AC 2010-980: GEOSPATIAL TECHNOLOGY IN A MULTIDISCIPLINARY ACADEMIC CENTER

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Dr. Tomaszewski is a Geographic Information Scientist whose research interests in the domains of Cartorgraphy, Geovisual Analytics, Geographic Information Retrieval, Context Modeling and Representation, Geocollaboration, and Disaster Management are targeted at developing web-based, collaborative geovisual analytic tools and computational procedures for contextualizing disaster situations through diverse forms of information. His relevant experience includes past work as a special consultant for the United Nations Office for the Coordination for Humanitarian Affairs (UN-OCHA) ReliefWeb group and an active partnership with the United Nations Office for Outer Space Affairs Platform for Space-based Information for Disaster Management and Emergency Response group (UN-SPIDER) developing web-based geospatial applications such as mapping mashups for humanitarian and disaster information. He has also worked on numerous academic research projects involving partnerships with corporate, government, and non-profit sectors such as the US Department of Energy, US Department of Homeland Security, and the Open Geospatial Consortium. He is actively involved in international scholarship through his involvement as program committee member for the Information Systems for Crisis Response and Management (ISCRAM) conference. He is also a core member of the committee developing a BS degree program in Geospatial Technology at the Rochester Institute of Technology (RIT), and teaches and develops undergraduate and graduate geospatial technology courses at RIT. Brian is currently an Assistant Professor in the Center for Multidisciplinary Studies, College of Applied Science and Technology (CAST) at the Rochester Institute of Technology. In 2009, he earned a Ph.D. in Geography from Penn State University.

Geospatial Technology in a Multidisciplinary Academic Center

Because the technical evolution of the geospatial technologies has led to new and exciting approaches to problem solving in technology fields, the Center of Multidisciplinary Studies at the Rochester Institute of Technology has developed six geospatial technology courses and is currently proposing a BS degree that focuses on developing, advancing, and studying the application of geospatial technology.

The Center has been the home for numerous certificate programs and BS and MS degrees in Arts and Sciences that encourage students to build personalized degree programs based on concentrations drawn from across the Institute. These geospatial technology courses are available to all university students and have been attracting students from a variety of majors. Because of the depth and breadth of geospatial applications, the design of the new BS program proposal integrates topics in Geographic Information Science as delineated in the UCGIS Book of Knowledge[1] with general education, professional minors and free elective choices.

In a world where computing, network access, and data sensors are ubiquitous, today's students and researchers are already capitalizing on the abundance of raw data. The capability to effectively summarize and draw inferences to transform this raw data into useful knowledge is critical in many undergraduate curricula. The pressing global issues in today's world that these students will face upon graduation require extensive measurements as well as the location and changes of those measurements over time. The underlying mathematics, sciences and technologies used in collecting, transforming, and communicating this data are vital components.

Introduction

This paper describes a proposed Bachelor of Science degree in **Geospatial Technology** to be offered by the Center for Multidisciplinary Studies in the College of Applied Science and Technology. This degree will educate a new generation of students who can combine spatial thinking, problem solving, and creative thinking skills with technical skills on effective use of the varied approaches to Geospatial Technologies (GTs). Achieving this combination will allow students to achieve maximum successes in their careers or research disciplines.

Background technologies and the anticipated future of the field

Geospatial Technologies (GTs) have evolved from initial beginnings as simple computer-based map making tools to complex visual and computational environments. GTs are used world-wide in diverse application domains ranging from community planning to the exploration of outer space. The increased use of GTs has led the development of new tools, techniques and theory that have imbued GTs with new forms of geographic visualization, support for spatial thinking, and opportunities for research and education. It is an exciting time for GT research and education. Industry standard, commercial desktop Geographic Information System (GIS) platforms such as ArcGIS[2] by ESRI Inc that were once the hallmark of GTs are now being complemented by freely available virtual globe software such as Google Earth[3] and NASA Worldwind[4]. The easy-to-use functionality of virtual globe environments provide users with rich interactivity and visualization capabilities that are allowing millions of people to develop interest and awareness of geography through means not possible only five years ago. Furthermore, the rise in web-based mapping tools with open application programming interfaces (APIs) such as Google Maps have a created a boom in the development of both commercialized personal navigation and business mapping applications and unique "mapping mashups" that represent specialized applications which have generated widespread, worldwide interest in GTs.

There is tremendous growth in the publicly available geographic information and data available through the geographic data clearinghouses[5] and so-called volunteered geographic information ([6]Goodchild, 2007), both of which can be incorporated into commercial products and present key opportunities for advancing GT education. For example, publically available data derived from SCADA (Supervisory Control and Data Acquisition) systems have emerged from the manufacturing field and are being installed in telecommunications, water and waste control, energy, oil and gas refining, and transportation systems to achieve increasing efficiencies in overall system operation. As geographically-aware sensors and mobile devices (such as GPS-enabled cell phones) become more ubiquitous and allow the public to capture where (a) the location of events happen or (b) data is gathered, such actions have potential impacts on future actions, strategic decisions and proposed policies. In particular, mobile GTs open the door to methods of reasoning and persuasion that would be impossible without the use of publically available spatial information. For example, during a disaster, location-based videos captured through cell phones at a disaster site can facilitate rapid allocation of resources to respond to the disaster.

Most data and information have geographic elements, and many problems facing the world today are geographical in nature. For example, the complexity of climate change can best be understood when viewed from a geographical, multi-scale perspective of interconnected human/environment systems. The inherent geographical nature of various forms of data, information, and structure of problems has lead to numerous applications of GTs in scientific and engineering disciplines. As the barriers to the use and exploitation of GTs have been lowered, the application of GTs in practical problem solving has grown. For example, GTs are now an integral part of society's approach in solving problems of emergency management response, transportation planning and control, forestry and agricultural management, tourism, and personal navigation. These applications illustrate the tremendous variation in both the geographic scale of the problem or issue being addressed and use of geographic information in these applications ([7] Longley et al., 2005).

Several agencies of the Federal government have recognized the need to increase the supply of Geospatial Technology professionals. These needs are reflected in the following research reports issues by the Federal government:

> The 2004 U.S. Department of Labor report *Geospatial Industry Snapshot* identified 12 diverse geospatial-related occupations, and employment in each was projected to increase by 8.1% to 29.1% over the period 2000-2010 (U.S. Department of Labor, 2004 [8]). There is currently no recognized educational pathway for individuals preparing for these positions. On their current web site[9] focusing on high growth industries, the geospatial

technology industry, as reported by Geospatial Information & Technology Association, is growing at an annual rate of almost 35 percent, with the commercial subsection of the market expanding at the rate of 100 percent each year.

The National Research Council (NRC) through the National Academy Press has issued a number of reports from select committees and task forces examining various issues faced by geospatial industries, researchers, and educators. The 2006 report titled *Beyond Mapping: Meeting National Needs through enhanced Geographic Information Science*, recognizes that the supply of professionals in the geospatial fields has not kept pace with the demands of a high growth technology (National Research Council, 2006a[10]). This report was requested by several government agencies (including the Census Bureau, the Federal Geographic Data Committee, the National Geospatial-Intelligence Agency, the National Oceanic and Atmospheric Administration, the National Science Foundation and the U.S. Geologic Survey) to assess the current state of the mapping sciences. The committee made several recommendations including increased flexibility by academic institutions in removing barriers to implementation of multidisciplinary GT programs and recognition of Geographic Information Science as a coherent research specialty by the National Science Foundation.

In recognizing that the development of a future GT workforce begins with K-12 education, the NRC's 2006 report titled *Learning to Think Spatially* proposed a goal of establishing a systematic research program into the nature, characteristics and operations of spatial thinking and in turn, fostering the development of a new generation of spatially literate students (National Research Council, 2006b[11]).

The NRC has also outlined a roadmap for interdisciplinary research at the intersection of Computer Science and Geographic Information Science as reflected in the 2003 report titled *IT Roadmap to a Geospatial Future* (National Research Cou[12]ncil, 2003). The report concludes that "The convergence of advances in location-aware computing, databases and knowledge discovery, and human interaction technologies, combined with the increasing quality and quantity of geospatial information, can transform our world."

At the same time the NRC has recognized that this new research capacity is not without personal dangers. In the 2007 report, *Putting People on the Map: Protecting Confidentiality with Linked Social-Spatial Data*, a panel examines the issues of availability of spatial data on research participants in investigations that allow identification of individuals who have been promised confidentiality (National Research Council, 2007[13]).

While not explicitly mentioning GTs, the Office of Cyberinfrastructure in the National Science Foundation states in the vision statement of *Cyberinfrastructure Vision for 21st Century Discovery* that it intends to lead in "the development and support of a comprehensive cyberinfrastructure essential to 21st century advances in science and engineering research and education" (National Science Foundation Council (NSFC), 2007:1[14]). The report reiterates the key points of the NSF Office of Cyberinfrastructure

(OCI) mission which is "the preparation and training of current and future generations of researchers and educators to use cyberinfrastructure to further their research and education goals, while also supporting the scientific and engineering professionals who create and maintain these IT-based resources and systems and who provide essential customer services to the national science and engineering user community[15]." This vision will assist in building the computing infrastructure on which researchers, educators, and students in diverse applications of Geographic Information Science and Technology will thrive.

Rationale for the program

Consistent with RIT's educational goals and mission, this program proposal responds to the increasing need for highly educated and capable professionals in the technological workforce. In 1997, NASA launched a National Workforce Development Education and Training Initiative to address the "serious shortfall of professionals and trained specialists who can utilize geospatial technologies in their jobs" (Gaudet et al., 2003:21[16]). Since that time the academic community, through the University Consortium for Geographic Information Science, has sought to address issues of unregulated academic certificate programs and insufficiently rigorous undergraduate programs.

This effort has resulted in a report titled the Geographic Information Science & Technology (GIS&T) Body of Knowledge (University Consortium for Geographic Information Science (UCGIS), 2006). This report is the result of a collaborative curricula project over ten years by representatives from more than 80 universities and continues to be developed with a 2nd edition scheduled for publication in 2010[17]. This program is first designed to meet the core requirements of this report, to further prepare students to function as professionals in the field with classroom and work learning experiences, and to prepare them for future education at the graduate level. It is required that students learn the core elements of the science and technology in the Geospatial Technology field and apply them in problem solving activities. At the same time, a very important element of the educational experience will be the association with students of other disciplines who will be pursuing elective courses in GT as a method for their own professional domains.

The Program of Study

The proposed Bachelor of Science program consists of 182 credits with an additional requirement for 3 quarters of Co-op experience in a professional employment situation. The program does not contain multiple concentrations or tracks. The program requirements are:

- GT courses in the major field of study - 56 quarter credits with 48 credits offered through the Center for Multidisciplinary Studies and 8 credits coming from other colleges at the Institute.
- Institute requirements for First Year Enrichment (2 credits) and Wellness are met. General education requirements include 92 credits from the Colleges of Liberal Arts and Science.

- Professional electives - 20 credits. These may include geospatial technology courses not specifically required in their program, and/or courses approved as professional electives that are offered from other RIT departments and minors.
- Free electives -12 credits

Educational and career outcomes

Career opportunities will abound for graduates of the proposed degree program. Examples of possible career paths that graduates of the proposed degree can pursue include but are not limited to cartography, surveying, and geospatial application development. See GIS Jobs Clearinghouse (2009)[18] for a continually updated list of industry-specific career opportunities related to GTs. Furthermore, any proposed curriculum in a professional field should meet the requirements of professional qualification – either a licensure or certification – of program graduates. The newly formed GIS Certification Institute (GISCI)[19] is seeking to address the issues of certifying GIS professionals (the GISP certification) and currently offers a portfolio based certificate pending development of curricula and appropriate examinations. This requires submission of documentation of educational and work experiences, professional recommendations, and agreement to abide by a published code of ethics.

In today's competitive work place, many students continue on after their Bachelor degrees for graduate education. This trend is no different in Geospatial Technology fields. Acknowledging this trend, the proposed curriculum is also designed to prepare students for graduate-level education. In this respect, the proposed curriculum will emphasize the acquisition of research skills and effective writing and communication. Even if students do not choose to continue on for graduate education, these skills will enable them to be leaders and innovators in their careers. Furthermore, in preparing students for graduate education, this curriculum fits within the institutional vision for increased scholarship at RIT. Upper level courses in the curriculum will be designed to create opportunities for students to work closely with faculty on research projects.

Relationship to RIT program portfolio

This BS program is the result of the continued development in the Geographic Information Science and Technology field over the last 30 years. The value of rigorous, creative spatial thinking and communication has been increasingly recognized and has resulted in opportunities for careers and further education in the field. This program will complement and enhance the current offerings in the RIT portfolio of programs. There are currently undergraduate and graduate programs that make significant use of geospatial technology, such as Imaging Science, Environmental Science, Public Policy, and Anthropology. These programs and others will benefit from the educational and research activities of faculty and students associated with this degree and create further synergy and opportunities for collaboration across the Institute through multidisciplinary connections. In addition to the core program requirements, courses specific to the GT BS degree can also be offered as minor with an existing degree. For example, GT would make an excellent minor to Environmental Science, Civil Engineering Technology, Imaging Science or any other existing degree that incorporates spatial perspectives. The interdisciplinary, unique nature of the proposed BS degree program makes quantitative information on student headcounts in related programs internal and external to RIT difficult to obtain. For example, the strong emphasis on technology makes the proposed degree distinct from BS degrees in Geography where GTs, in part, are typically taught but are not the main focus. The four year plan of study makes the proposed degree distinct and more in-depth from two year, vocationally-oriented type GT degrees.

Relationship to RIT goals

Goal 1. Improve student retention and graduation rates. This proposed degree program has tremendous career potential through involvement in many infrastructure industries and interdisciplinary nature. The Department of Labor has recognized the career field as one of fourteen fasted growing in the country. The placement of the degree program in the Center for Multidisciplinary Studies, which is known throughout the Institute for its strength in student retention, is a tremendous opportunity because of its faculty and experienced professional advising staff. The graduate and undergraduate courses -already available to other students in the Institute - will enable the degree program to attract students internally who might otherwise search elsewhere for such a degree.

Goal 2. Achieve "best in class" diversity for minority student, faculty, and staff populations. The Geospatial Technology industry has emerging careers that offer new opportunities to all comers. A good example is the program offered by the American Association of Geographers titled **My Community, Our Earth**[20] that promotes female and minority participation in geospatial technology training for sustainable development.

Goal 4: Increase percentage of graduating students with employment offers or graduate school. This field is regarded by the Department of Labor as one of the fastest growing 14 career fields in the nation. It has been recognized as one of the key components of industries building and maintaining the national infrastructure in many areas – electrical, telecommunications, transportation, emergency management, etc. Students who graduate from this program will be prepared to enter graduate school in many fields.

Goal 6: Increase Sponsored Research awards. Core faculty of the program are actively involved in obtaining sponsored research for Geographic Information Science and Technology (GIS & T) related research. A key part to GIS & T research is student RAs that receive relevant scholarship training via the GT program.

Goal 8: Achieve 100% faculty participation in scholarship as defined by RIT Scholarship Policy. Core faculty of the program are already actively involved in scholarship.

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