An Undergraduate Curriculum: Remote Sensing Instruction at SUNY-Oneonta Strategies and Innovations

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INTRODUCTION

THE PURPOSE OF THIS PAPER is to review the development and operation of a successful remote sensing-GIS-computer cartography undergraduate curriculum within a small geography program, namely, the program at the State University of New York (SUNY) at Oneonta. Although one cannot easily separate GIS and computer cartography from remote sensing, the focus of this paper will be on the remote sensing component of this curriculum. Building a strong instructional program in a particular field frequently requires a long term commitment to an institution by one or more individuals, a clear understanding that things are not going to happen overnight, the creation of a research-learning environment for undergraduates, and a diplomatically aggressive individual who can demonstrate to a college administration the merits of developing a certain curriculum. The program to be described in this paper has taken 25 years of systematic and tenacious work to produce. This paper specifically outlines the evolution and issues involved in developing a program, describes important courses within the program, and discusses extracurricular activities associated with the program.

PROGRAM DEVELOPMENT

SUNY-Oneonta is one of 12 four-year colleges within the State University of New York's 64-campus system. The college's student population of approximately 5500 is directed mainly toward the fields of business, teacher education, home economics, and educational psychology. The college has a small pre-engineering program but no applied science orientated programs such as forestry, agriculture, or mining. One might view that the school does not have the foundation on which a technically based field might be developed, especially one designed to deal with applied Earth surface conditions.

The Geography Department has a small staff of five full-time faculty members who teach approximately 1200 students per year and who each offer the equivalent of a 12 hours teaching load with three preparations per semester without the aid of any graduate teaching assistants. The bulk of the students taking geography enroll in the introductory level course and are mainly interested in the course with respect to fulfilling a general distribution requirement. Eight sections of this course are offered each semester with about 50 students per section. Although a single course with a large, mass-lecture approach might reduce the teaching load for the faculty and allow them to offer additional upper level courses, the small sections of this introductory level course form the most effective means for attracting students into the geography curriculum. Good, effective instruction at this introductory level is essential to the entire geography program, let alone any specialized component of the program. High schools and two-year colleges in New York State offer little in terms of formal geography instruction, resulting in very few students declaring themselves as geography majors upon entering college. Under these conditions the geography program maintains approximately 40 majors. Thus, with the lack of any strong support disciplines to assist with the development of a remote sensing curriculum and a great amount of energy being placed at the introductory level, the question arises as to how a remote sensing emphasis was developed.

Until recently, the requirements for the geography major at SUNY-Oneonta reflected the conventional undergraduate geography programs of the 1950s and 1960s where students were expected to take a traditional pen-and-ink cartography course and an even distribution of systematic and regional geography courses. However, since the mid-1960s the Geography Department had been developing new course offerings, many of which were in the areas of remote sensing, GIS, and cartography. Table 1 shows the courses presently offered by the Department in these areas. Only course numbers 240, 245, and 399 predate the mid-1960s. It is easier to get a new course approved than to change an entire program; thus, as the new courses were being developed, the logical building blocks for a program change were being put into place. Also, in the late 1970s, when minor programs were very popular and did not require a great amount of academic and administrative scrutiny, the Department elected to establish several minors based around the new courses being offered. One such program was in the area of cartography and remote sensing. In the 1980s, the Association of American

TABLE 1. COURSES IN REMOTE SENSING-GIS-CARTOGRAPHY

Course Number	Course Name	Credit	Frequency of Course
145	Remote Sensing: Principles and Applications	1-3	S
240	Cartography	3	1
241	Geographic Information Systems: Principles and Methods	3	2
242	Field Mapping and Mensuration	1	2
245	Remote Sensing: Aerial Photo Interpretation	3	1
246	Airborne Remote Sensing Systems	1-2	2
340	Advanced Cartography	3	2
341	Geographic Information Systems: Computer Cartography	3	2
343	Quantitative Geographic and Planning Models	3	2
345	Remote Sensing: Digital Image Processing	3	2
397	Geography Internship In:	1-15	X
399	Independent Study in Geography:	1-6	X

S = Every Semester, 1 = Every Year, 2 = Every Two Years, X = As Needed

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Geographers' Annual Reports on geography programs in the United States and Canada were clearly indicating trends toward undergraduate major programs being designed around special tracks, an increase in the number of new technical course offerings, and a decrease in traditional regional courses. With these trends and the previously mentioned building blocks, the time was appropriate to update the major. With three faculty members involved in teaching the technical courses and recognizing the different interests of the various faculty members, the new major was developed around three tracks which were labeled "General Geography," "Cartography and Remote Sensing," and "Urban and Regional Planning." Another major change between the old and new major was to reduce the number of required hours of regional geography courses; however, a student wishing to concentrate on regional geography can take the General Geography track which permits one to have more regional courses than the old major. The updated program was reviewed and either accepted or voted upon by the appropriate academic dean, the College's Curriculum Committee, the College Senate, the Vice President for Academic Affairs, and the New York State Department of Education, a much harder path to follow in order to bring about change than developing a new course.

Table 2 shows the requirements for the General Geography track under the revised major. The major is based on 33 semester hours and is divided into four components. The requirements for components "a" and "b" (Core Courses and Fields of Study) are the same for all three tracks. Component "c" under the General Geography track allows students to select 12 semester hours of geography and, in the process, design their own concentrations with advisement. Some students have elected to concentrate in physical geography or regional geography, whereas others have decided not to concentrate but, instead, take a broad range of courses. In some cases, students who wanted to focus strictly on remote sensing but not cartography selected the General Geography track with its flexibility.

Table 3 shows component "c" of the cartography and remote sensing track. Students are required to take 3 to 6 semester hours each under the cartography and remote sensing portions of this component and 3 hours from a select group of courses for a total of 12 semester hours. All of the courses in Table 3 are offered either under a one- or two-year rotation as indicated in Table 1. In addition to these specific cartography/remote sensing requirements, students take a general cartography course under component "a" as shown in Table 2. The three semester hour requirement under "Selections" links this track to the Urban and Regional Planning track and permits students the opportunity to see how some of these techniques can be applied to the planning world. The tracks provide flexibility and good use of the physical and human resources available. However, the wide variety of offerings does not allow for the development of new courses for the future.

TABLE 2. GENERAL GEOGRAPHY TRACK

a.	Core Courses		6 s.h.*
	Geog 100	Introductory Geography	
	Geog 240	Cartography	
b.	Fields of Study (3 s.h. in each field)		12 s.h.
	Field 1:	Physical Geography	
		Geog 201 Principles of Physical Geography	
		Geog 202 Regional Climatology	
	Field 2:	Human Geography	
		Geog 225 Population Geography	
		Geog 230 Cultural Geography	
	Field 3:	Urban-Economic Geography	
		Geog 210 Economic Geography	
		Geog 233 Urban Geography	
	Field 4:	Regional Geography	
		Any 200-level regional geography course	
c.	Selections in Geography		12 s.h.
	(Any combination of geography courses)		
		Total:	30 s.h.
d.	Course Work in Related Area		
	Selection in statistics		3 s.h.

*s.h. = semester hours

COURSE DEVELOPMENT

Several of the specific remote sensing courses under this program contain some interesting instructional aspects. Geog. 145, Remote Sensing: Principles and Applications, is a self-instructional course built around the 26 teaching modules produced by the Laboratory for Applied Remote Sensing at Purdue University. Each of these modules consists of a set of slides, an audio tape, and a workbook, and it takes between 45 minutes and 2 hours to complete a module. Students can take this course for 1 to 3 hours of credit depending on how many modules they wish to complete. Some of the modules were obtained as gifts and others purchased through the Department's library book budget. One copy was made of each module and the originals were maintained as the masters. The duplicated copies are kept in the media center of the College's Library where students can work with the materials in audio/visual carrels. After completing a module, a student makes an appointment with the Department secretary to take an exam based on the module. An instructor grades the exams. Thus, this course requires considerably less time and energy than an instructor would spend on a regular course. As previously indicated, the Department puts a tremendous amount of energy into its introductory level geography course in order to maintain and justify its overall program; thus, the resources were not available to provide a conventional introductory level remote sensing course. Geog. 145 is offered every semester and is limited to five students. The course, over subscribed every semester, is very popular and is taken not only by students concentrating in remote sensing but also by students who possess an interest in how the field relates to their respective majors. It is not taken for any general distribution requirement. The limitation of five students per semester is made in order not to over tax the one copy of

TABLE 3. COMPONENT "C" OF CARTOGRAPHY/REMOTE SENSING TRACK

Cartography		3-6 s.h.
Geog. 241	Geographic Information Systems: Principles and Methods	
Geog. 242	Field Mapping and Mensuration	
Geog. 340	Advanced Cartography	
Geog. 341	Geographic Information Systems: Computer Cartography	
Remote Sensing		3-6 s.h.
Geog 145	Remote Sensing: Principles and Applications	
Geog 245	Remote Sensing: Aerial Photo Interpretation	
Geog 246	Airborne Remote Sensing Systems	
Geog 345	Remote Sensing: Digital Image Processing	
Selections in Geography		3 s.h.
Geog 303	Regional Soils, Terrain Analysis, and Site Planning	
Geog 343	Quantitative Geographic and Planning Models	
Geog 347	Urban Spatial Planning	
Geog 348	Regional and Land Use Planning	

modules. Copyright laws do not permit the duplication of more than one copy. New modules are needed to deal with the more recent satellite systems and certain application areas such as land use planning and archeology.

Geog. 246, Airborne Remote Sensing Systems, is a very attractive course because it deals with taking students up in a small aircraft and having them use an aerial camera system. Such a course is what students talk about to other students on campus and what administrators like to stress as innovative instruction. The course is offered for 1 to 2 semester hours in the beginning of a fall semester when the best, cloud-free time for taking pictures is available. The Department, using its small equipment budget, took several years to acquire a good 70-mm Hasselblad Camera system. It took an instructor some time to learn how to use the system and design it for aerial applications. An owner of a small airport, approximately 20 miles from Oneonta, was found to have three single engine airplanes with FAA approved camera mountings that permitted vertical photography to be taken from inside a plane and to have direct access to the camera system while in flight. These planes were equipped for aerial photography in order to fly local crop survey missions for the U.S Department of Agriculture. Arrangements were made to have these planes flown to the small Oneonta airport where students would meet the planes to carry out their aerial photo missions. A fee of $70 is charged each student to cover two hours of flight time. Working with the instructor, students are put into teams and each team establishes flight objectives and routes. Once they have completed a mission, they develop their photographs and determine if the photographs meets their informational needs based on their objectives. The course is offered by the instructor as a teaching overload and is limited to about six students.

Geog 345, Remote Sensing: Digital Image Processing, is another attractive course due to its use of satellite imagery and high resolution computer graphics. It is designed to handle between 15 and 20 students. To develop this course took a considerable amount of time and resources. The instructor started in 1976 by applying for small local grants to obtain training and summer support to experiment with processing satellite data on computers. These grants paved the way for him to obtain larger national grants for instructional improvements and research. This grant approach has been used to develop several of the courses in this curriculum and grants are still being sought to upgrade these courses. This course is designed to put students into teams of two or three individuals and provide considerable hands-on work. Landsat MSS data sets have been created for several different environmental settings in central New York State and each team is assigned a data set. They are introduced to density slicing, the supervised and unsupervised approaches, and various classification methods. The teams are required to establish certain informational objectives that they want from the data and they experiment with these techniques to determine if they can achieve these objectives. After the teams have had an opportunity to use these techniques with their respective data sets, each team is given a new data set of the same geographic area. The new data set might be based on TM data, SPOT MSS data, topographic ancillary data merged with the MSS data set, or two merged MSS data sets of different seasons. Before, the teams were working basically with the same type of data sets and could assist each other, but the new data sets open up different conditions for each team. The students enjoy comparing their results with these various data sets, and this process provides an opportunity for each student to observe the products of these different types of data sets. Support materials such as aerial photographs and maps for the data sets have been obtained over the years, and some teams travel to their geographic area to do field work. The course starts predominantly with lectures and moves rapidly toward hands-on laboratory conditions. The students use special micro-based image processing workstations linked to a mainframe computer. These workstations are described in an article (Baumann, 1990) published in *Current Trends In Remote Sensing Education*. Students become totally engrossed with their work while using these stations, so much so that they occasionally forget to attend their other courses. Many of them enter a research realm that they have never experienced before and become totally engrossed.

After taking Geog 345, generally two to four students per year make arrangements to do independent study (Geog 399) on advanced digital image processing techniques. They are introduced to geometric rectification and merging procedures, principal component analysis, and raster scanning techniques. Some of the special data sets used in Geog 345 are developed by these students when they are working on the rectification and merging procedures. Also, some of the aerial photographs taken by students in Geog 246 are employed in studying scanning techniques.

In addition to its normal instructional program, the Geography Department maintains the Oneonta Laboratory for Computer Graphics and Spatial Analysis, its research and public service arm. Generally, at any given time the Laboratory is involved with two or three projects related to remote sensing, GIS, or computer cartography. On-campus internships (Geog 397) are available to qualified students who wish to work in the Laboratory. They help to maintain the general operation of the facilities, assist with some of the research and public service work, and help students who are using the facilities for instructional work.

Equipment based courses with small enrollments are hard to justify to college administrations. Thus, once equipment has been acquired, it is important to demonstrate its actual use to the appropriate college administrators in order to maintain a continuing level of support. This comment might appear obvious to most people, but faculty frequently fail to take the time to educate and work with their administrators.

EXTRACURRICULAR ACTIVITIES

Students within the program are strongly encouraged to attend and participate in professional meetings. They frequently attend the regional meetings of the Association of American Geographers and the Central New York Chapter Meetings of the American Society for Photogrammetry and Remote Sensing. They have presented papers at these meetings based on their remote sensing work and have received awards for their work. The major meeting that the students enjoy attending is the ACSM/ASPRS National Conference which is sometimes held in the Baltimore/Washington, D.C., area during the spring semester. This conference provides them the opportunity to encounter graduate students and faculty from schools that they are considering for graduate work, to meet with graduates from the Oneonta program and to discuss with them current career possibilities in the remote sensing field, and to savor the various displays showing the most recent technical developments in the field. The magnitude of the conference and the presence of major companies instill in them a feeling that remote sensing is not a small, esoteric field limited to the university environment but one that offers a wide range of career possibilities. Some students are able to attend the conference more than once if they enter the program as sophomores, and as many as 17 students have attended in any particular year. The instructor attending with the students frequently makes arrangements through various personal contacts for them to have special visits to the different public and private agencies in the Washington, D.C., area. One should note that these students have to make various

arrangements with their different course instructors to miss classes and to use their limited financial resources for professional purposes rather than personal reasons. Students attending this conference bring back many positive experiences that they convey to other students, one of the best means of attracting other good students to the program.

FINAL COMMENTS

This undergraduate remote sensing program with its special courses and various related endeavors has opened the door for a great many students to pursue careers in this field. Many graduates of this program have entered some of the best graduate programs in the United States in the areas of geography and remote sensing. Oneonta graduates of this program now work for such companies as Intergraph, Autometrics, Autodesk, AT&T, General Electric, Shell, and ESRI, and such federal agencies as the Defence Mapping Agency, CIA, and the USGS. Also, many graduates who elected to follow the urban and regional planning track of the curriculum have taken with them the knowledge of how remote sensing can be used in their careers.

As initially stated, this program has taken 25 years to build. It involves dedicated instructors who are willing to include undergraduates in their research and professional endeavors, to create innovative instruction under limited financial resources, and to understand that successful programs do not appear overnight.

REFERENCES

Baumann, P.R., 1990. Developing an Image Processing Workstation for Teaching Digital Remote Sensing, *Current Trends In Remote Sensing Education*, pp. 55-64.

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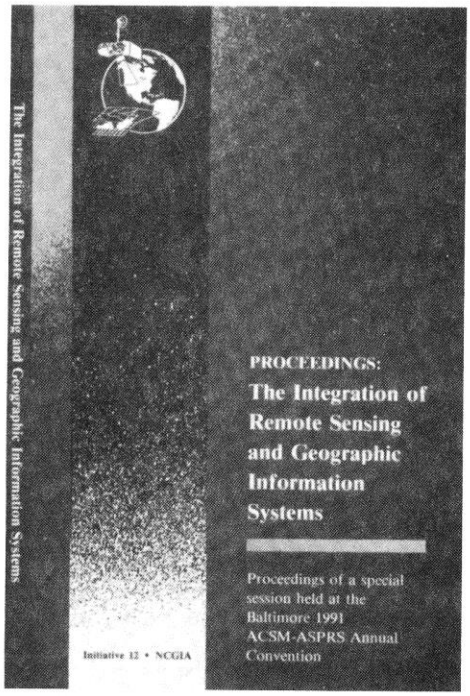

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