UNIVERSITY OF MAINE SYSTEM
ACADEMIC DEGREE: FULL PROGRAM PROPOSAL

I. Full Academic Degree Program Title

Master of Science: Spatial Informatics
University of Maine (CIP Code: 14.3801)

II. Program Objectives

The objective of this proposal is to provide an "all e-learning" "all coursework" master-of-science degree in Spatial Informatics (MSSI) for place-bound students that desire strong theory, computational, analytical, policy and technical foundations in geographic information science and systems. As a general rule, students may view class videos and accomplish assignments at any time throughout a week in any of the offered program courses and have the weekly opportunity (or requirement) to participate in a one to two hour "live" discussion session at a mutually convenient time for class members prior to the due dates for their weekly assignments. The MS Spatial Informatics graduate degree is an "online only" version of the existing and more intense on-campus research-focused *MS in Spatial Information Science and Engineering* degree. An innovative funding approach is used to ensure sustainability of the program and increase the potential for substantial financial benefits for the university.

A. Program Rationale

The business climate in Maine and the rest of the nation is characterized by rapid technological change, intense global competition, faster product life cycles and more complex, specialized markets. Individuals with information systems expertise who can design and develop information systems, manage sophisticated information resources, work on interdisciplinary teams and communicate effectively with business managers, engineers and other end-users are in short supply. A major goal of all the graduate programs in the School of Computing and Information Science is to produce individuals who can make significant contributions to economic development by ensuring that private and public enterprise have the expertise needed to remain competitive.

Already existing on-campus programs include the *Master of Science in Information Systems* (MSIS) and the *Graduate Certificate in Information Systems* (GC-IS) (http://www.umaine.edu/msis/curriculum-and-degree-requirements/) as well as the *Master of Science in Spatial Information Science and Engineering* (MS-SIE) and the *Graduate Certificate in Geographic Information Systems* (GC-GIS) (http://spatial.umaine.edu/graduate-info/sie-graduate-info/). Many of the courses affiliated with these programs are already offered with online class sections. This proposed graduate program will help us move to offering e-learning class sections for most of our non-research focused master's level courses.

Non-traditional students that may be working full time or who are otherwise unable to travel to Orono will be able to take this graduate degree anywhere that high speed Internet access is available (such as from their home or office) and will be able to view most class lectures or discussions in the courses at any time of their choosing.

Three existing graduate programs (GC-IS, MSIS, GC-GIS) and this proposed graduate program (MSSI) to be offered entirely by distance methods are highly intertwined in that the beginning core courses are largely the same for all four graduate programs. This common foundation and skills approach provides great flexibility for graduate students in the event they desire to switch to a different graduate program after taking a few courses. Courses offered online through the IS and GIS/geospatial programs will also

help support the proposed online graduate programs in Digital Curation and Bioinformatics as well as a proposed graduate program in Applied Geographic Information Systems at the University of Southern Maine.

B. General Program Goals:

The proposed *MS in Spatial Informatics* and the existing *Graduate Certificate in Geographic Information Systems* focus on technical, managerial and policy issues associated with constructing and managing computer-based information systems for modern organizations with a particular emphasis on spatial technologies. The objectives of these programs are to meet the growing demand in society for graduates with high-level geographic information system skills and provide a path for women and men from diverse fields to rapidly transition to information system career paths by providing them with foundation graduate level courses in IS and GIS. Similar to an MBA or Law degree, these programs are explicitly designed to accommodate students from wide ranging undergraduate degree backgrounds. Many past graduates from our on-campus spatially-focused graduate programs are involved in advancing spatial technology itself or developing software and systems to enhance the ability of individuals, business, government, and industry to better utilize location information, sensors and mobile systems in their daily tasks. Other graduates are involved in more traditional areas of managing land information systems, producing maps and digital databases through the application of geospatial technologies and techniques, or managing, developing, and preserving land and natural resources. Yet others are involved in managing information about the environment, transportation and communication networks, utilities and the built environment generally.

We view the online offerings as a means to better support and recruit for our on-campus research-focused MS and PhD programs in Spatial Information Science and Engineering. Through our long experience in offering distance courses and through capitalization on very recent simple-to-use distance delivery capabilities, we believe the distance program offerings will complement and help support our on-campus research-based graduate programs rather than detract from them.

C. Student Outcomes and Behavioral Objectives

Students will develop knowledge and technical skills in such areas as information system design, human-computer interaction, database systems design and management, systems development, computer networks, and information law and ethics. They will gain working familiarity with one or more programming languages, the concepts of managing resources across local and wide area networks including technical and managerial concepts of distributed systems, client-server systems, world-wide web, digital libraries, and further evolving network-based systems. Relational and object-oriented databases and systems for group decision support are addressed in the context of designing and managing databases. Virtually all of these general information systems graduate courses draw on spatial technology examples or contextual environments. This new online graduate program will specialize in preparing graduates to better utilize location information, geographic information systems, sensors and mobile technologies in accomplishing the day-to-day tasks of businesses and government and to help advance new innovations in these domains. In addition, students have the opportunity to take courses that provide an understanding of business and engineering applications and thus provide further foundations for effective communication with end users.

III. Evidence of Program Need

A. Evidence of Educational, Economic and Social Needs

(1) Workforce Needs

Geospatial technologies have been identified specifically as a High Growth Industry by the US Department of Labor[1] and "geographic information systems" is one of the academic programs suggested for focus among Maine's high-demand workforce areas in a report issued by the University of Maine System on Advancing Maine: An Action Plan to Transform Maine's Economy.[2]

Even a cursory look at job listings on the TechMaine web site[3] indicates that Maine businesses are in constant need of information systems professionals. In a time of high unemployment generally, Maine still has a substantial number of information technology employers actively looking for information technology professionals[4] and many are interested in providing internships for IS and GIS graduate students.[5] This same high demand is witnessed across the nation.

In a recent survey of companies in Maine with interests in computer science and information systems skills, respondents were asked: Please check any University of Maine System computer science or information system programs listed below from which your organization might have an interest in supporting internships or hiring graduates in the future.[6] From among the 27 programs listed from across the University of Maine System campuses, the MS in "geographic information systems" was ranked third from the top for degree backgrounds desired by employers and other UMS geographic information systems programs also ranked high.

The evidence is clear. The information technology skills provided through the graduate courses and programs offered by the Spatial Information Science and Engineering faculty in the School of Computing and Information Science will continue to remain in high demand both across the nation as well as in Maine.

(2) Targeted Audiences Related to the Need for Graduate Education in this Field

The advanced knowledge provided by graduate-level information systems programs is needed across a wide range of commercial, non-profit and government settings. Individuals in all areas of private and public enterprise rely on information systems for communication, planning, control and decision support. Location and spatial relations have emerged as key critical concepts for organizing information across all sectors and throughout the broadest range of Internet applications. The existing *Graduate Certificate in GIS* and the proposed *Master of Science in Spatial Informatics* will be marketed to people with strong computer science, math, science, and engineering backgrounds in addition to those who are working in research labs across the nation and those actively managing geographic information systems who need greater in depth knowledge of a domain in which they may have a job but not a strong foundational knowledge base. The term *Spatial Informatics* for the new graduate degree sends the message that the program builds from computer science and information technology foundations and is more technically focused than the competing geographic information science graduate programs offered by distance. Our four graduate distance programs might be further marketed to people with bachelor's degrees currently

[1] High Growth Industry Profile: Geospatial Technology, U.S. Department of Labor, http://www.doleta.gov/brg/Indprof/geospatial_profile.cfm

[2] Advancing Maine, The University of Maine System – A Key Economic Driver for Maine, http://www.umaine.edu/cis/files/2014/01/AdvancingMaineJohnDorrer.pdf

[3] High Technology Jobs, Technology Association of Maine, http://www.techmaine.com/technology-jobs

[4] Technology Employers Directory, http://www.techmaine.com/industry-directory

[5] Company and Agency Internships, http://spatial.umaine.edu/internships/

[6] Survey of Potential Actions to Increase the Number of Computing and Information System Graduates in Maine, Compiled Summary Results, *University-Business Information Technology and Computer Science Partnership,* Version: 24 Oct 2011 (available upon request)

working for natural resource companies, transportation agencies, conservation groups, mapping and mobile technology companies, utilities, and high tech companies advancing the next generations of such technologies as well as those people accomplishing research across many disciplines that rely on spatial analysis and location tracking as a core skill in accomplishing their work.

B. Survey of Similar Programs

Virtually all substantial geographic information science academic degree graduate programs in the U.S. are affiliated with member universities of the University Consortium for Geographic Information Science (UCGIS).[7] The University of Maine was one of the seven founding members and the organization now boasts over 70 university and national research lab members. Only a small number of the programs offer entirely online a Graduate Certificate or MS degree in Geographic Information Science or related titles. The most significant competition would be the online programs offered through University of Southern California[8] and Pennsylvania State University.[9] A relatively complete listing of online graduate degree and certificate programs in geographic information science (and related titles) may be found at the UCGIS web site.[10] Many of those shown are offered by lesser known academic degree programs. Our UMaine faculty members are extremely well known globally and have a high reputation within the geographic information science community. Further our program is distinguished from most of these other programs in that our degree will focus on those students that want strong theory, analytical and technical foundations taught by leaders in the field. Therefore we believe we may readily and successfully compete for graduate students in this general arena.

C. Enrollment Projections

(1) Demand by Students:

A survey was accomplished of University of Maine Alumni as a potential sample of college graduates that might have an interest in pursuing online graduate degrees through the University of Maine. The responses were very favorable for both our GIS and Information Systems graduate programs.[11] The market is of course much larger than Maine alumni and spans the English-speaking globe with good Internet access.

When the cross-disciplinary sample of UMaine alumni were asked which single graduate program of their choice they would most like to take online from among a list of 78 choices, only nine other programs ranked above *geographic information systems*. We learned from the survey that interest in both our GIS and IS program areas is approximately evenly split between those that would prefer a graduate certificate versus a full master's degree program. There was also a significant population desiring to take only occasional specific courses of interest. We learned further that approximately three times as many respondents replied that they could participate in an online live weekly discussion session in their early evening as opposed to other times of the day. Most respondents indicated a desire to view pre-recorded

[7] University Consortium for Geographic Information Science, http://www.ucgis.org/
[8] University of Southern California, MS Degree and Graduate Certificate in Geographic Information Science and Technology, http://gis.usc.edu/
[9] Master of Geographic Information Systems, Pennsylvania State University, http://www.worldcampus.psu.edu/MasterinGIS.shtml
[10] GIS Certificate and Master's Programs, Distance and Online Learning, UCGIS, http://www.ucgis.org/priorities/education/GIS_Cert+Masters_Prog/certificates.htm#DistanceLearning
[11] Survey of UMaine Alumni, *Graduate Course Distance Offerings: Preferred Programs and Delivery Methods*, Summary of Overall Results, February 2011 (available upon request)

lectures at their leisure and participate in only one or no live sessions each week although approximately two-thirds of the positive respondents agreed or strongly agreed that they could participate in online live sessions if offered at an appropriate time. Thus, all of our graduate course offerings have been designed to allow distance students to view video lectures at any time of their choosing and then deliver their weekly assignments prior to at least one "live" video conference session per week. The video conference occurs at a time likely to be convenient to all enrolled students.

(2) Enrollment Projections for Five Years

Assuming that we have the marketing resources and the self-generated incentive-based funding support specified later in this proposal, we believe the following goals should be achievable:

Academic Year	Number of SI Graduate Students
2014-2015	5
2015-2016	15
2016-2017	30
2017-2018	45
2018-2019	60

Table 1. Projected Enrollments

The number in column 2 represents an estimate of the number of Spatial Informatics graduate students likely to be formally admitted into the graduate program and enrolled in at least one SIE graduate course per semester. Once fully developed, we hope to admit an additional 15 Spatial Informatics graduate students each year holding the maximum cap at about 60 students. This is in addition to supporting our other distance graduate programs. Our goal after build up is to sustain 50 to 60 graduate students actively enrolled in distance courses in this program each year. Once fully developed, we hope to also graduate 15 to 20 graduate students on average each year. Because most of these students will be working full time and be place bound, we expect them on average to take three to four rather than two years to complete their degrees. The small number of admissions shown in the table for 2014-2015 is due to limited time to advertise the program in the initial year after it has been approved by the Board of Trustees.

IV. Program Content

The graduate program in Spatial Informatics focuses on gaining knowledge about spatial information particularly with respect to concepts needed in next-generation information systems. Emphasis is placed on learning novel concepts and methods in the broad field of geographic information science for: storing, accessing, analyzing, and managing spatial data, and modeling, extracting, integrating, visualizing, and communicating geospatial information. Students build on a solid foundation in computer science, mathematics, physics, geography, cognitive science, artificial intelligence, and related fields to study spatio-temporal phenomena and design intelligent spatial information systems. In addition to these concepts, the use and design of spatial information technologies requires a comprehensive understanding of the social, legal, economic, and institutional issues affecting such systems, a commitment to human users and ethical uses of such systems, dedication to the ethics of broad access to information, and commitment to quality of information.

A. Required and Elective Courses

The Master of Science in Spatial Informatics (MSSI) consists of 30 credits, all earned in course work. The program consists of five three-credit required core courses and a minimum of fifteen additional credits

from a list of elective courses approved for the program drawn from a range of disciplines but primarily from distance courses offered by the School of Computing and Information Science. If some required courses are duplicative of courses that may have been taken in the student's undergraduate degree program, those courses need not be repeated, and the student will select in consultation with the MSSI Graduate Coordinator and MSSI Steering Committee additional approved courses to arrive at the total of 30 credit hours.

(1) Required Courses
The following five courses must be taken and all count toward the graduate degree unless they were counted in a student's undergraduate degree program. All of these courses have included distance sections in their offerings for the past several years.

- SIE 505 - Formal Foundations for Information Science Credits: 3
- SIE 507 - Information Systems Programming Credits: 3
- SIE 515 - Human Computer Interaction Credits: 3
- SIE 525 - Information Systems Law Credits: 3
- SIE 550 - Design of Information Systems Credits: 3

(2) Elective Courses
Students must take at least fifteen additional credits that are approved in advance by the MSSI Steering Committee from an approved elective course listing in order to arrive at the total required of 30 credits. Students should NOT assume that any combination of the following courses will be approved by the Steering Committee. Students should obtain approval of their full program of study prior to taking elective courses to ensure that they will count towards their degree requirements.

Courses already taught by Spatial Information Science and Engineering faculty and which already have or will soon have distance section offerings include the following:

- SIE 509 - Principles of Geographic Information Systems Credits: 3
- SIE 510 - Geographic Information Systems Applications Credits: 3
- SIE 512 - Spatial Analysis Credits: 3
- SIE 555 - Spatial Database Systems Credits: 3
- SIE 557 - Database System Applications Credits: 3
- SIE 570 - Spatial Cognition and Computing Credits: 3
- SIE 590 - Information Systems Internship Credits: 3

Students may propose additional graduate courses than those listed above to be included on their program of study on a case-by-case basis or added to the list. The MSSI Steering Committee assesses the reasonableness of such requests and makes the final decision on whether specific additional courses serving the objectives of the MSSI program and the needs of the student may be included. Some of the elective graduate courses listed may require prerequisites in addition to the minimum required for general admission to the MSSI graduate program.

B. Development of New Courses

While there has been no need to develop any new courses for the Master of Science degree in Spatial Informatics (MSSI) to date, numerous courses have already been converted to allow them to be offered simultaneously to both off-campus and on-campus students. This conversion process has been funded by the Project 7 initiative. This degree is the "all e-learning" "all coursework" version of an already existing graduate degree. See the *Background* section under *V Program Resources* for a full description of the approach being used.

One new course will be developed upon approval of this degree program. This is *SIE 580 - GIS Field Data Collection Methods* and funds have already been reserved in the Project 7 budget for the development of this course. Each summer, beginning distance graduate students will gather in Maine for a week-long field course. Part of the goal is to provide students with valuable data gathering skills that can't be gained in the office or at home. A further important goal is to allow students to get to know each other working on teams on field projects. After the onsite working sessions they will return home to finish their projects with their team members but not cooperating online. Past experience has shown that distance students that identify positively with fellow graduate students and can call on them for mutual support have a greater likelihood of completing their graduate degrees.

Additional on-campus courses already offered by the academic unit are likely to be converted to make them available by e-learning methods. This will be a natural progression of the program after expenditure of the Project 7 start-up funds since there is a built in incentive in the proposed long-term funding of the program that will benefit both the teaching unit's income and expenditure streams.

C. Research Activity in Program Design

Because the degree program has been designed as an "all e-learning" "all coursework" program, it does not incorporate any research activity. Students desiring to become engaged in in-depth research work should enroll as on-campus students and pursue the affiliated Master of Science or PhD degrees in Spatial Information Science and Engineering.

D. Field Internships with Businesses and Agencies

Students pursuing the MS Spatial Informatics degree have the option of participating in a 3-credit graduate internship course titled *SIE 590 Information Systems Internship*. The course involves working closely for or with a private company or agency. The details of the graduate internship course requirements and the names of some of the companies we have worked with in the past may be found on the website of the School of Computing and Information Science (http://spatial.umaine.edu/internships/). In short, a detailed learning experience plan must be prepared and agreed to by both the intern and the internship hosting organization. The student is required to meet requirements such as keeping a daily work log, preparing a final report at the conclusion of the work period that includes an assessment of whether target goals in the plan were achieved, making a final advertised public presentation whether at the university or through video conferencing about the experience and preparing a short video summarizing the highlights of the experience for posting on the web. Both the employer and student assess each other at the end of the course and make suggestions for improving the internship experience with other students in the future. Several past students have had the opportunity to participate in graduate internships in their home communities. Typically, finding internship experiences for those graduate students that desire them has not been a problem in the past. Further, the faculty have been strongly engaged in supporting *Project>LogIn* (http://projectlogin.com/) which has provided additional opportunities for our students to participate with Maine employers in offering paid internships to students.

E. Impact on Existing Programs on the Campus

We believe this program will attract highly motivated mature graduate students that are place bound due to work and family obligations. Many are already working in the information systems or spatial informatics industry either at corporations, within government agencies or are independent consultants. While many have substantial work experience their goal is typically to expand their knowledge base to enhance their capabilities and skills, increase their value to their employers and to raise their prospects for

advancement. From past experience in teaching such students in our distance classes, we know that bringing this experience base of mature students into class discussions raises the quality of our on-campus classes as well. By offering and advertising strong graduate distance degree opportunities, we are confident that the marketing will also attract strong candidates to our on-campus research-based graduate programs. While reaching out to distance students can burden our on-campus teaching, distance delivery technology has advanced to the point that many of the previous challenges of even a couple of years ago have been greatly lessened. Section VI describes how additional teaching support resources will be brought to bear. Thus we see only positive influences on our other *Spatial Information Science and Engineering* and *Information Systems* graduate course programs in the *School of Computing and Information Science*.

V. Program Resources

A. Background

From the previously mentioned UMaine Alumni survey results, we conclude that student demand for this and other e-learning graduate programs largely depends on the methods by which courses are offered. Given the empirical data gathered and in an attempt to maximize the online market for our existing IS and GIS programs and the proposed Spatial Informatics graduate program, we are adhering generally to the following principles in designing our course offerings.

1. To maintain a level of consistency and avoid duplicative work by faculty members, the course material and class sessions both for on-campus and online students will be identical in most cases. This ensures the materials covered in the courses will be always equally rigorous and up-to-date. An additional live weekly discussion session for online students will be required for most courses.
2. All class sessions whether lectures or discussion sessions will be video recorded. Both on-campus and online students will have access to these recordings.
    a. *Pre-recorded Class Lectures*: Depending on the course and nature of the class materials, some instructors may choose to pre-record all or most lectures for some courses in advance. Typically, distance students will be expected to view the videos and submit assignments prior to a weekly live discussion session that is required or optional at the discretion of the instructor. To ensure that the videos are actually viewed, one device already used by one instructor is to make an oral assignment of a discussion question somewhere in each video lecture for which a short written response must be submitted by each student prior to participation in the end-of-week live discussion session.
    b. *Contemporaneously Recorded Class Sessions*: In most courses, professors are likely to record the live class sessions with on-campus graduate students as they occur. Students at a distance may either participate in the class sessions remotely from anywhere on the Internet as the classes occur if they happen to be available at that time or they may view the recording at any later time before the required or optional discussion session.
3. Technologies
    a. *Pre-recorded Videos*: For pre-recorded lectures, professors may select any recording software of their choice and several are already actively engaged in this process with no need for special facilities other than what has already been acquired.
    b. *Contemporaneously Recorded Videos*: For day-to-day regular recording of class sessions we use currently Connect Pro. All participating faculty members have Connect Pro accounts (cost of approximately $150 per year per professor) plus one or more years of experience in using Connect Pro. Students and faculty find it far superior for our needs over Polycom and Tandberg systems that are limited in reaching the market population of students which may be located anywhere across the Internet. Connect Pro is also better suited technically in that little to no external technical support is required once a stable installed setup is achieved. The

technology requires no scheduling of distant classrooms, provides multiple easily resized pod windows for providing multiple forms of communication and information, provides resolutions exceeding our needs, can be interfaced with digital tablets and smart boards for drawing diagrams and writing equations, and is low cost in comparison to the alternatives. The technology is not perfect but it has proven sufficient to more than meet our live distance education broadcast and two-way audio and video needs.

c. *Other Technologies*: **Web:** The syllabi and detailed daily assignments for each course are being hosted on the University of Maine server using WordPress at http://www.umaine.edu/computingcoursesonline/ This interface provides a consistent interface for both on-campus and off-campus graduate students, allows professors to have ready control over their own web content and allows them to control access to or provide open access to their course materials as they see fit. **FirstClass:** The UMaine FirstClass system may be used readily for submission of assignments by enrolled students, to support a class discussion list and for delivery of course materials to students as appropriate. **Skype:** In the event that bandwidth is slow on a particular day or the audio is malfunctioning, professors can readily convert to a Skype Conference Call on the fly for students that may be participating live from a distance. This needs to be prepared in advance so that a conference call to the entire group can be made quickly. **Other Course Management Systems:** Professors have the option to use other web-based course management systems such as Blackboard, Moodle, etc. but none have chosen to do so to date. Some professors pay personal subscriptions to GoToMeeting, WebEx, etc. and these may also be used at times

B. Personnel

Faculty: Courses taught by Spatial Information Science and Engineering faculty members will be sufficient for students to acquire any of four separate graduate programs offered by e-learning methods. These academic programs include:

- *Graduate Certificate in Information Systems* (GC-IS) **Existing** – see http://www.umaine.edu/msis/curriculum-and-degree-requirements/
- *Master of Science in Information Systems* (MSIS) **Existing** – see http://www.umaine.edu/msis/curriculum-and-degree-requirements/
- *Graduate Certificate in Geographic Information Systems* (GC-GIS) **Existing** – see http://spatial.umaine.edu/graduate-info/sie-graduate-info/
- *Master of Science in Spatial Informatics* (MSSI) **Proposed**

The Master of Science and PhD programs in Spatial Information Science and Engineering are research-based and require an on-campus presence to pursue. Some courses to be included in the e-learning graduate programs are offered in other departments but those courses are not required.

The core faculty members included in teaching the four graduate programs listed above include:

M. Kate Beard-Tisdale, Ph.D. (Wisconsin, 1988), Professor. Geographic information systems, spatial analysis, digital libraries.

Max J. Egenhofer, Ph.D. (Maine, 1989), Professor. Geographic database systems, spatial reasoning, GIS user interface design, research methodologies.

Nicholas Giudice, Ph.D. (Minnesota, 2004), Assistant Professor. Neurocognitive engineering, multimodal spatial learning, human computer interaction.

Torsten Hahmann, Ph.D. (University of Toronto, 2013), Assistant Professor. Expressive and lightweight ontologies, semantic technologies, interoperability, data and knowledge integration and spatial intelligence.

Reinhard Moratz, Ph.D. (Universitat Bielefeld, 1997), Associate Professor. Spatial knowledge representation in cognititve systems, qualitative spatio-temporal representation, human-robot interfaces, integration of spatial perception and description.

Silvia Nittel, Ph.D. (Zurich, Switzerland, 1994), Associate Professor. Spatial database management systems, data stream management systems, wireless geosensor networks, high performance distributed architectures.

Harlan J. Onsrud, J.D. (Wisconsin, 1982), Professor. Information systems law, responsible conduct of research, ethics driven information system design

Connie Holden (adjunct) Geographic information systems.

All of the faculty members listed above are tenured or tenure track except for Connie Holden. Connie is a tenured faculty member at University of Maine at Augusta (Bangor Campus) and regularly teaches our first level graduate courses in geographic information systems when we are able to fund her to do so.

All of the instructors above have taught courses by distance education by one method or another in the near or distant past with the exception of Torsten Hahmann who is the latest addition to our faculty. He is currently experiencing online teaching. Max Egenhofer offers a course through pre-recording of all lectures and posting them for viewing prior to a Friday discussion session. Nicholas Giudice uses a combination of videotaping lecture while presenting them to on-campus students as well as doing some pre-recording. Silvia Nittel and Reinhard Moratz have both successfully taught Java computer programming using live online distance technology methods and students respond that they find this method of class participation highly preferable to traveling to Orono. Kate Beard has regularly taught graduate courses in which more than half the students have been at a distance. Harlan Onsrud teaches a graduate course in Responsible Conduct of Research to graduate students at several distributed research lab sites and recently transitioned from use of Polycom to Connect Pro. He found that students much prefer the latter. He also now regularly teaches a graduate information systems law course using Connect Pro. Connie Holden has extensive previous experience using a Polycom system to teach a graduate laboratory course in GIS but we gave it up years ago due to the substantially increased burden of servicing the students at a distance. Availability of reasonably priced downloadable student software for each class member and readily available distance education facilities in our own classrooms suggests that those increased burdens will now be substantially lessened.

(1) Vitae of Faculty

Vitae of the above listed faculty are contained in Appendix 1 of this document.

(2) Effect on Faculty Assignments

There is no increased burden on the above faculty in terms of credit hour teaching load. All of the courses listed above are already being taught or are within the assigned teaching loads of the faculty. There will be an increase in burden in ensuring that the distance education technology is working smoothly and an increased burden to participate in an additional discussion session for each course each week if that is the model followed by the instructor. The increase in marketing burden for each of our faculty members will be primarily though increased use of our web site to sell our online program opportunities in addition to our on-campus programs (see the extensive use of videos on our web site at http://spatial.umaine.edu/faculty/ and at http://spatial.umaine.edu/student-project-videos/) and to make others aware of the new online programs through the extensive numbers of conferences that the faculty normally attend throughout the year. Our goal is to make all of our graduate courses when offered on campus also routinely available online.

C. Library Resources

All enrolled students will have access to all electronic journals, databases and other resources made available through Fogler Library. Because the MS Spatial Informatics graduate degree is an online version of the more intense on-campus research-focused *MS in Spatial Information Science and Engineering* degree, there are no additional library resources required. All enrolled tuition-paying distance students will have electronic access to all usual UMaine library resources from their homes and offices.

D. New Equipment and Plans for Acquisition

Two conference rooms (Rooms 326 and 336) and one classroom (Room 136) in Boardman Hall have been equipped with standard optimal Connect Pro hardware setups. In a conference room this consists of a minicomputer with small keyboard and monitor and mouse for the instructor interface. The monitor may be used as a digital writing pad as needed. There is a digital video camera on the instructor, wall mounted minicomputer connected to a video camera focused on the classroom, a high quality microphone in the middle of the conference table and an overhead projector for the class display. The cost for such a classroom setup is about $6,000 per classroom and may be far less if overhead projectors and other facilities are already contained in the classrooms. Experience with our current Connect Pro classroom suggests our proposed setup will work well but we are continually experiment with various configured options to thoroughly test and arrive at optimal hardware and software configurations. The costs to enable these classroom setups were borne by the Project 7 funding program to support graduate distance course offerings.

Other than the improved classroom facilities, we see little need for expanded additional equipment to serve distant graduate students. On-campus Spatial Information Science and Engineering students have access to state of the art labs and research facilities but these are used for on-campus research projects primarily. The distance students will be experiencing "all course work" and potentially internship experiences and thus will not need access to such specialized equipment typically.

The distance delivery methods used require only that place-bound graduate students have high-speed Internet access. The technology does not require that they participate through the use of facilities provided by any specific campus, agency, or organization.

Any software required by students will be listed in the relevant course syllabi and is typically available for a low fee for a limited period at a student discount rate. In some instances, specific hardware may be required in order to use available software (i.e. PC rather than Mac) but this has not been a significant hurdle for students currently enrolled in our distance courses.

E. Additional Space Requirements

There are no new space requirements based on the implementation of this degree program. Students enrolled at a distance will not use on-campus research, lab or office space. Unless we eventually institute an on-campus summer course to encourage students to meet each other personally and create bonds with each other to help promote retention, most of these new students will never have a need to visit the campus.

F. Extent of Cooperation with Other Programs

We have had discussions with the University of Southern Maine which is planning an *MS in Applied Geographic Information Systems* that will be offered primarily as an on-campus program in the Portland area. We have expressed a willingness to allow graduate students in that proposed program to enroll in our e-learning graduate courses originating from the Orono campus if appropriate to the student's overall

program of study and approved by their graduate advisors. Similarly, if USM offers some GIS graduate courses by e-learning methods that MS-Spatial Informatics students desire to take, our UMaine graduate committee advisors will approve them for student's program of study if appropriate. The same applies to the proposed graduate e-learning programs in bioinformatics and digital curation originating from the Orono campus.

USM Contacts: Matthew Bampton, Associate Professor, Geography, bampton@usm.maine.edu, and Vinton Valentine, Director of GIS, vvalentine@usm.maine.edu

In addition to the above collaborative efforts, we will enable students in our University of Maine graduate IS and GIS/spatial programs to take graduate e-learning courses offered by any other UMS campus assuming that (a) the UMS faculty member teaching the course meets the requirements to be appointed as a UMaine graduate instructor, (b) the course is at the 400 level or above, and (c) the course is approved as appropriate by the student's graduate committee to be included on their UMaine graduate program of study.

Further, we offer a ***Four Plus One*** program whereby undergraduate students enrolled in appropriate information technology programs on any of the other UMS campuses may apply for conditional admission to our master's programs during their junior or senior year and take up to a full year of graduate courses through our distance course offerings prior to finishing their undergraduate degree. This can considerably shorten their time required to acquire an IS, SI or SIE graduate degree. See the details at http://umaine.edu/msis/four-plus-one-program-and-conditional-admission-while-an-undergraduate/

GIS Communications Facilitator across the UMS Campuses: Tora Johnson, Director, GIS Service Center & Laboratory, University of Maine at Machias, tjohnson@maine.edu, (207) 255-1214

VI. Total Financial Consideration

A. Background and Funding

(1) Funds for Initial Equipment and Conversion of Courses to E-learning Formats

Project 7 is a University of Maine response to the call for significantly increasing the number of students in online graduate degree programs and the project is funded through strategic initiative funding returned from the University of Maine System. The goal of the Spatial Informatics faculty is to offer a critical mass of graduate courses online so that potential students have a choice from among four different but closely related programs from which to choose. (See Section VB for a listing of the graduate programs.)

Project 7 provided the funding to experiment with and install distance delivery facilities in two seminar rooms and one classroom in Boardman Hall. It also provided course conversion funds for several professors teaching courses within the suite of four graduate programs offered through e-learning

(2) Funds for Continued Support of the Expanded Teaching Effort

Full time faculty members are typically loathe to take on the additional burdens of teaching graduate students at a distance in addition to teaching their current full class loads of on-campus students. However, our proposal is that faculty in the unit will enthusiastically teach both on-campus and off-campus students as part of their regular teaching load and receive no extra compensation for teaching the distance students. If the unit fails to generate increased out-of-state distance tuition funds in excess of historical amounts, the unit will receive no financial support from the central administration for the unit's additional effort. The unit only receives a proportion of the increased funds directly generated by the unit and that has been received by the central campus administration in the previous year. The market of place-bound in-state and out-of-state graduate students can be reached only through e-learning

technologies and therefore the program is not diverting away any graduate students that otherwise would travel to campus to acquire their degrees.

The specific approach for funding the ongoing expanded teaching burden of this degree and the three other affiliated graduate programs offered by distance methods is as follows:

a. The University will compute the average amount of tuition income generated from out-of-state place-bound graduate distance students by the unit during a base five-year period (e.g. July 1, 2009 – June 30, 2014) as well as for the in-state distance students. For the Spatial Informatics degree that average amount is obviously $0.
b. The University will allow the unit to acquire an amount equal to 50% of the tuition generated from the out-of-state and in-state place-bound graduate distance students taking the unit's distance courses that exceeds the average of the base five-year period.
c. These funds will be spent by the unit in the next year to respond to such needs as on-campus graduate student assistantships to help handle the increased burden of responding to the distance students, web and technical support, distance technology upgrades, administrative support and similar unit needs.
d. The University will additionally allow the unit annually to acquire an amount equal to 8% of the new tuition income generated in the previous year (as computed above) to expend on Internet marketing or alternative forms of marketing for the graduate degree distance programs of the academic unit. The unit will work closely with the Vice-President for Enrollment Management in the expenditure of these funds.
e. The University will allow the unit to repeat the process in successive years since all risk of lost effort and resources is borne by the unit while the University as a whole shares substantially in any financial success.

The financial risk to the University for the involved faculty members teaching expanded numbers of graduate students is minimal to non-existent. Yet the potential income generated for the university from this novel approach could be substantial as indicated below.

The market of graduate students being sought under this proposal is those students that will never travel to and attend the University of Maine as an on-campus student. They will never attend except through this expanded distance program offering. All funds accruing to the academic unit will be spent meeting campus teaching needs such as supporting research-based graduate students to help as teaching assistants who themselves will spend money on tuition and fees. The approach creates a significant economic multiplier effect for the campus.

A. Anticipated Cost and Income for Five Years

The following table assumes each admitted distance graduate student will take on average three 3-credit courses each year. After building up the program, the goal is to sustain 60 graduate students each year that are actively working to acquire their degrees in the proposed program.

	Total Program Cost[1]	**Place-Bound Graduate Students**				**Projected Total Tuition & Fee Income**[5]	Distribution of Projected New Tuition and Fee Income		
		In-State		Out-of-State					
		Number of Students[2]	Tuition Income[3]	Number of Students	Tuition Income[4]		Mrktng Budget[6]	Increased Revenue for SI Program[7]	Increased Revenue for E&G Budget[8]
Year 1 2014-15	$0[9]	2	7524	3	23112	41391	2451	15318	23622
Year 2 2015-16	15318	7	26334	8	80892	139491	8578	53613	77300
Year 3 2016-17	53613	15	56430	15	173340	294300	18382	114885	161033
Year 4 2017-18	114885	22	82764	23	254232	433791	26960	168498	238333
Year 5 2018-19	168498	30	112860	30	346680	588600	36763	229770	322067
Totals	$352,314					$1,497,573			$822, 356

Table 2: Total Anticipated Costs and Income for Five Years

[1] The cost is covered by half of the income generated from the actual increase in tuition income from the previous year.

[2] Projected enrollments are drawn from Table 1. Assume that each student enrolls on average for 1.5 courses per semester and enrolls for two semesters each year for a total of 9 credits per year on average. Projected increased enrollments due to this new program are split about equally between in-state and out-of-state place-bound students.

[3] In-state graduate tuition is currently $418 per credit hour.

[4] Out-of-state graduate tuition is currently $1284 per credit hour.

[5] The total shown includes a graduate student fee of $239 per credit hour. It may be appropriate to drop a substantial portion of the per credit fee since distance students will never use many of the campus facilities which the fees are intended to support (recreation center, sports, etc.)

[6] This amount is based on 8% of the actual increased tuition income received. The amount is encumbered for expenditure in each next academic year for Internet and other marketing purposes to continue and expand the recruitment of students in a sustainable fashion.

[7] This amount is based on 50% of the actual increased tuition income received. The amount is encumbered for expenditure in the next academic year. This revenue will spent at the university to support the needs of the program bearing the increased burden of serving distance students with no additional compensation to the core professors teaching the courses.

[8] This amount represents the total amount received in the current year minus the encumbrances to be expended in the next year.

[9] Distance equipment costs are not included in the first year since they involve spent investment costs already serving existing graduate programs. Marketing costs are not included in the first year since they will be covered by a reallocation of funds already committed to the unit through Project 7.

In summary, over the first five years the University should expect approximately $1.5 million in increased revenue with only $352,000 expended by the program in supporting the increased burden along with a dedicated marketing budget to sustain recruitment of students for each successive year. If goals are met, the university should see an increase in its E&G Budget of $822,000 for general usage of the campus community plus the budget ascribed to the unit will all be spent in supporting the academic mission of the university. If goals are NOT met, any expenditures are automatically self-corrected since the program is allowed to expend only half the tuition it generated from the previous year. This same approach will be applied to increased numbers of place-bound distance students enrolled in all four graduate programs previously mentioned.

Although we do not know the financial arrangements with Study Group, we believe the financial gains to the University of Maine for through this funding approach are probably much greater as a percentage of income generated since no expanded physical facilities or remedial service expenses are needed for these distance students and no consultant fees will be incurred.

B. First-Year Costs

(1) New Personnel Requirements
None. All risk is on the faculty to accomplish additional teaching tasks under the incentive that the teaching loads will be partially borne by graduate assistants in the next year if their efforts are successful.

(2) First Year Revenue and Identity of Source
All first year revenue comes from tuition fees paid by the place-bound students taking courses at a distance. The predicted amount is shown in the table above.

(3) How operational costs are to be absorbed into current campus operating budget
The ongoing increased operational costs will be covered by the academic unit from the funds distributed to it from the sources of revenue generated by the unit. If no or few additional funds are generated, the faculty members in the unit bear the risk of the increased burdens in continuing the program

(4) Additional funding required to support the program
No further funding than the arrangement indicated above is required.

(5) Lifetime of outside or independent funding
As long as the program continues to recruit and retain place-bound students enrolling in its distance graduate offerings, the funding arrangement will continue. Notice that the system is automatically self-correcting in that if few students enroll in one year the funds distributed to the unit are automatically decreased the next year.

Ideally we would like to see a new cohort of approximately 20 highly qualified distance students enrolled in the MS Spatial Informatics graduate program each and every year and maintain an active group of 50-60 place-bound graduate students taking some distance courses each year. We believe that this will be highly dependent upon (a) aggressive Internet marketing and (b) ensuring that the initial cohorts have very good experiences and success so that we can use them to help sell the programs to others in future years.

By following the above principles we believe we can best meet the demands as expressed by potential online students while ensuring a low cost and low maintenance approach that should be sustainable over time both technologically and financially.

VII. Program Evaluation

A post audit of the new program with details on achievement of implementation goals, program objectives, and financial targets will be accomplished two years after the initial marketing and offering of the graduate degree program. The audit will be made under the leadership of the School Director and the results of the audit will be reported to the President and the Vice Chancellor for Academic Affairs.

Formative Evaluation Strategies:

Formative assessment is a reflective process to enhance learning whereby feedback from learning activities is used to adapt teaching to meet students' needs. Many of us design our courses to consistently

engage students in active learning and to redirect learning as a course progresses to allow us to see what material students truly understand and what they have missed. We don't envision changing our teaching styles much with our in-class students but the out-of-class distance students are likely to be more passive learners if they are primarily depending on viewing videos of the in-class active learning discussions and are doing assignments on their own. Thus we will need to pay particular attention to this issue in ensuring that students at a distance remain engaged. One mechanism we can use is that already described approach of requiring students to respond to short questions in writing to verify that they have read the assigned materials and watched the class videos prior to the end-of-week discussion sessions. In terms of formative assessment of the overall graduate degree programs our hope is that one or more assessment specialists on campus will be engaged to do surveys, focus group sessions, and similar appropriate assessment activities during and near the end of each semester with students enrolled in the new online graduate degree programs as well as with the instructors to gain feedback on what was successful and/or less than successful in the online teaching approaches pursued. Such assessments would allow both faculty and students to correct missteps early on in order to improve the on-line instruction and learning experience. In the event that an assessment specialist is unable to accomplish this on an overall basis we will create appropriate survey and focus group instruments in consultation with similarly situated initiators of online learning graduate programs and carry out such assessments ourselves.

Summative Evaluation Strategies:

Summative assessment occurs at the end of a learning unit and determines whether a student was able to acquire the knowledge expected. In addition to normal grading of assignments, participation and final exams, some faculty regularly do a pre and post unit assessment. By example, this is accomplished in the Information Systems Law course with the answers openly discussed in the final session of the course because past experience has shown that certain assumptions that students make about the law coming into a course are simply wrong but tend to persist even after studying and discussing material in depth to the contrary. The post unit assessment helps ensure that the material has finally assimilated. In terms of summative evaluation of the success of a course at the end of the course, one standard method is of course to receive anonymous student feedback from all of the students and this will of course be accomplished for all of the students. An online evaluation form system already exists. In terms of assessing whether an overall graduate degree online program has been successful we think needs to be evaluated ultimately based on student enrollments. Quality of the programs is very important in affecting enrollment numbers but the quality of the advertising and marketing of the programs is also extremely important. We would like to be visible on the first page when individuals search terms such as "masters degree in geographic information systems" or "MS Spatial Technologies." We are confident we can work with campus assessment specialists to come up with specific measures in terms of how much Internet marketing was accomplished and whether we were able to acquire a good percentage return on those individuals that actually clicked to our programs to take a look.

Submitted By:

_____	_____
Harlan J. Onsrud, Graduate Coordinator Spatial Informatics Programs School of Computing and Information Science	Date
_____	_____
Max Egenhofer, Acting Director School of Computing and Information Science	Date

Approved By:

_____	_____
Dr. Naomi Jacobs, Acting Dean College of Liberal Arts and Sciences	Date
_____	_____
Dr. Daniel Sandweiss, Dean Graduate School	Date
_____	_____
Dr. Jeffrey E. Hecker, Provost University of Maine	Date
_____	_____
Dr. Paul W. Ferguson, President University of Maine	Date

Appendix 1

Curriculum Vitae of Faculty Members

BIOGRAPHICAL SKETCH

Professor Kate Beard
348 Boardman Hall, School of Computing and Information Science, University of Maine, Orono, ME 04469, Phone: (207) 581-2147, FAX: (207) 581-2206
email: beard@spatial.maine.edu

Professional Preparation

Iowa State University, Ames, Iowa, Landscape architecture	BS 1976
University of Wisconsin, Madison, Wisconsin, Land Resources	MS 1984
University of Wisconsin, Madison, Wisconsin, Land Resources	PhD 1988

Appointments

July 2006-present	Director, National Center for Geographic Information and Analysis
July 2011-present	Professor, School of Computing and Information Science, University of Maine
Sept 2000-July 2011	Professor, Department of Spatial Information Science and Engineering, University of Maine
July 1997-June 2005	Chair, Department of Spatial Information Science and Engineering
Sept 1993-Sept 2000	Associate Professor, Department of Spatial Information Science and Engineering, University of Maine
Sept 1987-Sept 1993	Assistant Professor, Department of Spatial Information Science and Engineering, University of Maine

Ten Selected Publications

1. Rude, A. and **Beard, K**. 2012. High-Level Event Detection in Spatially Distributed Multi-variate Time Series. Proceeding GIScience 2012. LNCS 7478. Columbus OH
2. **Beard, K**. Emerson, J. Deese. H. Scott, M., Rude, A. and Pettigrew, N.R. 2011. Use of the EventViewer for visualizing and exploring events extracted from Ocean Observing System Data. Marine Technology Journal. Vol. 45. No.1 pp. 112-124.
3. Pettigrew, N.R, Fikes, C.P, **Beard, M.K**. 2011. Advances in Ocean Observing System in the Gulf of Maine: Technical Capabilities and Scientific Results. Marine Technology Journal. Vol 45, No.1 pp. 85-97.
4. **Beard, K**., Deese, H., Pettigrew, N.R. 2008. A framework for visualization and exploration of events. *Information Visualization* **7** pp. 133-151.
5. **Beard, K.** 2006. Modeling Change in Space and Time: An Event Based Approach, in *Innovations in GIS: Dynamic & Mobile GIS: Investigating Change in Space and Time.* Drummond, J., Billen, R., Forrest, D. and João, E. (eds) Taylor & Francis. pp.55-74.
6. Farah, C. Beard, K. Hess, C. T. and Hock, J. 2012. Analyzing Spatial and Temporal Radon-222 Trends in Maine. Health Physics. 102(2) 115–123.
7. **Beard, K** and Smitherman P. 2011 Creating Residential and Tenure Histories from Multi-Year White Pages. *Transactions in GIS*, 15(6) 811-827.
8. Doore, S**., Beard, K**., Bult C. 2010. An Ontology Based Personal Exposure History. First ACM International Health Informatics Symposium. Alexandria, VA Nov. 2010.
9. Dolan, M., Holden, C., **Beard, M. K** and Bult, C. 2006. Genomes as Geography: Using GIS technology to build interactive genome feature maps. BMC Bioinformatics. 7:416 http://www.biomedcentral.com/1471-2105/7/416/abstract
10. Deveillers, R. and **Beard, K**. (2005) Communication and utilization of information on spatial data quality. In R. Deveillers and R. Jeansoulin (Eds) Quality of Geographic Information. pp 275-290.

Synergistic Activities

1. Dr. Beard serves on the Cyberinformatics Committee for the University of Maine EPSCOR Sustainability Science Initiative

2. She was PI and Director of an NSF IGERT grant for an interdisciplinary PhD training program in Sensor Science, Engineering and Informatics.
3. Dr. Beard participated in the collaborative project for an Ocean Observing System for the Gulf of Maine (GoMOOS). GoMOOS was an interdisciplinary project among several marine scientists to deliver near real time data on the Gulf of Maine.
4. She collaborates in the area of bioinformatics. Dr. Beard was a PI on a two-year grant from NSF to investigate the application of spatial concepts to genome mapping. She currently serves on the Executive Committee for an NSF IGERT program in Functional Genomics and cooperates on a grant with the Maine Institute for Human Genetics and Health on developing a Maine Cancer GIS.
5. She served on a National Research Council committee for a USGS Center of Excellence for Geospatial Information Science. (2006-2007), US. National Committee on Data for Science and Technology (CODATA) (2003- 2006), and the Digital Library for Earth Systems Education (DLESE), Data Access Working Group (2003-2006).

BIOGRAPHICAL SKETCH

Professor Max J. Egenhofer
School of Computing and Information Science (SCIS) and National Center for Geographic Information and Analysis (NCGIA), Boardman Hall, University of Maine, Orono, ME 04469-5711, (207) 581-2149, Fax (207) 581-2206, max@spatial.maine.edu.

Professional Preparation:

University of Stuttgart, Germany	Surveying Engineering, Dipl.-Ing.	1985
University of Maine	Surveying Engineering, Ph.D.	1989
University of Maine	GIS, Postdoctoral Research Associate	1989-1990

Appointments:
Acting Director, School of Computing and Information Science, University of Maine (2012-ongoing)
Professor School of Computing and Information Science, University of Maine (2011-onoing)
Professor (Associate Professor 1994-1999; Assistant Professor 1992-1994), Spatial Information Science and Engineering, University of Maine (1999-2011)
Director, National Center for Geographic Information and Analysis (1993–2006)
Cooperating Professor**,** Computer Science, University of Maine (1991–2011)
Visiting Scholar, INPE, São José dos Campos, Brazil (2010)
Visiting Faculty**,** Westfälische Wilhelms-Universität Münster, Germany (2003)
Visiting Faculty**,** Universitá degli Studi dell'Aquila, Italy (1993)
Research Assistant Professor, National Center for Geographic Information and Analysis, University of Maine (1990-1992)

Ten Selected Publications
1. M. Yuan, D. Mark, **M. Egenhofer**, and D. Peuquet, Extensions to Geographic Representations, L. Usery and R. McMaster (eds.), *The Research Agenda of the University Consortium for Geographic Information Science*, Taylor & Francis, London, pp. 129-156, 2004.
2. G. Câmara, **M. Egenhofer**, F. Fonseca, and A. Monteiro, What's in an Image? in: D. Montello (Ed.), Fifth International Conference on Spatial Information Theory—COSIT 2001, Lecture Notes in Computer Science, Vol. 2205, pp. 474-488, 2001.
3. K. Hornsby and **M. Egenhofer**, An Algebra for Fields, *NCGIA Specialist Meeting on The Ontology of Fields*, June 1998, Bar Harbor, ME, 1998.
4. **M. Egenhofer** and H.T. Bruns, Visual Map Algebra: A Direct-Manipulation User Interface for Map

Algebra, *Visual Database Systems 3, Visual Information Management, Proceedings of the Third IFIP 2.6 Working Conference on Visual Database Systems*, in: S. Spaccapietra and R. Jain (eds.), Lausanne, Switzerland, pp. 235-253, 1995.
5. C. Dorenbeck and **M. Egenhofer**, Algebraic Optimization of Combined Overlay Operations , *Auto-Carto 10*, Baltimore, MD , Mark and D. White (eds.), pp. 296-312, 1991.
6. Rodríguez and **M. Egenhofer**, Determining Semantic Similarity Among Entity Classes from Different Ontologies. *IEEE Transactions on Knowledge and Data Engineering*, 15(2): 442-456, 2003.
7. F. Fonseca, **M. Egenhofer**, P. Agouris, and G. Câmara, Using Ontologies for Integrated Geographic Information Systems. *Transactions in GIS*, 6(3): 231-257, 2002.
8. **M. Egenhofer**, Toward the Semantic Geospatial Web, *ACM-GIS 2002*, pp. 1-4, 2002.
9. **M. Egenhofer**, Spatial SQL: A Query and Presentation Language, *IEEE Transactions on Knowledge and Data Engineering*, Vol. 6, No. 1, pp. 86-95, 1994.
10. **M. Egenhofer** and R. Franzosa, Point-Set Topological Spatial Relations. *International Journal of Geographical Information Systems* 5(2): 161-174, 1991.

Synergistic Activities:
1. Lead author of the 9-intersection, a model for topological relations that has been adopted by several international standards (ISO TC/211, OGC's Simple Feature Specification, SAIF, SQL/Multimedia) and has been incorporated into commercial spatial database systems (Oracle Spatial) and geographic information systems (Intergraph's MGA, ESRI's SDE, and Luciad's Java API for Geographical Mapping).
2. Designed the fundamental concepts of the iPointer (US Patents 7,245,923 and 8,023,962), which is now commercially distributed by the spin-off company iPointer Inc.
3. Designed an extension to SQL that provided input for the development of parts of the SQL/Multimedia standard.
4. Organized interdisciplinary research-agenda workshops in the areas of spatio-temporal reasoning, common-sense geographic worlds, interoperating GIS, and spatial relations and initiated the *GIScience* conference series.
5. Spearheaded activities to broaden the involvement of computer scientists in GIS research (e.g., SSD, *GeoInformatica*).

BIOGRAPHICAL SKETCH

Associate Professor Nicholas A. Giudice
University of Maine, Spatial Informatics Program, School of Computing & Information Science, 348 Boardman Hall, Orono, ME 04469, USA, 207-581-2187, nicholas.giudice@maine.edu

Education and Professional Preparation:

1993–1997	Providence College, Providence, Rhode Island B.A., (Magna Cum Laude), Psychology and Philosophy
1998–2004	University of Minnesota, Twin Cities Ph.D., Psychology: Cognitive and Brain Sciences Program
2005–2008	University of California, Santa Barbara Postdoctoral Fellow, Loomis Laboratory, Psychological and Brain Sciences: Cognition, Perception, and Cognitive Neuroscience Program (Supervisor: Prof. Jack M. Loomis)

Appointments:

2013–Present	Associate Professor, Spatial Informatics Program, School of Computing & Information Science, University of Maine
2011–2013	Assistant Professor, Spatial Informatics Program, School of Computing & Information Science, University of Maine
2008–2011	Assistant professor, Department of Spatial Information Science and Engineering, University of Maine
2008–Present	Cooperating faculty, Department of Psychology, University of Maine
2008–Present	Cooperating faculty, National Center for Geographic Information and Analysis (NCGIA), University of Maine

Ten Selected Publications

1. Giudice, N.A., Klatzky, R.L., *Bennet*, C.R., & Loomis, J.M. (2013). Perception of 3-D location based on vision, touch, and extended touch. Experimental Brain Research, 224(1), 141-153.
2. Giudice, N.A., Palani, H., Brenner, E., & Kramer, K.M., (2012). Learning non-visual graphical information using a touch-based vibro-audio interface. Proceedings of the 14th International ACM SIGACCESS Conference on Computers and Accessibility (Assets'12), Pp. 103-110).
3. Giudice, N.A., Betty, M.R., & Loomis, J.M. (2011). Functional equivalence of spatial images from touch and vision: Evidence from spatial updating in blind and sighted individuals. *Journal of Experimental Psychology: Learning, Memory, and Cognition.* 37(3), 61-634.
4. Long, R.G.*, & Giudice, N.A.* (2010). Establishing and Maintaining Orientation for Orientation and Mobility. In B.B. Blasch, W.R. Wiener, & R.W. Welsh (Eds.), Foundations of Orientation and Mobility 3rd Edition (Vol. 1, pp. 45-62). New York: American Foundation for the Blind. (* = author contribution)
5. Giudice, N.A., Klatzky, R. L., & Loomis, J.M. (2009). Evidence for Amodal Representations After Bimodal Learning: Integration of Haptic-Visual Layouts into a Common Spatial Image. *Spatial Cognition & Computation*, 9(4), 287-304.
6. Giudice, N.A., & Li, H. (2012). The Effects of Visual Granularity on Indoor Spatial Learning Assisted by Mobile 3D Information Displays. In C. Stachniss, K. Schill, and D. Uttal (Eds.). Proceedings of Spatial Cognition VIII: Lecture Notes in computer science (Vol. 7463, pp. 163-172). Berlin: Springer.
7. Wolbers, T.*, Loomis, J.M., Klatzky, R.L., Wutte, M., & Giudice, N.A.* (2011). Modality Independent Coding of Spatial Layout in the Human Brain. *Current Biology.* 21(11), 984-989. (*= author contribution)
8. Giudice, N.A., Bakdash, J.Z., Legge, G.E. & Roy, R. (2010). Spatial Learning and Navigation Using a Virtual Verbal Display. *ACM Transactions on Applied Perception, 7(1),* 3:1-3:22.
9. Giudice, N.A., & Legge, G.E. (2008). Blind Navigation and the Role of Technology. In A. Helal, M. Mokhtari & B. Abdulrazak (Eds.), *Smart technology for aging, disability and independence: Computer and engineering for design and applications* (pp. 479-500). John Wiley & Sons.
10. Giudice, N.A., Bakdash, J.Z., & Legge, G.E. (2007). Wayfinding with Words: Spatial Learning and Navigation Using Dynamically-Updated Verbal Descriptions. *Psychological Research, 71*(3), 347-358.

Synergistic Activities:

1. 2012 (August) - General co-chair, Workshop on Spatial Knowledge Acquisition Using Low Information Displays (SKALID'12). with Spatial Cognition 2012, Kloster Seeon, Germany.
2. 2012 (March) - Co-chair, Workshop on Designing Human-Centered Products and Services for Older Adults, with the American Society on Aging (ASA), Washington D.C.
3. 2011 - General Co-Chair, Conference on Spatial Information Theory (COSIT 2011), Belfast, ME
4. 2010–Present - Presidential level faculty appointee, President's Council on Disabilities, UMaine.
5. 2008-Present - Accessible Information Committee, UMaine.

BIOGRAPHICAL SKETCH

Assistant Professor Torsten Hahmann
School of Computing & Information Science, 348 Boardman Hall, Orono, ME 04469, USA, 207-581-3943, torsten@spatial.maine.edu, http://www.cs.toronto.edu/~torsten/

Professional Preparation:
M.Sc. University of Toronto (2008)
Ph.D. University of Toronto (2013)

Dr. Hahmann's research covers the areas of spatial informatics, knowledge representation, artificial intelligence, and logic. His current research resolves around how rich semantic descriptions of the information from complex and heterogeneous information systems in formal logical representations – so-called ontologies – can be efficiently obtained and integrated with one another. Key questions in this work are how to manage and break-down large ontologies (modularity), how to ensure that they are intrinsically correct (verification) and that they capture the right semantics (validation), how to combine different ontologies (integration), and how to automate the verification and integration process.
His work focuses particularly on spatial ontologies, which describe the spatial layout of, amongst others, digital and hand-drawn maps (sketches), route descriptions, building maps, geological and hydrological formations, room layouts, assembly instructions (such as furniture assembly), biological systems (such as the human body or a single bone), and chemical compounds. These find applications in domains as varied as geography (GIS), geology, hydrology, business informatics, architecture (CAD), manufacturing (CAM), and e-science. Such spatial ontologies serve as a testbed for Dr. Hahmann's research about formal ontologies and their development.

Appointments:

Nov 2013-present	Assistant Professor, School of Computing and Information Science, University of Maine
Nov 2013-present	Research Scientist, National Center for Geographic Information and Analysis (NCGIA)
2013	Postdoctoral Researcher, Parametric Human Project, Autodesk Research

Selected Publications

1. T. Hahmann, B. Brodaric: Kinds of Full Physical Containment. In Proc. of the Int. Conference on Spatial Information Theory (COSIT-2013)
2. T. Hahmann, M. Gruninger: Complementation in representable theories of region-based space. Notre Dame Journal of Formal Logic (NDJFL) 54(2):177-214, 2013.
3. T. Hahmann, B. Brodaric: The Void in Hydro Ontology. In Proc. of the 7th Int. Conference on Formal Ontology in Information Systems (FOIS-2012)
4. T. Hahmann, M. Gruninger: Region-based Theories of Space: Mereotopology and Beyond. In: S. Hazarika (ed.): Qualitative Spatio-Temporal Representation and Reasoning: Trends and Future Directions, 2012. pp. 1-62. IGI Publishing
5. M. Winter, T. Hahmann, M. Gruninger: On the algebra of regular sets: Properties of representable Stonian p-ortholattices. Annals of Mathematics and Artificial Intelligence 65(1):25-60, Springer, 2012.
6. T. Hahmann, M. Winter, M. Gruninger: Stonian p-Ortholattices: A new approach to the mereotopology RT0. Artificial Intelligence 173:1424-1440, 2009.

BIOGRAPHICAL SKETCH

Associate Professor Reinhard Moratz
333 Boardman Hall, School of Computing and Information Science, University of Maine, Orono, ME 04469, Phone: (207) 581-2188, Fax: (207) 581-2206, email: reinhard.moratz@maine.edu

Professional Preparation

University of Hamburg, Hamburg, Germany	MS 1993
University of Bielefeld, Bielefeld, Germany	PhD 1997
University of Bremen, Bremen, Germany	Habilitation 2008

Appointments

Sept 2008-present	Associate Professor of Computer Science, University of Maine
Oct 2007-Aug 2008	Senior Researcher at Plath GmbH, Germany
Oct 2005-Jul 2007	Freelancer for it kompetenz, Germany
Apr 2001-Sep 2005	Assistant Professor, Faculty of Mathematics and Informatics, University of Bremen, Germany

Ten Selected Publications

1. **Moratz, R**., Wallgruen, J.O.: Qualitative Spatial Reasoning with Augmented Points: Extending the Cardinal Direction Calculus with a Local Distance Concept, *Journal of Spatial Information Science*, Volume 5, pages 1-30, 2013
2. Mossakowski, T., **Moratz, R**.: Qualitative Reasoning about Relative Direction of Oriented Points, *Artificial Intelligence Journal*, Volumes 180-181, pages 34-45, 2012.
3. **Moratz, R**., Luecke, D., Mossakowski, T.: A Condensed Semantics for Qualitative Spatial Reasoning about Oriented Straight Line Segments, *Artificial Intelligence Journal*, Volume 175, Issue 16-17, pages 2099-2127, 2011.
4. **Moratz, R**., Tenbrink, T.: Spatial Reference in Linguistic Human-Robot Interaction: Iterative, Empirically Supported Development of a Model of Projective Relations, *Spatial Cognition and Computation*, 6:1, pages 63-107, 2006.
5. **Moratz, R**., Fischer, K., Tenbrink, T.: Cognitive Modelling of Spatial Reference for Human-Robot Interaction. *International Journal on Artificial Intelligence Tools*, 10(4): 589-611, 2001.
6. Moratz, R., Ragni, M.: Qualitative Spatial Reasoning about Relative Point Position *Journal of Visual Languages and Computing*, Volume 19, Issue 1, pages 75-98, 2008.
7. **Moratz, R**.: Representing Relative Direction as Binary Relation of Oriented Points, Proceedings *of the 17th European Conference on Artificial Intelligence (ECAI 2006)*, pages 407--411, IOS Press, Amsterdam, 2006.
8. **Moratz, R**.: Intuitive linguistic joint object reference in Human-Robot Interaction: Human Spatial Reference Systems and Function-based Categorisation for Symbol Grounding, *17th National Conference of the American Association for Artificial Intelligence* (AAAI 2006).pages 1483--1488, AAAI Press, 2006.
9. Dylla, F., **Moratz, R**.: Exploiting Qualitative Spatial Neighborhoods in the Situation Calculus, *Proceedings of the Spatial Cognition 2004 Conference, Frauenchiemsee*, Lecture Notes in Computer Science 3343, pages 304--322, Springer, 2005.
10. **Moratz, R**., Wallgrün, J.O.: Propagation of Distance and Orientation Intervals, *Proceedings of the 2003 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Las Vegas*, pages 3245--3250, IEEE Press, 2003.

Synergistic Activities

The project "Perception of Scene Layout by Machines and Visually Impaired Users" (NSF-CDI-1028895), Principal Investigators: Beard, K., Giudice, N., **Moratz, R**. This project started 10/2010 and will continue until 9/2014 and deals with the interpretation of spatial layouts of indoor scenes based on visually perceived data. My contribution is the integration of low-level spatial features with domain specific background knowledge.

The following grants were part of the Transregional Collaborative Research Center "Spatial Cognition – Reasoning, Action, Interaction" funded by the German Research Foundation (DFG) from January 2003 until December 2006

1. Project "Reasoning about Paths, Shapes, and Configurations" (QShape)
   Principal Investigators: Freksa, C., **Moratz, R.**
2. Project "Three-Dimensional Map Construction" (ThreeDSpace)
   Principal Investigators: Burgard, W., **Moratz, R**., Roefer, T.
3. Project "Ontologies for Spatial Communication" (OntoSpace)
   Principal Investigators: Bateman, J. Fischer, K. , **Moratz, R.**

The first project dealt with the efficient representation of space for mobile robots. The second project dealt with object recognition on the basis of linguistic categories. The third project dealt with communication between humans and robots

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BIOGRAPHICAL SKETCH

Associate Professor Silvia Nittel
School of Computing and Information Science (SCIS) and National Center for Geographic Information and Analysis (NCGIA), Boardman Hall, University of Maine, Orono, ME 04469-5711, (207) 581-3681, Fax (207) 581-2206, nittel@spatial.maine.edu.

Professional Preparation:

CS, University of Erlangen-Nuernberg, Germany	Dipl-Informatiker	1989
CS, University of Zurich, Switzerland	Ph.D.	1994
CS, University of California, Los Angeles	Postdoctoral Researcher	1995-1998

Appointments:

SCIS & NCGIA, University of Maine	Associate Professor	2011-current
Oxford University	Visiting Faculty	2008
SIE & NCGIA, University of Maine	Associate Professor	2007-2011
SIE & NCGIA, University of Maine	Assistant Professor	2001-2007
CS, University of California, Los Angeles	Research Staff	1998-2001

Ten Selected Publications

1. J.C. Whittier, S. **Nittel**, Q. Liang, and M.A. Plummer (2013) Towards Window Stream Queries over Continuous Phenomena, *International Workshop on "Geostreaming", in conjunction with ACM SIGSPATIAL'13, Orlando, FL.*
2. S. **Nittel**, J.C. Whittier and Q. Liang (2012) Real-time Spatial Interpolation of Continuous Phenomena using Mobile Sensor Data Streams, *Proc. of* Int' Conf *ACM SIGSPATIAL'12*, Redondo Beach, CA.
3. Y.J. Jung and S. **Nittel**, (2008) Geosensor Data Abstraction for Environmental Monitoring Applications, in *Proceedings of 5th Int' Conference on Geographic Information Science (GIScience'08), Springer LNCS, Park City, UT.*

4. S. **Nittel**, and K. Leung (2004) Parallelizing Clustering of Geoscientific Data Sets using Data Streams, in *International Conference on Scientific and Statistical Data Base Management (SSDBM'04)* Santorini, Greece, June 2004.
5. K. Ng, Z. Wang, R.R. Muntz, and S. **Nittel** (1999) Dynamic Query Re-Optimization, in Proc. of *Int Conference on Scientific and Statistical Databases (SSDBM99)*, Cleveland, Ohio, July, 1999.
6. G. Jin and S. **Nittel** (2011) Efficient tracking of 2D objects with spatio-temporal properties in wireless sensor networks, in *Journal of Parallel and Distributed Databases*, Springer, Vol 29(1-2), pp.3-30.
7. S. **Nittel** (2009) A Survey of Geosensor Networks: Advances in Dynamic Environmental Monitoring, in *Sensors* 2009, *9*(7), 5664-5678; doi:10.3390/s90705664.
8. Y. J. Jung, Y. K. Lee, D. G. Lee, Y. Lee, S. **Nittel**, K. Beard, K. W. Nam (2011). Design of Sensor Data Processing Steps in an Air Pollution Monitoring System. In *Sensors Journal*. 11(12):11235-11250.
9. G. Jin and S. **Nittel** (2007) Towards Spatial Window Queries Over Continuous Phenomena in Sensor Networks, *IEEE Transactions on Parallel and Distributed Systems* (TPDS), Vol 19(4), pp. 559-571.
10. S. **Nittel**, A. Labrinidis, and A. Stefanidis (2008) Advances in Geosensor Networks, Springer, LNCS 4540, August 2008.

Synergistic Activities:

1. Dr. Nittel is the Director of the *Geosensor Networks Laboratory* at the University of Maine and the co-founder of the conference series in Geosensor Networks, which brings together the interdisciplinary communities of sensor networks, database systems, and geographic information science. She co-edited 2 books in the Geosensor Networks conference series. Recognized as the leading expert in geosensor networks, Dr. Nittel was invited to present several keynotes and invited talks at 12 international conferences since 2005. She was the editor for the area Geosensor Networks for the *Encyclopedia of GIS* (2007), the *Encyclopedia of Geography* (2010) and the *Handbook of Geographic Information* (2012). She was the Co-Program Chair of ACM-GIS in 2006 and SSDBM in 2003. She teaches a graduate course on "Geosensor Networks" at the University of Maine.
2. Dr. Nittel investigated dynamic query re-optimization techniques and developed high performance data mining tools for climate research using data streams systems in collaboration with JPL/NASA. This has resulted some of the first publications in dynamic re-optimization (1999). Additionally, she was an active member in NASA's Earth Science Information Partners (ESIP) Federation and co-chaired the Interoperability Committee in 2001.
3. Dr. Nittel was a co-author of the Open Geospatial Consortium's *Interoperability Specification for Simple Features*, which is a widely accepted industry standard for interoperable spatial DBS products today, supported by all major DBS vendors.
4. In collaboration with Global Relief Technologies and the Maine National Guard, Dr. Nittel served as the technology lead for the development of a sensor data management system, which automatically harvests real-time sensor data such as Maine stream gauges data, NOAA weather data and real-time bus tracking data for emergency situation management. This work was adopted by project partner GRT, Inc. and resulted in a commercial product in use by national emergency management agencies today.

BIOGRAPHICAL SKETCH

Professor Harlan J. Onsrud
School of Computing and Information Science (SCIS) and National Center for Geographic Information and Analysis (NCGIA), Boardman Hall, University of Maine, Orono, ME 04469-5711, (207) 581-2175, Fax (207) 581-2206, harlan.onsrud@maine.edu.

Professional Preparation

Harlan Onsrud is Professor in the School of Computing and Information Science at the University of Maine (SCIS) and a research scientist with the National Center for Geographic Information and Analysis (NCGIA). He received the following undergraduate and graduate degrees: 1. University of Wisconsin, Civil and Environmental Engineering, Bachelor of Science, 1974, 2. University of Wisconsin, Civil and Environmental Engineering-Surveying and Photogrammetry, Master of Science, 1979 and 3. University of Wisconsin Law School, Juris Doctor, 1982. His research focuses on the analysis of legal, ethical, and institutional issues affecting the creation and use of digital databases and the assessment of the social impacts of spatial technologies.

Appointments

Professor of Spatial Informatics, School of Computing and Information Science, 7/11-present
Professor, Department of Spatial Information Science & Engineering, Univ of Maine, 7/99 – 7/11
Chair, Department of Spatial Information Science & Engineering, Univ of Maine, 7/94 - 6/97
Associate Professor, Department of Spatial Information Science & Engineering, Univ of Maine, 9/90 – 7/99
Research Scientist, National Center for Geographic Information & Analysis, Univ of Maine, 9/89 - present; Chair of Science Policy Committee, 12/92 - 9/96; Science Advisory Panel of Varenius Project, 9/96-present
Acting Chair, Department of Surveying Engineering, University of Maine, 9/88 - 7/89
Assistant Professor, Department of Surveying Engineering, University of Maine, 1/87- 9/90
Assistant Professor, Department of Civil Engineering, Virginia Polytechnic Institute & State University, 9/82 - 12/86
President, Faculty Senate, University of Maine, 2012-2013, 2013-2014

Ten Selected Publications

1. **Onsrud, Harlan**, Legally Supportable Scientific and Technical Linked Data Sharing, Information Without Borders Conference, School of Information Management, Dalhousie University, Halifax, N.S., 2 February 2012, http://connect.maine.edu/p3nv2hdc7uo/
2. **Onsrud, Harlan**, Ubiquitous Personal Location Tracking: Protecting Both Privacy and Free Speech, GSDI 12 World Conference Proceedings, 20 October 2010, Singapore (CD and web publication) http://www.gsdi.org/gsdiconf/gsdi12/prog_details.html
3. **Onsrud, Harlan J**., Implementing Geographic Information Technologies Ethically, ArcNews, Fall 2008, Vol 30 Number 3, pp. 1-8.
4. **Onsrud, Harlan J**., Balancing Security, Access to Government Information and Privacy: Legal and Public Policy Issues Surrounding Access to Spatial Data for Disaster Planning and Emergency Response, White Paper, Workshop on Geospatial Information for Disaster Management, National Research Council Committee on Planning for Catastrophe: A Blueprint for Improving Geospatial Data, Tools, and Infrastructure, October 5-6, 2005, Washington, D.C.
5. **Onsrud, H.J**., J. Johnson, and X. Lopez, 1994, Protecting Personal Privacy in Using Geographic Information Systems. Photogrammetric Engineering and Remote Sensing, LX(9), 1083-1095 (ESRI Award for Best Scientific Article in the Journal for 1994).
6. **Onsrud, Harlan** and Abbas Rajabifard, Eds, *Spatial Enablement in Support of Economic Development and Poverty Reduction* (GSDI Association Press) 2013, http://www.gsdi.org/openaccessbooks
7. **Onsrud, H.J**., James Campbell and Bastiaan van Loenen, 2010, Towards Voluntary Interoperable Open Access Licenses for the Global Earth Observation System of Systems (GEOSS), *International Journal of Spatial Data Infrastructure Research,* http://ijsdir.jrc.ec.europa.eu/index.php/ijsdir/article/view/168/203

8. **Onsrud, Harlan**, Gilberto Camara, James Campbell, and Narindi Sharad Chakravarthy. Public Commons of Geographic Data: Research and Development Challenges. In *Geographic Information Science*, edited by Max J. Egenhofer, Christian Freska, and Harvey J. Miller, 223–38. Berlin: Springer-Verlag, 2004. Lecture Notes in Computer Science #3234
9. **Onsrud, H.J.**, Privacy in the Use of Spatial Technologies: Ethics as a Driver of Technological Research Priorities, NSF Confidentiality Workshop, May 12-13, 2003, Hilton Arlington Towers, Washington D.C., http://www.urban.org/nsfpresentations/index.html
10. Maurer, S., P.B. Hugenholtz, and **H. Onsrud,** 2001, Europe's Database Experiment, *Science*, 294: 789-790, 26 Oct 2001.

Synergistic Activities

1. Teaches the graduate course in Responsible Conduct of Research which is now required of ALL graduate students pursuing thesis work at the University of Maine
2. Selected by the J. William Fulbright Foreign Scholarship Board for Fulbright Specialist teaching assignments in Law which resulted in completion of assignments at the University of Melbourne in 2009 and at the University of Muenster in 2012. A unifying theme in much of his teaching and research involves the concept of "ethics driven design."
3. Chaired or participated in numerous US National Research Council studies addressing spatial data and services, privacy and data infrastructure issues; named a lifetime National Associate of the U.S. National Academies of Science for his extensive service.
4. Executive Director, Global Spatial Data Infrastructure Association, 2005 – present. GSDI is a non-profit philanthropic organization promoting geospatial technology transfer across the globe with a particular emphasis in responding to the needs of peer professionals in developing nations.
5. Past-president of the University Consortium for Geographic Information Science (UCGIS) and past Chair of the U.S. National Committee (USNC) on Data for Science and Technology (CODATA) of the National Research Council.
6. Member of the Advisory Board of the SHRP 2 Safety Technical Expert Task Group (T-ETG) on Data Access for the Naturalistic Driving Study, FA009, Transportation Research Board, Washington, D.C., 2010 – present. Currently involves oversight of the responsible conduct of research and protection of privacy in a study of human subject drivers of 2000 vehicles
7. Chair, Socieconomic Data and Applications Center (SEDAC) Working Group. SEDAC is a Distributed Active Archive Center (DAAC) in the Earth Observing System Data and Information System (EOSDIS) located at CIESIN, Columbia University.