter, and in a subsequent discussion session, attendees asked questions and provided reaction relative to the implications of the transition activities planned. Among other things, these discussions surfaced the practical hardships which economic cuts are causing in the transition plan. In short, all agencies involved seem to have much more mandate than money. Further, it was indicated that Landsat-D is scheduled for launch during the third quarter of 1982 (July) and D' will come on line upon the failure of D (with both having a three year design life). However, the initial availability of thematic mapper data from the system will be extremely

Table 1. U.S. Colleges and Universities: Mapping Sciences Course Subject Group Offerings by Highest Level of Offering at Institution.

	2 to 4 Year	4 or 5 Year	First Professional	Masters	> Masters and < Doctorate	Doctorate	Total
Remote Sensing/API	32	19	3	78	48	511	691
Cartography	232	65	9	226	167	580	1,279
Surveying	1,316	143	15	136	71	512	2,193
Geodesy	19	8	1	7	5	92	132
Geographic Information Systems	--	--	--	2	--	21	23
Photogrammetry	59	17	1	22	5	176	280
Totals	1,658	252	29	471	296	1,892	4,598

Source: Mapping Sciences Education Data Base.

Table 2. U.S. Colleges and Universities: Mapping Sciences Course Offerings by Discipline and by Subject Groups.

	Remote Sensing	Cartography	Surveying	Geodesy	Geog. Inform. Systems	Photogrammetry	Totals
			Conventional Academic Subdivisions				
Natural Resources & Agriculture	72	11	58	--	2	31	174
Engineering	130	12	510	62	4	120	838
Physical Sciences	175	99	32	27	--	26	359
Social Sciences	259	906	6	3	15	15	1,204
Other Subdivisions	17	27	20	6	2	6	78
Sub-Totals	653	1,055	626	98	23	198	2,653
			Technological and Occupational Curricula				
Engineering Technologies	17	200	1,490	34	--	71	1,812
Natural Science Technologies	21	21	77	--	--	11	130
Other Subdivisions	--	3	--	--	--	--	3
Sub-Totals	38	224	1,567	34	--	82	1,945
Totals	691	1,279	2,193	132	23	280	4,598

Source: Mapping Sciences Education Data Base.

VIII. REFERENCES

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AUTHOR BIOGRAPHICAL DATA

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