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UNIVERSITY EDUCATION IN REMOTE SENSING: ILL-DEFINED AND ILL-EQUIPPED

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ABSTRACT

Training in remote sensing, like that for chemistry and physics from which it draws, demands a "hands-on" experience by students. Explosive growth in the field over the past decade has left instructors and professors in the untenable position of having inadequate instructional aids. Moreover, the extraordinary breadth of sensor applications, both proven and feasible, has led to almost ad hoc decisions as to what should be included in current course work. This ill-defined and ill-equipped status, in the absence of common denominators, results in students whose training is difficult to assess.

Two recent compilations (Morain,[5] Nealey[6]) summarize the current expanse of remote sensing education in the U.S. Conservatively, there has been a 400% increase in educational opportunities since Eitel[2] published his survey in 1972. Since the late 1960's, however, research has so concentrated on analog and digital electronic processing that students can often only claim introduction to topics rather than active hands-on activity.

The need for inexpensive and widely available instructional aids has become critical if future remote sensing specialists are to be trained to meet the expanding demand. New and forthcoming materials from the Laboratory for Applications of Remote Sensing (LARS), the Technology Application Center (TAC), the EROS Data Center (EDC), the U.S. Department of Agriculture and Pilot Rock, Inc. (PRI) will greatly increase the availability of instructional aids. They should also help define the set of common denominators heretofore missing. A logical extension of these efforts is the acquisition and mass production of hard copy images and other training aids for individual student use.

INTRODUCTION

My choice of a title that includes inflammatory words like "ill-defined" and "ill-equipped" is based on a premise developed over the last half decade of teaching and research. That premise, simply stated, is that remote sensing education is founded largely on an ad hoc collection of studies performed with little better than dart board techniques. This accusation is charged to training image interpreters and not to training sensor technologists. Sensor technology, to be sure, is complicated; but, because of its base in mathematics and physics is relatively straight forward. The training of image interpreters, on the other hand, is a subjective undertaking requiring in-depth knowledge of a discipline's philosophy and models, married to common sense personal experience. The problem is not dissimilar to that described by Mr. Viglioni in his discussion of the role of the supplier. He states..."The business community is faced with the problem of attempting to provide an ill-defined product to an uninformed consumer to satisfy some real and some yet to be determined needs and requirements." In this paper I will attempt to give background on the origin of my premise and, hopefully, to end on a positive note by discussing some new and forthcoming materials, and what I perceive to be some of the immediate future needs for both instructors and students.

THE CURRENT SITUATION

At the outset I should stress that my discussion is based on experience as a professor of geography and as program manager for a NASA technology transfer center. In these capacities I frequently receive inquiries from earth sciences departments regarding the establishment of remote sensing courses. Generally, these requests include questions on the availability of inexpensive teaching aids and student "hands-on" materials. To give a positive response to such requests requires considerable imagination in view of the limited funds generally available for new program start-ups, and in view of the fact that more than a few such inquiries come from young professionals who appear to be only modestly trained in this new technology. Pursuing these inquiries with personal interviews suggests to me that, aside from a few well established centers, many new course offerings are ill-defined and ill-equipped to provide first rate training in image interpretation. As a result we seldom know the quality of students who apply for jobs on the basis of their remote sensing background.

It is important that I place an additional caveat on my remarks here; namely, that my experience is limited primarly to discussion with geographers, both young and established, and to less contact with geologists, foresters, biologists and hydrologists. The situation in geography is more serious by virtue of the fact that the discipline, itself, is exceptionally wide. This forces young professors to cover many fields and many techniques within the confines of a ten to fifteen week term. From the professor's point of view, there seems to be concensus that classes are too large and equipment too scarce to provide individual students anything more than modest practical experience. To overcome these handicaps instructors are led to the strategy of turning classrooms into day-to-day slide shows describing well documented studies.

In the best interests of students, instructors, industry and the users, we must ask what the minimum level of achievement and understanding should be for the student. We also must ask what is required in order to produce that level of achievement and then as an academic department, face the hard decision as to whether or not we have the resources to fulfill those needs.

If one wanted to assess current remote sensing education in geography he might conclude that most course offerings consist of lectures designed around readily available slide material. A smaller number of courses, where the student enrollment is purposely kept small, might also include workshops on selected topics, according to the instructor's background. An even smaller number of courses might include field trips to nearby facilities where more sophisticated interpretation equipment is available for demonstration. Only the well-endowed departments would have a balanced curriculum of lecture, laboratory, demonstration and field excursion.

With regard to the current availability of material, professors in virtually all departments should be commended for their ingenuity. We are all in the unenviable position of having to beg, borrow or purloin almost all of our illustrations. Industrial firms who provide illustrated brochures are contributing an excellent source of free color illustrations containing basic sensor imagery as well as computer processed and color enhanced images. Most all of us have, from time to time, made slides of those as well as formally copyrighted material in a desperate move to have something for classroom use. A few of us through our contact with NASA, USDA or other federal agencies have acquired sizable image libraries which we can devote to student use. Still there exists a very large "have not" community and a very small "have" community. The future, however, is not all bleak. There are several new and forthcoming materials that should offer relief to both instructor and student and which should upgrade the general quality of remote sensing education to achieve basic levels of understanding.

There remains the haunting question of interpretation equipment. Many departments have accumulated basic photo interpretation devices like stereoscopes, parallax bars, dot grids or planimeters, and these are still among the most important items in remote sensing. A few departments have acquired or jerry rigged color additive viewers, zoom transfer scopes and simple electronic planimeters. Very few of us, however, can afford closed circuit TV systems, tape units or software packages and this prevents us from being serious contenders in the more sophisticated types of interpretation research.

NEW AND FORTHCOMING MATERIALS

In the past few years concern for improved remote sensing education has been felt by all earth science disciplines. Perhaps nothing will improve the overall effort as much as the recent publication of the Manual of Remote Sensing (Reeves).[7] Through this document, even though it is rather encyclopedic, we should all be more able to define the common denominator for instruction to produce students whose background we can assess. For geography in particular there are several new books, including Estes and Senger,[3] Rudd,[8] and Holz[4]. In the last two years the Association of American Geographers, Committee on Remote Sensing has also initiated a newsletter titled "Remote Sensing in the Electromagnetic Spectrum" (RSEMS). This latter document is serving as an excellent means for instructors to keep abreast of developments in remote sensing, as well as providing an outlet for encapsulated treatments of particular remote sensing topics. As an example of forthcoming issues of RSEMS there will be an edition devoted to radar image interpretation, one devoted to laboratory exercises and one devoted to the design of a remote sensing curriculum.

In audio-visual materials several new series are available. The Laboratory for Applications of Remote Sensing (LARS) has produced a "mini-course" series of self-instructional slide/tape programs. Each program is a self contained unit such that purchasing institutions can mix and match modules describing systems, interpretation techniques and applications. To my knowledge this is the only series designed around the concept of programmed learning. The slides are carefully selected and executed to be of value both to the instructor and to the student.

Pilot Rock, Inc. (PRI) has also produced several slide series. Its Signature Series consists of seven slide groupings on various disciplines written by qualified research investigators. They have also produced an Earth Sciences series based on NASA U-2 photography. These are regionally oriented sets focusing on agriculture, urbanization, geomorphology, weather and climate, and environmental quality. Their Planetology series consists of three sets on topics of Martian geology, Lunar geology and Martian duststorms. Lastly, Pilot Rock has undertaken the sale and distribution of Skylab slide sets produced by the Technology Application Center (TAC). With the availability of these materials from one source, educators should be in a better position to select visual aids to fill their needs.

In addition to the efforts of Pilot Rock, Inc. and LARS, a number of other interests for visual aids are emerging. The USDA and Forest Service have produced remote sensing slide programs for use by agency personnel. The EROS Data Center at Sioux Falls is currently in the production stages of a slide/tape series for use in their own training program. At the time of this writing it has not been determined whether or not these programs will be available to the educational community. Lastly, the Audio Visual Institute (AVI) of Albuquerque in association with TAC has produced two slide/tape presentations and is now in the production stages of its third program on the uses of remote sensing for energy.

In sum, except for the cost involved, there appears to be an ample supply of visual aids available for instructors. One might lament, however, the more or less ad hoc development of those resources. To remedy this situation there has been discussion by the Board of Directors of ASP to produce a slide series directly from the Manual of Remote Sensing.[7] If this eventuates, both instructors and students will have an organized "state-of-the-art" reference manual supported by a systematic collection of visual aids.

Even with the availability of these materials we still lack one of the most critical ingredients in the educational process. That ingredient is the availability of low cost sample imagery, color enhancements and color composites for use by students. This remains the single most critical gap in our repertoire. To my knowledge only one organization (PRI) has plans to alleviate this need through the production of an image packet. As currently conceived this packet will contain ten or so black-and-white images and several color reproductions for areas on the west coast, the gulf coast and the north east. If successful as an entrepreneurial effort, future plans are to expand the packet to include imagery for other parts of the country. Pilot Rock is also in the final production stages of a much needed document titled Everyone's Space Handbook. This document should satisfy a need expressed not only by the educational community, but also by government agencies and industries as well. Witness for example a comment by Mr. Barker of the St. Regis Paper Company that ..."Descriptive information...advertising the virtues of remote sensing techniques must be placed in a language oriented to the market place or user communities, even if this means 'Golden Book' terms." Everyone's Space Handbook is designed to inform the reader on where to get remote sensing information and how to use that information once obtained.

FUTURE NEEDS

Among the most pressing needs in the future is a concentrated effort to produce hard copy prints for use by students. These could be so designed as to be useful either in the laboratory as part of formal exercises, or as self-teaching aids. I am aware, of course, that most professors prefer to have a variety of such materials available, around which they can design their own exercises. At the same time, if growth continues in numbers of remote sensing courses, there may be many instructors who desire packages of programmed training. It is difficult to prejudge what kind of exercises should be created because these will vary as the needs of the disciplines vary. The forthcoming issue of RSEMS on remote sensing exercises in geography might, in this instance, be a good trial balloon. In the interim it seems reasonable to conclude that the use of properly prepared laboratory exercises would guarantee job interviewers that applicants have met some minimal requirements. This approach is perhaps no different from that used in introductory physics and chemistry courses, which for years have had exercise books. I am fairly certain, based on my experience and discussion with young geographers, that standardized exercises would be used, if they were accompanied by appropriate and inexpensive imagery.

As I review the possible sources of inexpensive hard copy material, I see few alternatives. Either the major publishing houses must be approached to produce both black-and-white and color lithographic reproductions; or, smaller firms will have to undertake a significant entrepreneurial risk. One wonders if such organizations like the EROS Data Center might not be able to initiate a new product line of this type. It could both increase public awareness as well as further the cause of education. We normally do not think of federal agencies as ones which undertake such activities, but in this case EDC is already in the business of reproducing training material, and of selling imagery. Furthermore they already have the world's largest repository of aircraft and satellite images.

As a final consideration I would suggest to the major publishers that a classroom text series be initiated similar to those already available in biology and the earth sciences. These "mini" texts should, in my opinion, be concise, sole authored and technique oriented. In a real sense they should be an interpretation manual a la those currently available for photo interpretation in forestry, soils and photo geology. A book similar to what I have in mind is currently being prepared under National Park Service sponsorship titled Manual on Remote Sensing in Archaeology,[1] authored by Drs. Avery and Lyons. In the past, these documents have been prepared for distribution through the Superintendent of Documents as the need for widespread dissemination became apparent. I suggest here that the need for a systematic series is clear and apparent, and that we in the educational community should undertake their writing and publication immediately.

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