NCGIA UPDATE

National Center for Geographic Information and Analysis

June 1, 1989 Vol. 1, No. 1

Research Progress

Research at the National Center for Geographic Information and Analysis is carried out by teams working on a specific research issue, or Initiative. There are currently 12 Research Initiatives planned for the first three years, each under the direction of an NCGIA faculty member. The format for each of the Initiatives follows the same pattern. Given the initial definition of the Initiative area of investigation, a Specialist Meeting is held to identify and prioritize a number of feasible research topics that can be investigated and brought to closure in the time allotted to the Initiative. Participants, representing a multi-disciplinary approach to the subject, are asked to define the issues and generate strategies to find solutions.

Research Initiatives generally last from 12 - 18 months. During that time researchers, who might be faculty, post-

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NCGIA Management

The Center is a distributed enterprise and requires imaginative and effective management. This is accomplished by having three different governing bodies. The first, the Executive Committee, comprising of the two Co-Directors, Michael Goodchild and David Simonett, and the three Associate Directors, Andrew Frank (Maine), Ross MacKinnon (Buffalo), and Terence Smith (Santa Barbara), has the responsibility for all management decisions such as policy on affiliate programs, education initia-

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NCGIA Research Initiatives

1: **Accuracy of Spatial Databases**
Specialist Meeting: December, 1988
2: **Languages of Spatial Relations**
Specialist Meeting: January, 1989
3: **Multiple Representations**
Specialist Meeting: February, 1989
4: **Use and Value of Geographic Information**
Specialist Meeting: May, 1989
5: **Architecture of Very Large Spatial Databases**
Specialist Meeting: July, 1989
6: **Spatial Decision Support Systems**
Specialist Meeting: January, 1990
7: **Visualization of the Quality of Spatial Data**
8: **Expert Systems for Cartographic Design**
9: **Institutions Sharing Spatial Information**
10: **Temporal Relations in GIS**
11: **Space-Time Statistical Models in GIS**
12: **Remote Sensing and GIS**

Educational Initiatives

GIS education and training, both at the university level and for the user community, are issues that are receiving an increasing amount of attention. In the academic sector, GIS courses are spread throughout the spectrum of departments including Geography, Surveying Engineering, Forestry, Geology, Marine Sciences, Environmental Studies, Planning, Urban Studies & Landscape Architecture. Current studies underway estimate that over 250 institutions offer at least an introductory course in GIS and a number of schools are planning to initiate such a course this Fall. Training for the user community is offered by vendors on specific systems, conference & professional association workshops, commercial workshops & seminars, university extension programs, and consultants as well as in-house training. Conferences, which occur on a weekly basis, also provide information for the user community.

With the rapid expansion of the GIS market, trained individuals are much in demand by vendors, users, consultants, and service companies. To help offset

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Contents:

Upcoming Events

June6
Workshop on Use and Value of Information (2nd Annual Maryland GIS Conference)
Towson State University
John Morgan, 301-321-2964

June 10-11
Workshop on GIS in Higher Education
Ohio State University
Duane Marble, 614-292-2250

June23-24
Board of Directors Meeting
Executive Meeting
SUNY Buffalo
Ross Mackinnon, 716-636-3101

July 17-18
Symposium on the Design and Implementation of Very Large Spatial Databases
Santa Barbara, CA
Sandi Glendinning, 805-961-8224

August 5-6
Workshop on Spatial Analysis
Boston, MA (URISA)
Phil Parent, 805-961-4617/ 8224

August25
Workshop on Census Databases (In conjunction with the California State Census Data Center)
Santa Barbara, CA
Phil Parent, 805-961-4617/ 8224

November 10-12
Regional Science Association North American Meeting
Santa Barbara, CA
Luc Anselin, 805-961-2599

November 26-30
GIS/LIS '89
Orlando, Florida
703-241-2446

Research (cont. from p. 1)

doctoral fellows, or advanced graduate students from the NCGIA sites, faculty from other institutions on sabbatical leave, or representatives from private industry or governmental agencies, are divided into small working groups to investigate specific problems. Typical products from these groups will include papers published in reviewed journals, presentations at GIS conferences, bibliographies, algorithms or models for analysis, Technical Publications distributed by the Center, short courses or workshops, and, ultimately, new ways of dealing with the issues at hand.

Initiative One:
So far, four Specialist Meetings have been held with the fifth taking place in July in conjunction with the Symposiumon the Design and Implementation of Large Spatial Databases. The first, on The Accuracy of Spatial Databases, took place at the Santa Barbara site on December 13-16. Held at the Casa de Maria, a non-profit ecwnenical retreat located in Montecito, California, the meeting provided a forum for specialists from government, private industry, and academia to exchange perspectives on the issue of accuracy and methods for dealing with the uncertainty of data that is inherent in a spatial database. Three major premises were presented:

- All spatial data are of limited accuracy
- Precision in GIS processing nonnally exceeds the accuracy of the data;
- We lack adequate means to characterize the accuracy of spatial track uncertainty through GIS processes, or compute and report uncertainty.

The major goals of the initiative are to improve models of uncertainty, to develop methods of encoding and tracking uncertainty in databases, to formulate methods of computing and communicating error in GIS products, and to identify policies that encourage the implementation of results.

Forty-one attendees represented interested federal agencies such as the Geological Survey, the Census Bureau, and NASA, Universities from as far away as Zurich and Rome, and private sector organizations such as TYDAC, Intergraph, Prime, The Institute for Marlcet and Social Analysis, and Environmental Systems Research Institute. The format of the meeting was a continuous series of one-half hour presentations by each of the participants and the resulting discussion. Rapporteurs took notes and transcribed them on the premises for almost immediate distribution to the attendees for corrections and revisions. A conference Proceedings is tentatively scheduled for release by summer.

Initial discussion centered around the issue ofliving with inaccuracy. There is no way to banish errors from the database, so what approach is best for dealing with uncertainty. Where does the responsibility lie? With the database itself or with the end user of the data? Can inaccurate data produce accurate output? Mike Goodchild pointed out that the more data layers, the greater the chance of contamination, but by the same token, the more data layers, the more information on which to base a decision. Indeed. a trained analyst can look at two inaccurate images and improve on the accuracy of both. It was agreed that inaccurate data, if correctly analyzed, can produce valuable information.
There were a number of clear-cut items that were identified as key issues. First and foremost it was decided that a taxonomy, or classification scheme, of error needs to be developed and some general observations made on how those errors are handled at the present time. Secondly there should be a systematic approach to defining how error propagation occurs across the range of GIS operations. In respect to error modeling, most of the work will be centered on incremental advances due to the complex and difficult nature of the problem. And finally it was suggested that a bibliography and workshop be developed as part of the Center outreach program.

For more information on Initiative One contact

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Initiative Two:

The Specialist Meeting for Research Initiative Two. the Languages of Spatial Relations. also held at the Casa de Maria in Montecito, followed a slightly different formal A smaller group consisting of 26 participants from the fields of linguistics. geography, computer science, and engineering held directed discussions rather than formal presentations. The specialists focused their discussions on such topics as Standard Query Languages (SQL). user interfaces. algebraic topology. natural language understanding. knowledge representation. cognitive science, navigation. and way-finding. A full day was spent identifying specific areas of investigation that would be practical for the Centec iescarch cycle. The. full report of the meeting and the Initiative Research Agenda is available from the NCGIA Publications Department

For more information on Initiative Two, contact

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Initiative Three:

Buffalo was the site of the third Specialist Meeting dealing with the issue of multiple representations of objects in spatial databases. Thirty specialists were invited to investigate such issues as scale changes. the concept of space. and line generaliz.ation. The goal of the meeting was to develop a series of projects that will help define and overcome the impediments to a more effective utilization of GIS graphic capabilities. The vehicle for reaching this research agenda was a series of small group discussions that centered on three basic concepts: digital descriptions of map features. database considerations. and automatic scale-changing problems. Eachgroupthen identified impediments for these areas in consistancy. physical impediments. and cartographic traditions. The discussion then focused on the pros and cons of adopting a single or multiple representational solution. Should a single database be adopted with other scales generated from it? Or should multiple representation be recognized as a necessary evil?

Research priorities were then developed with respect to the current state of knowledge. The priorities fell into two general categories: database issues with the need to store and link various levels of resolution, query processes, and the need for database lineage; and generalization issues such as improveddefinition foe resolution, fonnalized feature description and and categoriz.ation, and the need to explicitly define rules for map generalization.

A direct result of the Specialist meeting will be a standardized database generated by a joint federal agency team to serve as a standardized data domain in which to develop benchmarks for algorithms and in which to establish comparable results for generalized research.

For more information on Initiative Three, contact

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Initiative Four:

The value and use of geographic information was the focus of Initiative Four which was held in Maine in early May. About 25 experts from many different rusciplines met and hammered out a plan of action to define how geographic information is used in the decision-making process, how the introduction of an automated geographic information system impacts the quality and quantity of spatial information, and how to put a monetary value on any changes that occur in the decision making processes as a result of the adoption of a GIS.

The mix of specialists brought many different perspectives to the meeting. Roger Tomlinson, widely credited with the coining of the term GIS and now a consultant in the field. asserted that the implementation of a GIS does not reduce staff nor reduce expenses in map production. the usual output of a GIS. Instead. he argued, the main benefit of a GIS is the ease of producing new information and analyzing already existing data. The key issue, he stated, is putting a value on this new information. The economists were of the opinion that assigning values is a futile exercise as there is no way to accurately measure, in monetary terms, what is basically an intuitive process such as judging the benefitsof'irnproveddecision-making'. However, the specialists representing federal agencies such as the Forest Service, EPA, and the Bureau of Land Management are faced with that very problem and need some methodology to document the benefits of automating their spatial data handling capabilities.

Once the issues and impediments were laid out, the discussion shifted to designing a research agenda that would address these issues and begin to develop a framework for putting a value on spatial information. There were three main ideas presented, each inexorably intertwined with each other: the development of a taxonomy of the use and value of geographic information, a preliminary survey to help establish such a taxonomy, and a series of in-depth case studies to test the taxonomy in a rigorous process. The process will be, by definition, an iterative one with each building on the other. At this point the users and social scientists added perspectives on methodology and strategy for designing the actual research agenda.

Research (cont. from p. 3)

Of all the Research Initiatives, this one, due to the sheer size of the field for study, will be perhaps the toughest to bring together. But, by the same token, again due to the scope of uses of geographic infonnation, the value to the majority of users and potential users of GIS technology might very well be the greatest.

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Initiative Five:

Due to the intense interest in the subject ofthe next initiative, Very Large Spatial Databases, The NCGIA, in conjunction with NASA, the Environmental Protection Agency, and the Geological Survey, is sponsoring a Symposium on the Design and Implementation of Large Spatial Databases to be held in Santa Barbara on July 17-18. See page six for further information on the Symposium and Initiative.

Future Initiatives:

The last of the scheduled Initiative Specialist Meetings, dealing with Spatial Decision-making Systems, is tentatively scheduled for January, 1990, probably to be held in Santa Barbara. It is the NCGIA plan that results from the first five initiatives will feed into the next round of projects. In this way, NCGIA hopes to build a level of knowledge that will pave the way for development of enhanced GISs which can deal with the increased amounts of spatial data that will become available in the next few years.

Management (Cont. from p 1)

tives, outside funding strategies, and reporting to the NSF. The second governing body, the Scientific Policy Committee, consists of the Executive Committee as well as Waldo Tobler, the Senior Scientist, and representatives from Buffalo (Barbara Buttenfield & David Mark) and Maine (Kate Beard). This committee has the responsibility of planning and implementing the research component of the center. All Research Initiatives have to be approved by the Scientific Policy Committee.

The final governing body is the Board of Directors, chaired by Jack Estes of Santa Barbara. Consisting of 17 prominent representatives from academia, public and private sectors (see list below), the Board has, in addition to an advisory role, the task of overseeing the reporting of Center activities to the NSF. The Board, by its very makeup, has a well-defined view of the needs of the GIS community for both short-tenn and long-tenn projects.

Both the Scientific Policy Committee and the Board of Directors meet twice a year while the Executive Committee meets quarterly. In addition, the Executive Committee communicates on a weekly basis. Each site prepares a research report monthly and a management report quarterly which is reviewed

NCGIA Board of Directors

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by the Executive Committee. Open communication among the Board and the enter Committees is the key to keepmg the Center on track with the purposes for which it was intended: to remove impediments for the longterm adoption and implementation of the tools of geographical analysis & GIS.

Education (cont. from p. 1)

this increasing demand, the NCGIA is developing, with the help of academic & private sector experts and institutions, a core curriculum GIS course sequence. This sequence, consisting of 75 one-hour lectures, accompanying laboratory exercises, teaching materials, an a bibliography, iscurrentlybeing compiled and edited for content and format at the University of California site in Santa Barbara. Target date for completion of the draft materials is August 1.

present. 35 Universities (representmg over 1000 students) have signed Memoranda of Understanding to test the material this coming academic year. These programs range from schools with no prior course offerings in GIS to schools which have been teaching GIS technology for a number of years. The level of participation in the testing phase varies with the institution. While some prograr_ns ill offer the entire sequence, the maJonty of universities will utilize only. one quarter or semester, usually the mtroductory sections. Instructors that teach established GIS courses are encouraged to integrate Center material into their current curriculum. Extensive evaluations will be carried out throughout the year by the testing institutions to improve the sequence. Key questions to be answered are what type of background is necessary to begin work in GIS, what type of students benefit the most, and how can this type of program translate into augmenting the supply of people needed to operate and manage GISs.

Divided into 25 modules that lend themselves to either semester or quarter systems, the course sequence is based on GIS and related courses taught at the three NCGIA institutions, The State University of New York at Buffalo, the University of Maine, and the University of California at Santa Barbara. Using a co bination ofhands-on laboratory exercISes and practical theory, the course sequence is designed to introduce the upper-division college student to the technical and applied side of GIS. Students taking the entire sequence will be expected to complete an independent project from conceptualization to finished product utilizing the skills gained from the course. This project will also expose the student to management and organizational issues.

The laboratory exercises are designed to run on inexpensive PC-based GIS software. It is the rare university that does not have a PC lab on campus. Datasets will be provided and conversion routines for unusual system configurations can be arranged. These exercises will demonstrate GIS functionality and provide students the concrete skills that employers are demanding. At the same time, the lectures will be giving students the intellectual frameo k that will allow them to adapt eastly m changing hardware and software nvir?n?1ents. In addition, accompanymg b1bhographies can steer students to in-depth research.

The curriculum will be examined and critiqued at the 2nd GIS in Higher Education Conference to be held at Ohio State University in June. It is anticipated that discussions will focus on laboratory session content and context as well as lecture formats. For the program to be successful, the Center is looking to the GIS community for feedback and ideas in improving the program. Please feel free to forward any comments or concerns about this program to:

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Maine Site of NCGIA Named Center for Excellence

The Surveying Engineering Department of the University of Maine at Orono one of the three sites of the Nationai Center for Geographic Information and Analysis, has been designated as a Center for Excellence in Land Information Studies by the international Institute for Land Information (ILi). The UM program is only the second in the United States to be so designated. The Land Information Program at the University of Wisconsin is the other, with two in Australia and one in Canada. The UM site was chosen because of its combination of strong undergraduate and duate curricula, multi-disciplinary mix of faculty research interests, and substantial involvement in land information studies.

The Institute of Land Information is a non-profit corporation which seeks to foster the development of improved land information systems, including the creation and adoption of advanced technology for any activity affecting land, such as title transfer, valuation, surveys, mapping, graphic display, information management. indexing, recording, planning and development Over 30 organizations participate in ILI activities including the American Bar Association the National Association of Counties' US Census, US Forest Service, th; Canadian Department ofEnergy Mines & Resources, and the Australian Survey Office. One of goals of the ILi is to coordinate efforts of all levels of business and government in developing coordinated land information systems for such purposes as more equitable taxation, better land development processes and to increase facility and economy in land transfer.

For more information on the ILi and their activities, write to:

Institute for Land Information
440 1st St. NW, 8th Floor
Washington, DC 20001

Graduate Student Opportunities at NCGIA

In case you haven't noticed, this industry, technology, or discipline (whatever you want to call it) is really talcing off. According to a survey taken at the LIS/ GIS '88 Conference held last November in San Antonio, vendors estimated sales growth between 20% & 100% over their 1988 figures. The market is predominately governmental agencies (over 80%) with the federal agencies talcing the lion's share of thaL The private marketplace is virtually untapped. There is a tremendous potential for growth. However, this growth is predicated by a need for trained personnel not only to operate and manage the systems but to design and develop the enhanced systems of the future that will be needed to manage the ever increasing flow of information.

The educational mandate of the NCGIA is twofold. The first is to educate users on the principles of GIS and provide a certain amount of hands-on training. This part is being partially implemented by the core curriculum program that was highlighted on page one of this newsletter. The second is to provide an in-depth education on the advanced principles of geographic information and analysis for students at the three university sites. The three departments are actively recruiting talented graduate students for this aspect of Center operations.

State University or New York at Buffalo:
The Geography Department at SUNY-Buffalo has been offering GIS education for over 12 years. It is the site of the first GIS education laboratory in the US and has produced a number of leading professionals and academic researchers. Strengths include cartographic design, languages of spatial relations, spatial analysis, and other related areas. UB has an established Research Center for Geographic Information and Analysis with a research staff including 14 faculty from 6 academic departments. There is in place an already impressive array of hardware and software for the students and faculty to conduct research with more on the way. Multi-disciplinary research is strongly encouraged. Research assistantships for projects relating to the NCGIA Initiatives are available. For further information on admissions, please write:

Director of Graduate Studies
Dept. . of Geography
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716-636-2722

University of Maine
The Surveying Engineering Department at the University of Maine offers coursework and independent study in both technical issues relating to database design, spatial query languages, and software engineering and the institutional, economic, and legal issues associated with the adoption of GIS. As a surveying program, the emphasis is on land information with courses on geodesy, the new global positioning satellites, and cartographic transformations. A growing department in faculty and hardware and software, the program offers graduate students the type of education that will position them for opportunities in either the public or private sector or in academia. There is support, both departmental and NCGIA, for students wishing to pursue research in conjunction with the NCGIA research agenda. For further information, please write:

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Surveying Engineering Department
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Orono,ME 04469
207-581-2188

University or California
The Department of Geography at the University of California at Santa Barbara offers graduate students specialties in quantitative methods & modeling, remote sensing, biogeography, water resowces, and spatial perception among others. A highly quantitative department, most students utilize computermodeling techniques in the course of their studies, whether it is in agricultural prediction, global carbon flux or hazardous waste monitoring. Students are strongly encouraged to initiate funding proposals and participate in research projects. Faculty and students work very closely with one another and cooperative research is the norm rather than the exception. Funding for graduate research is available for most students in the Department For further information, write:

Graduate Advisor
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93106

Call for Papers

The International Journal of Geographic Information Systems, the leading peer-reviewed scholarly journal dealing exclusively with GIS and associated issues is planning a special issue dedicated to new methods of spatial analysis, wtth me expressed view of improving the analytical functionality of GIS. Closing date is November 1.

For further information, please contact the editor:

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Dept. of Geography
University of Edinburgh
Drummond Street
Edinburgh, EH8 9XP UK

Symposium on Large Spatial Databases

A Symposium on the Design and Implementation of Large Spatial Databases will be held in Santa Barbara on the 17 & 18th of July, 1989. Co-sponsored by NASA, USGS, Oak Ridge National Laboratory, and the EPA as well as the NCGIA, the symposium will serve as a forum for leading researchers and practitioners in spatial data management A major focus will be on issues that arise in handling very large spatial databases. There will be 16 papers presented on

various topics with additional invited presentations by Hanan Samet, Jurg Nievergelt, and S.K. Chang on special issues. Two panels are planned, one on database requirements for a GIS and the other on database solutions for a GIS. Panel participants will be composed of vendors, academic researchers, and users in both the private and public sectors. A proceedings volume is included with registration and will be published in the Fall by Springer-Verlag. For further infonnation on registration and accommodations, please call or write:

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NCGIA Publications

Center Research Publications:

Full Proposal: 300+ pages that outlines what the Center plans to do in the upcoming years. Contains appendices of Center personnel & bibliography. — $17.50

Edited Proposal: Abridged version of above containing sections on rationale, research, and education plans. No appendices. — $ 8.00

Accuracy of Spatial Databases: Initiative One Specialist Meetine; Report: Short (22p.) summary of issues involved with Initiative One. List of research topics & abstracts of papers presented. — $ 2.50

Languae;es of Spatial Relations: Initiative Two Specialist Meetme; Report: This 50+ page report provides an in-depth look at the issues involved with spatial languages and a comprehensive discussion of a possible research agenda. — $ 6.50

Multiple Representations: Initiative Three Specialist Meeting Report: This report presents a comprehensive overview of the challenge of storing digital versions of geographic features. — In Press

Associated Center Publications:

Cofnitive and Lln&yistic AS1Jects of Space: Report of a workshop held in 1988 Ifl uffalo dealing with the human conceptualization of space. Related in content to Initiative Two. — $ 5.00

Spatial Analysis Using GIS: Seminar workbook presented by Mike Goodchild at various conferences. Stresses GIS analytic capabilities and gives overview of current GIS functionality. — $15.00

Object Oriented Database Technology for GIS; Seminar workbook presented by Andrew Frank. Deals with data models, object-oriented DBMS, architecture, and query languages. Includes extensive bibliography. — $15.00

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