

# UC Santa Barbara

## Newsletters

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**Author**

National Center for Geographic Information and Analysis (UC Santa Barbara, SUNY at Buffalo, University of Maine)

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# NCGIA *Update*

National Center for Geographic Information & Analysis

August 1997

## *The Varenius Project's New Arrangements at NCGIA*

The National Center for Geographic Information and Analysis is pleased to announce the signing of a new Cooperative Agreement between the National Science Foundation and the University of California, Santa Barbara, with subcontracts to the University at Buffalo and the University of Maine. NSF will provide up to three years of funding, through the calendar year of 1999, for Project Varenius, NCGIA's project to advance geographic information science. The project will be directed by Michael Goodchild, with the assistance of an executive committee.

The project is named for Bernhard Varenius, a 17th Century Dutch geographer and author of the *Geographia Generalis*. His influence on Newton is described by William Warntz [*Annals of the Association of American Geographers* 79: 165-191 (1989)].

The project will initiate research in three strategic areas of geographic information science: cognitive models of geographic space, computational implementations of geographic concepts, and geographies of the information society. Each strategic area will be steered by a panel of experts. David Mark (University at Buffalo) will chair the panel on cognitive models of geographic space; Max Egenhofer (University of Maine) will chair the panel on computational implementations of geographic concepts; and Eric Sheppard will chair the panel on geographies of the information society. The entire project will be overseen by an Advisory Board. Further details, including membership of the panels and Advisory Board and detailed description of the project,

can be found under the Varenius home page: [www.ncgia.ucsb.edu/varenius](http://www.ncgia.ucsb.edu/varenius).

There will be many opportunities for the research community to participate in Varenius. During the

next three years approximately nine research initiatives will be announced and distributed among the three strategic areas. Each research initiative will hold a specialist meeting, with an open call for participation. Suggestions for topics for research initiatives are welcome, and should be sent to the Director or the appropriate panel chair. In addition, Varenius will sponsor a visiting scholars program, under which scientists can receive funding to participate in research at other institutions; and a program of small seed grants to stimulate continuing research.

Changes are being made in the management structure of NCGIA to coincide with the start of Project Varenius. Each of the three NCGIA

sites now has a Director. Keith Clarke is the Director at the UCSB site, David Mark the Director at the Buffalo site, and Max Egenhofer the Director at the Maine site. Michael Goodchild becomes the Chair of the NCGIA Executive Committee and Karen Kemp continues as Assistant Director of NCGIA.

### **Varenius Project Gets Under Way**

NCGIA's new Varenius project is designed to focus research attention on three strategic areas of geographic information science. The advent of digital technologies, and their wide-

*—continued on page 20*

### **Announcing the International Conference & Workshop on Interoperating Geographic Information Systems**

*Santa Barbara, California • December 3-4 & 5-6, 1997*

The National Center for Geographic Information and Analysis and the Open GIS Consortium Inc. announce an International Conference on Interoperating Geographic Information Systems to be held in Santa Barbara December 3-4, 1997, and to be followed December 5-6 by an invitational Workshop. Topics to be addressed at the conference include the current state of research in related disciplines concerning the technical, semantic, and organizational issues of GIS interoperability; case studies of GIS interoperability; theoretical frameworks for interoperability; and evaluations of alternative approaches. The program will include invited keynote presentations and contributed papers; limited space will also be available for posters, demonstrations, and exhibits.

Proposals for contributed presentations are invited. They should include an extended (1,000-word) abstract, and must be submitted by email prior to September 15, 1997. Full versions of papers will be due by the conference date. Further information on registration are available via the NCGIA Web site. This site

will also be used to post the program and full papers as they become available. A CD of the papers will be issued after the conference.

The workshop following the conference will be limited to approximately 30 invited participants. It will build on the conference proceedings by focusing on the development of a research agenda, identifying those topics of interest that will likely yield to concentrated research effort within short, medium, and long time frames. Funds to support participation in the workshop will be provided by the US National Science Foundation through NCGIA's Varenius project. Expressions of interest in participation in the workshop should also be submitted by email prior to September 15, 1997. They should include a short resume and short (1,000-word) position paper on the issues to be addressed by the conference and subsequent workshop.

Email concerning the conference and workshop, including submissions or requests for information, should be sent to [I-20@ncgia.ucsb.edu](mailto:I-20@ncgia.ucsb.edu).



# From the Chair of the Executive Committee

Way back in 1987 (it seems so long ago), the National Science Foundation envisioned NCGIA as an eight-year center, at which time it would either dissolve or become self-supporting. Centers tend to have such maximum funding periods not because of any sense that all of the research problems would be solved in a given time, or that the need for educational materials or outreach activities would disappear—but rather because research in any area, especially in one as fast-moving as geographic information technology, needs periodic assessment and redirection. That process started for us in 1994, when Center researchers and the Board of Directors held separate retreats to think about the future of the Center. It continued through 1995, when a proposal was submitted by the Center to NSF for a new major project; and it culminated in Febru-

ary 1997 with the signing of a new Cooperative Agreement.

I am very excited about the new Varenius project, because to me it is one further indication of the progression of the field from a set of activities based around a particular type of computer software to a science of geographic information, and a new recognition of the fundamental significance of what we do. In the past year the University Consortium for Geographic Information Science (UCGIS) has held its first Assembly and developed a basic research agenda; the *International Journal of GIS* has changed its name from 'systems' to 'science'; and NSF has agreed to fund a three-year effort by NCGIA to coordinate and stimulate research.

The change from an NSF-funded center to a self-supporting center undertaking

major research projects for a variety of agencies is a bold step, and we have made several changes in the makeup of the Center to help it work. Each of the three sites now has its own Director—I'm very happy that Keith Clarke, who joined the UCSB faculty from Hunter College in September 1996, has agreed to become the Director of the Santa Barbara site. David Mark and Max Egenhofer continue as the Directors of the Buffalo and Maine site. Several major projects are in the works at all three sites. Each year we will have a 'main event' at one of the sites, bringing researchers and students together for several days to exchange ideas and report new results.

— Michael F. Goodchild

## Education

by Steve Palladino

*NCGIA education activities continue to serve educators and others involved in GIS-based education in the universities, colleges, and K-12 schools. The most visible projects at this time are a series of GIS Core Curriculum development efforts. The newest among these is the GIS Core Curriculum for Technical Programs being developed under an National Science Foundation grant as part of our Community College Project. While support for community college GIS education is now receiving much of our attention, we continue to sponsor conferences that support GIS education at all levels. In addition, our Secondary Education Project which has focused on K-12 GIS over the past five years continues, but our primary focus has shifted to the two-year colleges and towards activities for post-secondary GIS education.*

### GIS Core Curriculum Projects

#### The New On-line Core Curriculum in Geographic Information Science

The new Core Curriculum in GIScience (the GISCC) will incorporate many of the best elements of the original Core Curriculum while taking advantage of the digital innovations provided by the WWW. Like the original, it is a joint project of the inter-

national community of higher education GIS educators, but this time the opportunity for involvement is even greater. Beginning with an entirely new outline, more than 170 units have been designated for development. Like the original, each unit is structured as a textual outline of the critical information which might be included in a lecture, practical exercise or other instructional unit based on this topic. However, since the materials will be on the WWW, color graphics and pointers to other on-line instructional materials are included.

More than 20 section editors now oversee the assignment of units to appropriate authors and the peer review process which each unit now undergoes. Following the peer review, all units are posted on the WWW for public review and comment (via email). In this way, the materials will continue to evolve for some time. The unit outline is constructed in a tree, so that new units can be added as needed while links between separate branches and individual units can be created where appropriate.

Following the initial creation of the set of units, a number of partner projects will be conducted, including: the development of navigation tools such as a "map", an index and a search tool; a demonstration project to develop student-oriented materials based on the outline structured instructor-oriented materials of the GISCC; and a set of model course syllabi, each designed

for a different discipline or audience and linked as an index to the on-line units. Suggestions for additional partner projects are encouraged.

Keep an eye on the progress of the new GISCC through the Education web page. Contact [giscc@ncgia.ucsb.edu](mailto:giscc@ncgia.ucsb.edu) if you would like to contribute by preparing a unit, by proposing and conducting a partner project, or by providing constructive comments on what has been posted.

#### Remote Sensing Core Curriculum

The NCGIA Remote Sensing Core Curriculum (RSCC) represents a logical extension of the NCGIA's educational activities to create curriculum materials for geographic analysis education. The RSCC developed as an outgrowth of NCGIA's Initiative 12, "The Integration of Remote Sensing and Geographic Information Systems," and, particularly, given the interest of Arturo Silvestrini, President of EOSAT. The project seeks to develop educational materials to advance scientific understanding of the field of remote sensing for the large community of environmental engineers and scientists, resource planners and managers, and geographers in colleges and universities nationally and internationally. Lecture materials, outlines, exercises to build on theory and technique, and applications encompassing a robust set of real-world uses will be provided through a network of re-

searchers and educators specializing in key areas of remote sensing. Materials will be distributed via the World Wide Web, CD-ROM, and hardcopy formats.

The American Society for Photogrammetry and Remote Sensing has accepted the RSCC as one of its educational initiatives, and will eventually administer the RSCC from the association's Bethesda, Maryland headquarters. The RSCC is still accepting contributions, and will be starting the beta testing process late in 1997. More information is available at the RSCC Homepage, located at <http://www.umbc.edu/rscc>.

### **GIS Core Curriculum for Technical Programs**

NCGIA has been awarded a two-year grant from the National Science Foundation Advanced Technological Education (ATE) Program to develop a core curriculum in GIS for two-year colleges. This GIS Core Curriculum for Technical Programs (CCTP) draws from the Core Curriculum in Geographic Information Science, but is focused towards technician training in the community colleges. Thus it provides course content from the perspective of what practitioners need to be able to do, rather than what they need know. Like the other Core Curricula, it will be World Wide Web based and will include access to a number of resources for GIS instructors in technical programs. The CCTP project began with a one-week Working Session in summer 1996 at which fourteen GIS instructors and other experts developed a framework for the core curriculum. During the remainder of 1997 and the beginning of 1998, the curriculum will be completed, tested, and revised. For current information please visit our Community College Project page in the Education section of NCGIA's web site.

## **GIS Education Conferences**

### **The Second International Symposium on GIS in Higher Education**

GISHE '96 was held in Columbia, Maryland in September 1996. The theme for this symposium was "Expanding GIS Education through Technology and Outreach" and its purpose was to provide a forum for discussion of today's strategic issues in GIS Higher Education. Several plenary sessions plus three parallel tracks of paper presentations followed by focused discussions held over 2 1/2 days resulted in a stimulating opportunity for old and new GIS edu-

cators to share experiences and great ideas. While most of the 140 participants came from US and Canadian institutions, people from the UK, Europe, Africa, Australia and New Zealand also attended. A group of local high school teachers and a number of community college instructors were also invited to attend. Separate one-day parallel tracks for each of these special audiences were provided.

Paper session discussions were recorded and carried forward to the final morning when a conference summary was prepared by the remaining participants. This summary along with the conference program and paper abstracts (including some outlines of talks actually presented) is posted on the GISHE '96 page in the Meetings section of the NCGIA web site. Several papers have been chosen to appear in a special issue of *Transactions in GIS* planned for publication in late 1997.

### **The Third International Symposium on GIS in Higher Education**

The Third International Symposium on GIS in Higher Education (GISHE '97), which will expand upon important themes discussed at GISHE '96, will be held October 31-November 2, 1997, in Chantilly, Virginia. Please check the meeting section of the NCGIA web site.

### **California GIS Educators' Symposium**

In addition to helping put on an international symposium for GIS educators, NCGIA-Santa Barbara also organized a smaller symposium for California GIS Educators in August, 1996. Forty representatives from the University of California, California State Universities, community colleges, private universities, and a high school, met for a day and a half in Santa Barbara to plan strategies for cooperation among GIS educators in different institutions. The outcome of this meeting is posted on the Education section of our web site.

### **K-12 GIS Research Agenda Meeting**

The NCGIA along with TERC and the National Council for Geographic Education (NCGE) organized EDGIS 96, a meeting of research specialists in the area of K-12 GIS education, held in Santa Barbara in November 1996. This K-12 GIS Research Agenda meeting took place in conjunction with the NCGE Annual Meeting also held in Santa Barbara at that time. The researchers who participated developed an agenda of key research issues to improve the use

of GIS in the schools. This research agenda identifies research needs in the areas of pedagogy, cognition, curriculum, and software. See the our web page for more information.

## **NCGIA GIS Education Projects**

### **Community College Project**

The two-year colleges are an important and rapidly growing sector for GIS education and training. GIS courses and programs exist or are being developed in nearly one hundred colleges in North America. The NCGIA continues to support efforts to provide GIS learning experiences in the colleges through the conferences and curriculum efforts listed above. In addition, Steve Palladino, the NCGIA Education Projects Manager, is keeping a master list of community colleges with GIS instruction and parties interested in community college GIS. Please contact him at 805-893-4305 or [spalladi@ncgia.ucsb.edu](mailto:spalladi@ncgia.ucsb.edu) if you would like more information or to be added to the mailing list.

### **Secondary Education Project**

The Secondary Education Project (SEP) continues to function as one of the sources of information on activities and materials for using GIS in the pre-collegiate classroom. This includes outreach efforts by the NCGIA sites to schools in their respective regions. For more information on the SEP, visit the World Wide Web page for the project (<http://www.ncgia.ucsb.edu/education/projects/SEP/sep.html>).

### **Arcview Modules**

Paul Van Zuyle, Paul Sutton, and Steve Palladino, at NCGIA-Santa Barbara have developed a series of demonstration GIS Learning Modules based on ESRI's ArcView 2.0 software.

The first of these, *Color Your World*, has a game-like interface which introduces students to geographic data and the capability of ArcView 2.0 to integrate cartographic data, tabular records, and images. It leads the player through a series of rounds that test knowledge of country names, location, and thematic attributes. The followup modules are *Know Your Neighborhood* and *Light Up the Nation*. *Know Your Neighborhood* is an exploration [ArcView 2.0] of WESSEX census data from the US

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President's neighborhood and in the user's neighborhood. *Light Up the Nation* explores NOAA Defense Meteorological Satellite Program scenes of nighttime satellite imagery patterns.

The development of these modules was supported by generous gifts from ESRI. The *Color Your World* module is being distributed as *NCGIA Technical Report 95-5* and through the ftp site (<ftp.ncgia.ucsb.edu>, directory `pub/arcview2`). Check with the NCGIA publications staff for information on the availability of the other modules.

Our experience in module development has been recorded by Palladino and Van Zuyle in an NCGIA Technical Report titled "Critical Issues in GIS-Based Educational Module Development" (*Technical Report 96-6*).

### Spatial Horizons

The University of Maine's Department of Spatial Information Science and Engineering has designed a curriculum (Spatial Horizons) which provides a representative picture of spatial information gathering, processing and analysis for implementing information technologies in the secondary education curricula. Beginning with the information superhighway and search engines, educators and students develop necessary skills to retrieve data from the wealth of freely available satellite-generated geographic databases. Using experiential education, participants then explore cutting-edge tools in GIS, global positioning sys-

tems (GPS), remote sensing and digital image processing. Program materials include public domain GIS software, a web page construction disk, and a workshop manual with exercises and extensive resources. These materials were designed for direct use by educators in implementing information technologies in their respective schools. Participant feedback was overwhelmingly positive. Numerous teachers have indicated a desire to begin development of pilot programs for their schools.

### Site Outreach

At NCGIA Santa Barbara: NCGIA researchers continue to present GIS in local school classrooms and give seminars for science teachers taking part in in-service opportunities at the university. Paul Van Zuyle demonstrated our ArcView modules at the annual Oxnard College Geo Bowl for Ventura County high schools.

At NCGIA Buffalo: NCGIA and the SUNY Buffalo Geography Department have been working with an inner-city K-6 magnet school in the city of Buffalo to implement the National Geography Standards into the school curriculum. The NCGIA is providing support for the exploration of GIS as a part of this curriculum.

NCGIA Buffalo researchers, led by Hugh Calkins, have been working with faculty members of Erie Community College (ECC), a 2-year SUNY college in Erie County, New York, to assist them in their

efforts to develop a GIS program. NCGIA researchers helped ECC faculty design an introductory GIS course, and identified a doctoral candidate from the SUNY Buffalo Geography Department to serve as the course instructor. In the summer of 1997, ECC submitted a proposal for National Science Foundation funding to develop a GIS Certificate Program for ECC students, and a GIS Infusion Program to train ECC faculty. Hugh Calkins is Co-Principal Investigator on this project, and Karen Kemp and Steven Palladino of NCGIA Santa Barbara have agreed to act as consultants.

At NCGIA Maine: In addition to the regular Spatial Horizons workshops described, other workshops using segments of Spatial Horizons include the Young Scholars program, the Summer Institute in Technology for teachers, and various middle school, high school, and girl scout groups.

Continuing their tradition of public service, UMaine graduate students have also recently developed two-day ArcView and one-day Avenue training workshops. Designed with Maine data, this customized curriculum is centered on problems encountered by foresters, tax assessors, and environmentalists in the State of Maine. Businesses and industries now have access to fundamental GIS training on a popular software without having to leave the state. Development of intermediate and advanced training courses is being considered.

### Keith C. Clarke — New Santa Barbara NCGIA Director

Dr. Keith C. Clarke is a research cartographer and professor. He holds the B.A. degree with honours from Middlesex Polytechnic, London, England, and the M.A. and Ph. D. from the University of Michigan, specializing in Analytical Cartography. He joined the faculty at the University of California, Santa Barbara in 1996. Dr. Clarke's most recent research has been on environmental simulation modeling, on modeling urban growth using cellular automata, on terrain mapping and analysis, and as a consultant for UNICEF and US-AID on mapping to support disease control programs in Africa. Dr. Clarke is the current North American Editor of the *International Journal of Geographical Information Sciences*, serves on the editorial board of *CAGIS*, and as series editor for the Prentice Hall Series in Geographic In-

formation Science. He is the author of the textbooks, *Analytical and Computer Cartography* (Prentice Hall, 1995), *Getting Started with GIS* (1997) and about thirty book chapters, journal articles, and papers in the fields of cartography, remote sensing, and geographic information systems. In 1990 and 1991 Dr. Clarke was a NASA /American Society for Engineering Education Fellow at Stanford University, and in 1992 served as Science Advisor to the Office of Research, National Mapping Division of the US Geological Survey in Reston, Virginia. Since January 1997, he has been the Santa Barbara Director of the National Center for Geographic Information and Analysis.

Otherwise, Dr. Clarke enjoys watching the New York Yankees, canoeing, and his family.

### Order Your Copy Now

*GIS and Environmental Modeling: Progress and Research Issues*, edited by Michael F. Goodchild, Louis T. Steyaert, Bradley O. Parks, Michael P. Crane, Carol A. Johnston, David R. Maidment, and Sandi Glendinning. GIS World, Inc., Ft. Collins, CO

8.5 x 11, hardcover, illustrated, color plates, 486 pages.

ISBN 1-882610-17-2

\$50 per copy

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# Features

## Santa Fe Conference

*Third International Conference/Workshop on Integrating GIS and Environmental Modeling, Santa Fe, New Mexico, January 21-25, 1996*

Continuing the tradition started in Boulder in 1991, NCGIA organized the Third International Conference/Workshop on Integrating GIS and Environmental Modeling in Santa Fe, NM, January 21-25, 1996. Over 100 papers were presented, and the conference also included workshops, special meetings, keynote presentations, and general discussion. Approximately 500 people participated, drawn from academia, the private sector, and government agencies. The attendance was particularly gratifying given that the meeting occurred in the midst of the 1995-96 government shutdowns.

The program, lists of participants, abstracts, and the full texts of papers can be found on the NCGIA web site under "Meetings". In addition, NCGIA has published a CD-ROM of the conference proceedings—to order, contact the NCGIA Publications Office at the Santa Barbara site, 805-893-8224, FAX 805-893-8617, email [ncgiapub@ncgia.ucsb.edu](mailto:ncgiapub@ncgia.ucsb.edu). To order this CD through the web, click to "Ordering Information" in the "Products" section of our web site.

This conference follows previous meetings in Boulder in 1991, and Breckenridge in 1993, and total attendance at the three conferences exceeded 1700. The papers from the previous two meetings were published as edited books:

*Environmental Modeling with GIS*, edited by M.F. Goodchild, B.O. Parks, and L.T. Steyaert. New York: Oxford University Press (1993)

*GIS and Environmental Modeling*, edited by M.F. Goodchild, L.T. Steyaert, and B.O. Parks, et al.. Fort Collins: GIS World (1996).

Generous contributions from several organizations including the National Science Foundation (NSF), US Geological Survey, Environmental Systems Research Institute (ESRI), National Oceanic and Atmospheric Administration (NOAA), GIS World and Los Alamos National Laboratory are gratefully acknowledged.

## NCGIA Research Conference on "Spatial Technologies, Geographic Information, and the City"

*September 9-11, 1996*

*Helen Couclelis*

*805-893-2196*

*cook@geog.ucsb.edu*

A research conference on this topic took place at the Lord Baltimore Hotel in Baltimore, Maryland, September 9-11, 1996. Spatial technologies—that is, the complex of new transportation, communication, and information technologies—are rapidly changing spatial relations in today's cities. They affect accessibility conditions for different activities and population groups, as well as the urban structure itself, in ways that are not as visible and often very difficult to gauge. The conference explored the ways in which these technologies are both transforming our cities and, in the case of information technologies in particular, also expanding our ability to plan for these changes. A specific focus was on the role of geographic information technologies. The conference addressed the following broad questions:

- What changes in accessibility are brought about by spatial technologies affecting spatial interactions in cities?
- How do these changes affect different geographically or socially defined urban population groups?
- How can geographic information science and technology be used to help identify, measure, model, and plan for the impacts of changing spatial technology on the city?

The conference was advertised through an open call, and participants were selected on the basis of a research note submission. A number of well-known scholars working in the field were also invited. Some 30 participants came together for three days in a workshop-like format alternating plenary and small-group sessions. Their discussions and recommendations for a national research agenda are summarized in a report published as *NCGIA Technical Report 96-10, Spatial Technologies, Geographic Information, and the City*. The conference steering committee included: Ron Abler (AAG), Mike Batty (University College, London), Helen Couclelis (NCGIA/University of California, Santa Barbara), Ken Dueker (Portland State University),

Susan Hanson (Clark University), Kingsley Haynes (George Mason University). More information about the conference, as well as the conference report, can be found in the "Meetings" section of our web site.

## Spherekit

Spherekit is a spatial interpolation software toolkit developed at NCGIA as part of Initiative 15: Multiple Roles of GIS in US Global Change Research. Developers include: Cort Willmott (University of Delaware), Rob Raskin (Jet Propulsion Laboratory), Chris Funk (NCGIA), Scott Webber (University of Delaware), and Mike Goodchild (NCGIA). The alpha (preliminary) version was released into the public domain in October 1996. Version 1.0 will be released in 1997. The source code is freely distributed over the internet. The package features several unique capabilities.

Spherekit allows interpolation over continental or global domains by computing distances and orientations (among data and interpolation points) from geodesics on the surface of the globe. Conventional interpolations typically are based upon Euclidean distance in Cartesian 2-space which involve planar projections that produce distortions of some kind. In Spherekit, projections are applied only for display purposes after the interpolation has been carried out using spherical geometry. Users can select from several interpolation algorithms that have been adapted to the sphere: inverse distance weighting, thin plate splines, multiquadrics, triangulation, and kriging. Portions of the GSLIB package have been modified for the sphere and are used in Spherekit to compute variograms for the kriging algorithms.

Spherekit enables the user to incorporate knowledge or information about the processes that produce the underlying spatial variations into the interpolation model. A built-in equation editor and a collection of nonlinear transforms allow the user to create and experiment with new, physically meaningful variables from the independent and dependent variables available. This "smart" interpolation capability allows Spherekit to intelligently interpolate using auxiliary information. One use of the smart interpolation feature is to incorporate elevation information when interpolating variables that are correlated with height. A digi-

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tal elevation model (DEM) is included with the package for this purpose.

Error analysis is an integrated component of Spherkit making the package particularly useful for comparing interpolation methods and parameters. Interpolation method performance is measured using cross-validation. Cross-validation error is defined at each observation point as the difference between its actual value and its interpolated value estimated from the remaining points. The resulting error field can be displayed either at the data points or by interpolating to a regular grid to reduce spatial biases. Error difference fields, comparing methods or parameter settings, can be created and displayed with ease.

Spherkit software is compatible with most computers running the UNIX operating system. The software uses Tcl/Tk for its Graphical User Interface (GUI), Generic Mapping Tools (GMT) for display of output fields, Ghostview for display of PostScript files, and netCDF for storing the DEM. All of these auxiliary packages are required and can be downloaded together with Spherkit. See the "Products" section of our web site.

### **1996 International Young Scholars' Summer Institute in Geographic Information**

*July 24-31, 1996  
Berlin, Germany*

For eight days during summer 1996, some 50 junior and senior US and European scientists working in the general area of geographic information lived and studied together in the elegant setting of the Villa Borsig conference facility in Berlin, Germany. This Summer Institute, like the first one that took place in 1995 at the Wolfe's Neck Conference Center near Portland, Maine, was sponsored jointly by the US National Science Foundation (NSF) and the European Science Foundation (ESF), and was organized by the European GISDATA program and NCGIA. The Institute provided a superb opportunity for the participants to develop networks with their peers from across the Atlantic, exchange views and experiences, present their research in a highly qualified international forum, and have their work considered for publication in an edited volume.

Fellowships for the early career US scholars attending the institute were awarded following a national competition. The US fellows were: Roberta Brody

(Rutgers University), Aileen Buckley (Oregon State University), Yelena Ognera-Himmelberger (Clark University), Francis Harvey (University of Washington), David Howard (University of Pennsylvania), Stephanie King (Stanford University), Susanna McMaster (Macalester College), Eric Miller (Ohio State University), Paul Patterson (University of Pennsylvania), Laxmi Romasubramaian (University of Wisconsin-Milwaukee), Jayant Sharma (University of Maine), Daniel Sui (University of Georgia), and Dawn Wright (Oregon State University). The Senior participants were: K. Clarke, H. Couclelis, M. Goodchild, H. Onsrud, T. Nyerges and S. Smyth from the U.S.; and H. Alders, H. P. Baehr, M. Craglia, T. Gatrell, I. Masser, J. Raper, and M. Wegener from Europe.

### **Collaborative Research Projects**

In 1994 the National Science Foundation made funding available for three years for projects that involved collaboration between NCGIA and other institutions not part of the three-site consortium. The following sections describe the four projects that have been funded under this program.

#### **UMaine — Collaborative Research Project**

*Data and Management Information System for the Gulf of Maine  
Kate Beard, PI*

Work is under way on this collaborative project to develop a Data and Information System for the Gulf of Maine. The collaborators are in the process of coordinating data sets compiled by marine researchers working in the Gulf of Maine. Some of these data sets are historical and some are current, even real time data sets (e.g., meteorology). UMaine is developing a user interface for access to these data sets. This involves development of a spatial data browser implemented using Java. Java was selected as the development software since it supports much more interactive browsing than does HTML. Java allows use of vector graphics and the ability to make interactive selections from the map base. The interface supports zoom operations, navigation feedback (coordinates change as the cursor moves over the canvas), and interactive selection tools. The users can access data by specifying requests on three dimensions: spatial, thematic and temporal. Geographic requests can be made by selecting

a region from a list, drawing the region on a map or specifying latitude/longitude coordinates. Thematically the user can select data types (cruise, image, model output) and variables (e.g., temperature, salinity). The temporal dimension can be accessed by specifying calendar dates as an interval or by specifying tidal cycles (e.g., high, low, ebb). Users receive feedback on their query requests before submitting them to the database. The next steps in the project are to solicit input on the interface design from our marine scientist collaborators and to develop the database and metadata components of the project.

#### **SUNY-Buffalo — Collaborative Research Project**

*Predator-Prey Modeling of Fish Populations within Three-Dimensional GIS —  
Ling Bian, Stephen Brandt, Hugh Calkins, Joseph DePinto, PIs*

The project "Predator-Prey Modeling of Fish Populations within Three-Dimensional GIS" is an NSF funded project conducted in collaboration with Dr. Stephen Brandt at Great Lakes Center, Buffalo State College. The PIs of the project are Hugh Calkins, Joseph DePinto, and Ling Bian at the NCGIA Buffalo site. The primary objective of the research is to develop more realistic spatial models for predator-prey populations in Lake Ontario. The collaborator institution has developed spatial models that predict potential growth rates of predator populations in a two dimensional space. The current research effort is to adopt the existing models to a three dimensional environment and extend the models to simulating the spatial and temporal dynamics of the predator-prey populations.

One of the key research objectives was to interpolate a two dimensional data set into a three dimensional environment. The data available were in a matrix of two dimensional transects in Lake Ontario. The transects are arranged in both north-south and east-west directions. Because of the pattern differences in sampled data, the work was conducted in two studies, one for prey density data which were collected using underwater acoustics, and another for water temperature and plankton data collected using OPC technique. Both sets of data are basic input information for fish modeling.

The first of these two studies was to identify the optimal method to interpolate the prey data to a three dimensional data set.

Geostatistical and GIS methods were used to analyze the data. Given the preliminary observations, different spatial interpolations were experimented with. The second study was to interpolate water temperature and plankton data. These two types of data are sampled at the same time and location with the prey data but in a different pattern. The sample data display a undulating pattern within each transect, posing a challenge for spatial interpolation. Linear, inverse distance, and kriging methods were used to interpolate each transect in order to generate a series of continuous, two dimensional data sets. Different search strategies, diel sampling, and isotropies were applied to the interpolations. Cross validation measurement of mean absolute error, mean squared error, and minimum and maximum error are used to compare accuracy between interpolations. The preliminary results of both studies were presented at the 1997 annual meeting of the Association of American Geographers at Fort Worth, Texas. A complete report was presented at the UCGIS conference held at Bar Harbor, Maine.

The last objective of the project is to extend the current two dimensional, static fish growth models to a more realistic, three dimensional framework. The three dimensional data interpolated previously will be used in this study. An object-oriented framework is used, in combination with a bioenergetics model and movement rules, to simulate the growth of individual fish. The simulation implemented the behavior of individual predator fish in their selection of habitat and their subsequent growth in the three dimensional environment. Results of this work will be presented at the GIS/LIS '97 conference.

#### **UCSB — Collaborative Research Project**

*Integration of Remote Sensing and GIS, Assessment of Land Cover Change and Regrowth in a Northern California Forested Ecosystem*  
Dar Roberts, Michael Goodchild, PIs

The primary goals of the research are to integrate GIS into a study of temporal changes in land cover and regrowth in a mixed evergreen forested region of northern California, in order to assess the success of conifer regeneration in a watershed within the Six Rivers National Forest using remote sensing and to evaluate environmental, biotic and anthropogenic factors that may have influenced regrowth success.

Collaborators at the University of Washington have assembled an extensive satellite-based data set consisting of a 21 year/ time series of Landsat MSS, 10 years of Landsat TM and one full-season data set of MSS starting in August of 1987. These data have been co-registered and inter-calibrated. Considerable supporting geographical information including digital elevation data, soils maps, seral stage maps and vegetation associations, assembled by the US Forest Service, have been integrated into an ARC/INFO database. Forest Service stand treatment histories have also been integrated into the data base. These histories consist of more precise logging data including month of cut, method of clearing, method of burn, and extent of replant. The resulting data set represents one of the most complete temporal records of land use for the Pacific Northwest.

This research is designed to contribute to this multi-temporal study by integrating GIS into the research program to study regrowth. Methods employed combine remotely sensed analysis and geographical analysis using ARC/INFO. Remotely sensed analysis focuses on multitemporal image classification and the establishment of temporal profiles for regrowth. A classification approach based on the use of spectral mixture models is being used to develop temporal maps showing transitions in land cover. A spectral library of reference materials has been constructed from laboratory and field spectra of samples collected from various forest regions in California and Washington. These spectra are being used as reference patterns to model the land cover mixtures. The accuracy of the classification is being evaluated through comparison to existing vegetation maps and field notes taken on-site in April 1996. Spatial and temporal relationships have been used to correct Forest Service cut data and to help improve classification accuracy. Regeneration success is being evaluated by comparing regrowth across the study area to a temporal profile of regrowth under optimal conditions. This optimal growth profile has been developed from the imagery in conjunction with published growth patterns and confirmed by a forest service vegetation regrowth model specific for the area: System One. Models of regeneration based on optimal growth are being used to assign apparent stand age, then compared to absolute stand age determined from the GIS to locate areas of substandard regeneration. Environmental, biotic and anthropogenic

factors are being evaluated with respect to regrowth success through GIS. These results form the basis of thesis research for Charles Kayman and were presented at the ACSM-ASPRS Annual Convention in Seattle in 1997.

#### **UCSB — Collaborative Research Project**

*Worlds of Information: the Geographic Metaphor in the Visualization of Complex Nonspatial Information*  
Helen Couclelis, PI

The purpose of this collaborative project with a group of researchers from the Pacific National Laboratory (PNL) is to investigate the potential of the geographic metaphor in the design of visualizations of complex non-spatial data. The advantages of the geographic metaphor are twofold: First, geographic space constitutes a generally accessible and very comprehensive realm of experience for humans. This minimizes the amount of learning effort necessary for people to make sense of the vast array of possible geographically-structured representations. Second, over the more than two millennia of its existence, geography has developed a formidable arsenal of theories and tools for the representation and analysis of spatial information. Moreover, the quintessential presentation format of spatial information—the map—has always been visual. GIS, the electronic-age addition to this long tradition, successfully integrates the theories and tools of geography and its preferred, visual mode of data presentation, with the computer's capabilities of data storage, manipulation and retrieval. Thus GIS can serve as the technological bridge for moving the geographic metaphor over to the domain of general data representation and analysis.

A first paper based on this research was presented by the PI at the 1997 UCGIS Annual Assembly held in June in Bar Harbor, Maine. The paper investigates the possible significance of certain fundamental geographic concepts, such as place, way, and region, in an information space that is only metaphorically geographical. These metaphorical meanings are then associated with specific functions and user actions that make sense in the context of exploring and searching an information space consisting of textual document objects. The work continues by extending the vocabulary of geographic concepts that can be given practical

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cal interpretation in terms of interacting with complex nonspatial information databases.

### **NCGIA-Maine researchers receive four NSF grants**

Over the last nine months, NCGIA researchers at the University of Maine were successful with four proposals to the National Science Foundation. Harlan Onsrud, the organizer of the UCGIS 1997 Annual Assembly and Summer Retreat, led an effort to support the travel of student participants to the meeting in Bar Harbor, Maine. This proposal was funded through NSF's Geography and Regional Science program. Max Egenhofer received a 4-year grant from the Interactive Systems program for a research project on "Multi-Modal Spatial Querying," which investigates the interaction with GISs through the combination of voice and sketching. Peggy Agouris received an NSF CAREER award from the Database and Expert Systems program for research into the integration of image processing and information systems. Out of the Biological Infrastructure program, Kate Beard, Carol Bult, and Max Egenhofer received funding for a 2-year project on the "Application of Spatial Concepts to Genome Data" to explore the use of spatial concepts that are used in GIS, to the microscopic space of DNA.

### **NCGIA receives NURI funding**

In late April 1997 the National Imagery and Mapping Agency (NIMA) announced the six winners of its first University Research Initiative (NURI) competition. At Maine, Max Egenhofer will lead a project on "Similarity Assessments Based on Spatial Relations and Attributes," developing new computational measures to detect different levels of differences. His group will collaborate on this effort with Robert Rugg from Virginia Commonwealth University. At Santa Barbara, Michael Goodchild, Dan Montello, and Keith Clarke will research Uncertainty in Geospatial Information Representation, Analysis, and Decision Support, and will collaborate in this project with Kate Beard at Maine. Both projects are for an initial three years, and are intended to enhance universities' capabilities to perform research and related education in science and engineering areas critical to national defense and NIMA missions.

### **UCGIS sets national priorities in GISci**

The University Consortium for Geographic Information Science (UCGIS), founded in December 1994, is now firmly established and growing. As of early 1997, the membership roll counted 35 university, research lab and scholarly association members. Thomas M. Palmerlee has been appointed Executive Director for the consortium and will oversee operations and membership activities. The UCGIS is linked to NCGIA's new Varenus project through the president, currently Jerome Dobson from Oak Ridge National Laboratories, who becomes an ex-officio member of the new Advisory Board.

In June 1996, sixty representatives from the member institutions met for three days in Columbus, Ohio, to lay out a set of national research priorities for Geographic Information Science. This meeting culminated in the development of 10 white papers describing the following priority areas:

- Spatial data acquisition and integration
- Distributed computing
- Extensions to geographic representation
- Cognition of geographic information
- Interoperability of geographic information
- Scale
- Spatial analysis in a GIS environment
- The future of the spatial information infrastructure
- Uncertainty in spatial data and GIS-based analyses
- GIS and society

These papers can be found on the WWW through the UCGIS web site noted below and are reviewed in a summary paper "Research Priorities for Geographic Information Science" published in *Cartography and Geographic Information Systems*, 1996, vol 23(3).

UCGIS held its second Annual Assembly and Retreat in Bar Harbor, Maine (hosted and organized by NCGIA-Maine), June 15-21, 1997. This year's annual retreat was devoted to education, and a major focus of the week was on the development of UCGIS's education priorities, to complement the research priorities that were the subject of last year's annual assembly in Columbus, Ohio. There are drafts of the priority documents on the UCGIS web site. In addition, the program included 85 contributed papers, with many from graduate students associated with the NCGIA institutions, keynotes, and 11 workshops. An evening presentation by Ian McHarg was

one of the highlights of the meeting. Joe Ferreira (MIT) sailed his yacht from Boston and offered several excursions, and a wide range of other social and recreational activities helped to make for a memorable meeting.

The University Consortium for Geographic Information Science (UCGIS) is a non-profit organization of universities and other research institutions dedicated to advancing our understanding of geographic processes and spatial relationships through improved theory, methods, technology, and data. UCGIS membership is open to all US academic and research organizations that meet the membership criteria. Member institutions have the opportunity to participate in reviewing and setting national research and education priorities in GIS and related specialties.

More information about the UCGIS can be found on the web at <http://www.ucgis.org> or by contacting the Executive Director at 319 C Street, SE Washington, DC 20003, phone: (202) 544-1419, email: [execdir@ucgis.org](mailto:execdir@ucgis.org).

### **VITAL**

#### *The Vehicle Intelligence Testing and Analysis Laboratory*

Picture this scenario. You are on your way to an important meeting. Traffic is backing up on the Interstate. There's an alternate local route, but is it likely to be any better? You consult the dashboard computer. It has a digital map on board. It's in communication with the Traffic Management Center (TMC) that continually monitors highway speeds, and it uses a Global Positioning System (GPS) to track your location every couple of seconds. It works out likely arrival times based on the latest traffic observations: 11.24 a.m. using the local route, 11.47 a.m. along the Interstate.

This is the arena of Intelligent Transportation Systems (ITS: previously Intelligent Vehicle/Highway Systems, IVHS). ITS can be applied to a variety of problems such as automatic toll collection, collision avoidance, tracking of hazardous chemicals and weapons in transit, coordination of public transit schedules, and traveler information (e.g., where's the next motel in a specified price range with an available room). It consists of a network of information exchange points including the intelligent vehicle, Road Side Beacons and Communications Systems, TMCs and other Information Service Providers (ISPs), Electronic Toll and Traffic Management

(ETTM) systems, etc. ITS principles are also used in agriculture — sensors built into tractors measure soil characteristics and yield as they traverse a field, and determine seed mix and fertilizer concentrations to be applied to each portion of the field.

The scenario presented above is being tested by government and industry players in North America, Europe, Japan and Australia. Before they become part of our everyday life, some standards issues need to be resolved. Two specific solutions have been proposed by Oak Ridge National Laboratories (ORNL), Tennessee.

The Vehicle Intelligence Testing and Analysis Laboratory (VITAL) was established in January 1997 as part of the National Center for Geographic Information and Analysis (NCGIA) at the University of California, Santa Barbara, with funding from the California Department of Transportation's (Caltrans) Testbed Center for Interoperability (TCFI).

By late summer 1997 VITAL will have a small fleet of test vehicles in two-way communications with one or more servers in the Santa Barbara area. A selection of popular commercial data bases will be deployed in the servers and mobile client systems. Messages will be transmitted between servers and clients, and experiments designed to analyze information uncertainty and error. Test locations will include points on a network, off-road points, highway segments, intersections and landmarks.

Special-interest organizations such as Emergency Management Systems (EMS) groups and fleet managers may have specific research problems in ITS; and research groups will inevitably propose solutions on data models, protocols and communications technologies. VITAL will be a functioning test site with the ability to test proposals and to offer innovative solutions.

These efforts will help future ITS planning, shorten travel times, and improve highway utilization.

How to Contact VITAL: Dr. Val Noronha, Director, VITAL, NCGIA, 3510 Phelps Hall, University of California, Santa Barbara, CA 93106-4060, USA. Phone: (805) 893-8992; Fax: (805) 893-8993; E-mail: vital@ncgia.ucsb.edu (under the "Research" section of our web site).

## Initiatives

### Initiative 8: Formalizing Cartographic Knowledge

Barbara P. Battenfield (Colorado)  
303-492-3618  
babs@Colorado.EDU

**Many aspects of cartography have been difficult to formalize, such as selection of color progressions or tolerance value modification. The incompleteness of formal cartographic guidelines, which has impeded fully automated mapping, is addressed by this initiative.**

Research has focused in three areas, first the representation of uncertainty by graphical displays, second, the formalization of spatial metaphors to navigate through very large archives of (possibly nonspatial) data, and third the formalization of coordinate and computational strategies for manipulating large cartographic datasets. Work has continued at Colorado, Maine, Buffalo, and Switzerland by researchers who attended the original I-8 Specialist Meeting (1993) in Buffalo. Some of this work is related to the Alexandria Digital Library Project continuing at Colorado and UCSB. The most recent project research is summarized below:

**Visualizing spatial uncertainty.** Michael Leitner has completed his dissertation research at Buffalo, supervised by Barbara Battenfield. He formalized graphical guidelines for including attribute certainty information on thematic maps. The intention is to offer GIS vendors clear principles for setting graphical defaults. Three visual variables (value, saturation and texture) were assessed in an experimental siting decision for a natural conservation park and airport. Pretesting established perceptually equivalent pairs controlling for each visual variable. Additional pretesting allowed users to prioritize their own criteria for the siting decisions. The main experiment involved 72 subjects. The most exciting finding is that people respond differently to the details added by embedding attribute certainty information than to detail created by additional classes. Shorter response times indicate that attribute certainty does not increase the visual complexity of a map display. When certainty information is displayed by value, people make the correct decision more often and more quickly. For CRT displays, data that is

"more certain" should be shown as the lighter value. If this visual variable is not available, color saturation is associated more quickly than is texture. Subjects' confidence in their decisions did not differ significantly regardless of graphical treatment or difficulty of decision.

**Assessing icon design for a direct manipulation interface.** Traditional GIS software provides complex commands or macro languages for users to process and analyze information. Many use errors occur as a result, particularly for naive users. We have developed the initial design of a GIS interface encapsulating both data and GIS overlay operators in object form, and reported on its implementation in an ARC/INFO environment. At Colorado, subject testing has established principles for graphic design on interface icons. We tested icons for point, line and polygon data, for environmental and socio-economic files. Currently the experimental design is being refined. A paper reporting on the interface was presented at the Spatial Data Handling conference in Delft in August 1996.

**Cartographic representation of "fuzzy" phenomena.** At Buffalo, doctoral student Brandon Plewe has completed his research on digital and cartographic representations of gradation and fuzzy categories. Brandon's current work formalizes predicates by which data representations may incorporate each type of gradation.

In summary, a closing report of this research is pending.

### Initiative 10: Spatio-Temporal Reasoning in GIS

Max Egenhofer (Maine)  
207-581-2114  
max@spatial.maine.edu

Reginald Golledge (Santa Barbara)  
805-893-2731  
golledge@geog.ucsb.edu

**Research into spatial and temporal reasoning focused on the development of formalizations for spatial relations and the interaction with time through direct-manipulation user interfaces.**

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As a final activity for the I-10 Initiative, a small symposium was held in Santa Barbara on June 7-8, 1996. The symposium focused on the relationship between GIS and disaggregate individual and behavioral transportation modeling. This activity completed the cycle of planned effort in I-10, which started with a strong temporal presence, then shifted to a predominantly spatial context, and now finishes with suggestions for expanding GIS into the transportation modeling area by emphasizing both temporal and spatial features. The temporal features are embedded in the concept of episodic activities and activity scheduling on the part of households and individual household members, with data being collected using temporal procedures such as travel diaries, episodic surveys, and long-term data collection from panels. The activity scheduling and activity-based approach as epitomized within the context of this symposium appears to be a very challenging set of circumstances for potential integration of both spatially dominant and temporally dominant GIS.

The symposium brought together academic participants from fields such as economics, civil and environmental engineering, transportation engineering, architecture and urban planning, and geography, and representatives from federal and state government including the Department of Transportation, Caltrans, and Oak Ridge National Labs. The deliverable product from this symposium was an agenda for expanding GIS into the transportation research, planning, and policy making arenas.

At Maine, Jayant Sharma's Ph.D. thesis proved that individual inference mechanisms for topological and direction relations are not powerful enough to correctly derive spatial relationships; however, by adding topological relations that are implied by combinations of direction relations, enough information can be obtained to make the reasoning process complete and correct. As part of his Ph.D. dissertation, Rashid Shariff calibrated for fifty-nine English-language spatial and spatio-temporal relations the values of their metrical parameters. This knowledge enables us to automatically generate a description of a spatial scene, and it is critical input for processing natural-language-like spatial queries.

## **Initiative 15: Multiple Roles for GIS in US Global Change Research**

Kate Beard (Maine)  
207-581-2147  
beard@spatial.maine.edu

John Estes (Santa Barbara)  
805-893-3649  
estes@geog.ucsb.edu

Tim Foresman (Univ of Maryland-  
Baltimore County)  
410-455-3149  
foresman@umbc.edu

Michael Goodchild (Santa Barbara)  
805-893-8049  
good@ncgia.ucsb.edu

**Initiative 15 concerns the ways in which GIS could better support regional and global change research. GIS could play an important role in enhancing models of Earth system phenomena operating at a variety of spatial and temporal scales across local, regional, and global landscapes, as well as in improving assessments of the effect of global change on ecological systems over a range of spatial and temporal scales. The importance of GIS can only increase as global change research becomes more computationally and data intensive, as it moves from studies of single processes to integrated modeling, and as it struggles to link human and physical processes.**

The second specialist meeting was held in Santa Fe, NM, January 25-26, 1996. The original intent had been for the first specialist meeting to bring together global change researchers to give their perspective on the objectives of the initiative; and for the second specialist meeting to bring GIS researchers together to discuss possible solutions. That model was modified when it became clear that the first specialist meeting would not be able to divorce its discussions from GIS quite so cleanly; and when the range of problems and issues identified in the first meeting, and published in its report (*NCGIA Technical Report 95-10*), were found to be so broad. Instead, the second specialist meeting was planned as a much smaller gathering (twenty rather than fifty) with a discussion focused on data modeling as an organizing framework.

The report from this second specialist meeting (*NCGIA Technical Report 96-5*)

identifies major problems in bringing the data models used in the various global change disciplines into any kind of common framework. One of the most significant problems concerns data quality. Within any one discipline, the quality of a data set is likely to be known, as part of the shared expertise of researchers. Not only are descriptions of data quality commonly lacking in shared data sets, but the terminology needed to create them is not even shared across disciplinary boundaries. The meeting found major problems in reaching a common understanding even of the term "data model"—the GIS community tends to take a much more generalized view of the term and associated process than does the oceanography community, for example. It was determined that the term "data model" must be interpreted in a variety of ways depending on the domain of the usage. It was also determined that data modeling can be extended as a useful framework for all aspects of the data life cycle, both analog and digital, and that data modeling decisions and transformations occur at many stages, both in and outside the digital domain. Five fundamental extensions of GIS data models were identified — three spatial dimensions, time, the curved surface of the Earth, multiple scales, and uncertainty. While significant progress has been made on the first two, there is very little to date on the next two, and virtually none on the last.

Interest in developing formal methods for data description is now widespread in the geographic data community. The report of the one-day metadata workshop organized in Santa Barbara in November 1995 is now available in draft form on the web at <http://alexandria.sdc.ucsb.edu/metadata>.

Many of the sessions and papers at the GIS and Environmental Modeling Conference organized by NCGIA in Santa Fe in January 1996 were of direct relevance to the objectives of I-15. A session on modeling gradual and abrupt spatial transitions at the Spatial Accuracy Symposium in Fort Collins in May 1996 contained several papers of direct relevance to I-15's fifth objective, and it appears that substantial progress is being made on this issue. Other papers reflected growing interest in conditional simulation as a way of modeling uncertainty in spatial data.

At Maine, Bhesheem Ramlal completed his Ph.D. work on a mixed variation model for soil information. His model treats soil properties as exhibiting both continuous

and abrupt change. The model incorporates measurements of soil properties, quality of the measurements, delineations of abrupt change in properties, and an interpolation method to generate fields from the above components. His interpolation method accommodates both discontinuities in a soil property as well as the reliability of the measured position and attribute. He presented preliminary findings in a paper at the GIS and Environmental Modeling conference in Santa Fe, and Kate Beard presented a paper on a Structure for Organizing Metadata at the same conference. This paper investigates metadata content and collection strategies for marine data and for marine related process models such as circulation models. She has continued work on metadata representations for global coverages and visualization of metadata.

A closing session for I-15 was held at Auto Carto 13 in Seattle, Washington in April 1997. Nine abstracts on I-15 topics were submitted for this closing session. From the nine submissions, five papers were selected for inclusion in the program.

## **Initiative 16: Law, Information Policy and Spatial Databases**

Harlan Onsrud (Maine)  
207-581-2173  
onsrud@spatial.maine.edu

Robert Reis (Buffalo)  
716-645-2354  
reis@acsu.buffalo.edu

**This research initiative explores four interrelated aspects of information law that affect the handling of geographic information: access rights of citizens to publicly held information, intellectual property rights in spatial databases, privacy rights and principles, and potential liability of using, sharing, and distributing GIS data and analysis results.**

Several research projects have been accomplished over the past several years under the auspices of this research initiative. The closing session for the initiative will be held at GIS/LIS 97 and will review the results of research work on (1) a comparative analysis of information policy approaches among mapping agencies of several nations, (2) a comparative analysis of citizen access and revenue generation ap-

proaches pursued by local governments in the U.S., (3) a survey of data supplier preferences regarding the application of intellectual property rights in protecting digital spatial data or in allowing a supplier's use of others data, and (4) ethical considerations in the use of geographic information. Recommendations for future research on information policy and law issues also will be addressed. The first half of the session will consist of short concise summaries by five panelists on the results of recent studies and on research yet needed. The second half will be reserved for an open discussion with the audience on any of the legal or information policy topics raised by the panelists. Participating researchers and panelists will include: Dr. Harlan J. Onsrud, NCGIA, University of Maine; Dr. Xavier Lopez, School of Information Management and Systems (SIMS), UC - Berkeley; Jeff Johnson, Third Year Student, Stanford University Law School; Yvette Pluijmers, MS Student, NCGIA, University of Maine; and Bishop Dansby, Esq., AmCad, Harrisonburg, Virginia.

The web page for the initiative continues to be maintained at UMaine, though it can be accessed through the "Research" section of our web site. In addition to the specialist meeting proceedings, this site provides access to papers prepared by I-16 researchers, a legal and information policy bibliography, and links to related legal index sites.

Yvette Pluijmers, M.S. student, has spent the past year researching appropriate limits of protection for intellectual property in geographic datasets in the commercial sector. In her work she explores competing theories from both legal and economic views on protecting intellectual property and evaluates those theories in the context of the commercial sale of geographic datasets. A survey with two objectives was distributed to sellers of spatial datasets. The first objective was to determine the current level of satisfaction with current means of intellectual protection of spatial datasets; satisfaction both in the ability to build on the datasets of others as well as the ability to restrict use of their own datasets by others. The second objective was to outline competing models for protecting intellectual property in geographic datasets and determine commercial seller preferences in regard to these alternatives. The results of this survey work should have value in assessing and developing new models and methods for protecting intellectual property

in spatial datasets.

Xavier Lopez completed his Ph.D. case study and survey work and defended his Ph.D. dissertation on "The Impact of Law and Information Policy on the Dissemination and Commercialization of Scientific and Technical Databases: A North American - European Community Comparative Study." His research addressed international issues relative to the interplay of access, copyright, and cost recovery issues relative to geographic databases. The work focused on the policies of national mapping agencies in Canada, France, Great Britain, and the United States and the effects of those policies on key stakeholder groups.

Paul Schroeder, with current graduate degrees in Political Science and Library Science, continued work on his Ph.D. program. His research focuses on effective end-user access to electronic data sources and his approach serves as a counter-approach to studies of network deployment and the development of centralized information services. The role of GIS is pivotal in this work, both as a tool to evaluate the distribution of information services and as an example of the advanced information systems to which the general public will increasingly expect access. His dissertation work on end-user access models will utilize the ongoing experiences in increasing access to GIS technology, datasets and other information resources in Maine's libraries and schools.

## **Initiative 17: Collaborative Spatial Decision Making**

Paul Densham (University College London)  
+44-171-387-7050 ext 5502  
pdensham@geog.ucl.ac.uk

Marc P. Armstrong (Univ of Iowa)  
319-335-0153  
marc-armstrong@uiowa.edu

Karen Kemp  
805-893-7094  
kemp@ncgia.ucsb.edu

**The major objectives of Initiative 17 are to: 1) examine the body of theory on the design, implementation and use of computer supported cooperative work (CSCW) environments and evaluate its utility for GIS/GIA; 2) identify impedi-**

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ments to the development of highly interactive, group-based spatial modeling and decision-making environments; 3) develop methods for eliciting, capturing and manipulating knowledge bases that support individual and collective development of alternative solutions to spatial problems; 4) develop methods for supporting collaborative spatial decision-making (CSDM), including methods for managing spatial models; 5) extend capabilities for supporting multicriteria decision-making in interactive, CSDM environments; and 6) characterize CSDM processes to understand how CSDM technology is and potentially can be used in various CSDM subject domains.

Initiative 17, Collaborative Spatial Decision Making (CSDM), was launched at a September 1995 Specialist Meeting in Santa Barbara, CA. The Specialist Meeting report was published as NCGIA Technical Report 95-14. A web page in the "Research" section of the NCGIA web site contains a web version of the Specialist Meeting report, as well as links to several sites that are maintained by I-17 meeting participants.

A special session on Initiative 17 was held at the *Third International Conference/Workshop on Integrating GIS and Environmental Modeling*, Santa Fe, New Mexico, January 21-25, 1996, and researchers working on projects related to I-17 participated in a special session at GIS/LIS '96 in Denver in the fall. Papers presented at the Santa Fe conference are on-line in the "Meetings" section of NCGIA's web site, and papers presented at GIS/LIS '96 are published in the *Proceedings*.

Recent Initiative-17 research included the following efforts:

- Armstrong and Densham have been collaborating on a new approach to the decomposition and representation of multiple scenarios, formulated, for example, by several members of a decision-making body, so that they can be summarized and visualized. This approach is based on an extended form of map algebra. The decomposed solutions are transformed into matrix form, operated on using a set of operations to derive, for example, summary measures and indices of agreement, and the transformed information is then visualized so that it can be used by individuals working to sort through the alternatives they have generated, or

by groups who are working to reach consensus.

- David Bennett (Southern Illinois University) and Marc Armstrong have been investigating ways that can be used to generate and evaluate new land management scenarios in multiple stakeholder settings. They have recently begun to focus on the use of a two dimensional genetic algorithm approach.
- Armstrong, working with Richard Marciano at the San Diego Supercomputer Center, has initiated work that uses a network of workstations (NOW) to implement parallel versions of computationally intensive algorithms, thus opening the way for interactive modeling in decision-making environments.
- UCSB researchers Church and Figueroa have been working to develop a prototype for generating spatial alternatives in a spatial decision support system, the Regional Ecosystems and Land Management Decision Support System (RELMdss). The major objective of this effort is to develop and test a method for generating alternatives within a location-allocation module; a graphical user interface to present alternatives; and a method to spatially direct searches for alternatives. I-17 research at SUNY Buffalo is led by investigator Rajan Batta, and includes work on the routing of hazardous material shipments, incorporating factors such as time of day, weather systems, accident statistics, among other variables.
- At University College London, Paul Densham is a co-Principal Investigator on a recently awarded grant "A Virtual Reality Centre for the Built Environment: Specialising in research applications and training for Construction, Retailing and Transport." This grant will support, among other things, research that contributes to I-17. More specifically, the grant will enable the researchers [including Michael Batty (University College London and Planning Group for I-17)] to look at the integration of GIS, urban planning and virtual reality to support collaborative spatial decision-making.

## **Initiative 19: The Social Implications of How People, Space, and Environment are Represented in GIS**

Trevor Harris  
304-293-5603  
tharris2@wvu.edu

Daniel Weiner  
304-293-5603 ext 4326  
dweiner@wvu.edu

**The initiative focuses attention on the social contexts of GIS production and use and addresses a series of conceptual issues:**

- In what ways have particular logic and visualization techniques, value systems, forms of reasoning, and ways of understanding the world been incorporated into existing GIS techniques, and in what ways have alternative forms of representation been filtered out?
- How has the proliferation and dissemination of databases associated with GIS, as well as differential access to spatial databases, influenced the ability of different social groups to utilize information for their own empowerment?
- How can the knowledge, needs, desires, and hopes of marginalized social groups be adequately represented in GIS-based decision-making processes?
- What possibilities and limitations are associated with using GIS as a participatory tool for more democratic resolution of social and environmental conflicts?
- What ethical and regulatory issues are raised in the context of GIS and Society research and debate?

The Initiative 19 specialist meeting was held at the Koinonia Retreat Center, South Haven, Minnesota, March 2-5, 1996. The meeting was organized as a workshop. A call for position papers was emailed to numerous bulletin boards and posted in the AAG newsletter. In response, over 40 position papers and expressions of interest were received. After a peer review process, 32 position papers were accepted and invitations to attend were offered. Attendees were geographically distributed throughout the US and representatives from the United Kingdom and Switzerland were also present. All position papers were posted to an Initiative 19 Home Page on the World Wide Web: <http://www.geo.wvu.edu/www/I-19/page>, also linked from the "Research" section of NCGIA's web site.

At the specialist meeting, there was considerable discussion regarding the possibility of developing what became known as 'GIS2'. Although multiple meanings of GIS2 were presented and discussed, the core of this idea is an alternative GIS constructed with community participation and incorporating non-conventional knowledge types. One of the key objectives of GIS2 is to facilitate more inclusive spatial decision-making processes. Other key issues to emerge from the specialist meeting are discussed in the specialist meeting report (*Technical Report 96-7*).

The steering committee also organized two I-19 sessions at the Association of American Geographers annual conference held in Charlotte, NC in April, 1996. The first session comprised a 'meet the editors' discussion in which Eric Sheppard and John Pickles provided an overview and responded to 'critics' and questions regarding the *GIS and Society* theme volume published by CAGIS, and the edited volume *Ground Truth*. The second session comprised several short presentations by members of the I-19 steering committee which focused on the objectives, conceptual themes, and research projects of I-19. Both sessions were well attended and generated substantial discussion and interest.

Current effort under I-19 focuses on four projects being funded at non-NCGIA institutions from the core NCGIA budget. These comprise:

- A regional and community GIS-based risk analysis [led by Eric Sheppard or Bob McMaster (Minnesota)]
- GIS and Society research in the Kanawha Valley, West Virginia [led by John Pickles (Kentucky), Trevor Harris (West Virginia), or Dan Weiner (West Virginia)]
- The social history of GIS project [led by Jon Goss (Hawaii), David Mark (Buffalo), or John Pickles (Kentucky)]
- The ethics of spatio-visual representation: toward a new mode [led by Michael Curry (UCLA)]

As part of I-19, NCGIA Buffalo will be hosting an invitational workshop on environmental risk methodologies, September 6-8, 1997. This workshop will be led by Robert McMaster (Geography, University of Minnesota) and Susan Cutter (Geography, University of South Carolina), and will involve approximately 10-12 researchers. The workshop will explore the state of current research in risk assessment and the ways that GIS use and mapping can influ-

ence risk assessment and public perceptions of risk from hazardous materials.

As part of the GIS History Project, Buffalo will host a workshop November 6-8, 1997. The objective of the workshop is to assess progress on the project and to plan and prioritize future activities. The workshop will be led by David Mark (NCGIA Buffalo) and involve a series of round-table discussions and presentations on the topic. The GIS History Project has a Web site at <http://www.geog.buffalo.edu/ncgia/gishist/> For further information, please contact David M. Mark, NCGIA, Buffalo ([dmark@geog.buffalo.edu](mailto:dmark@geog.buffalo.edu)).

### **Initiative 21: Formal Models of Common Sense Geographic Worlds**

David M. Mark (Buffalo)  
716-645-2545 ext 48  
[dmark@geog.buffalo.edu](mailto:dmark@geog.buffalo.edu)

Max Egenhofer (Maine)  
207-581-2114  
[max@spatial.maine.edu](mailto:max@spatial.maine.edu)

**Initiative 21 focuses on the cognitive aspects of geographic space and computational methods and models of geographic concepts as well as the design of systems that integrate the ideas of naive geography. In the long run, the models developed from this research can be used to refine GIS technology so that GISs can be made to "reason" or "think" like a human expert.**

The multidisciplinary Steering Committee for the Initiative includes the following members: Roger Downs, Geography, Pennsylvania State University; Andrew Frank, Geoinformation, TU Vienna, Austria; Janet Glasgow, Computing and Information Science (AI), Queen's University, Canada; Pat Hayes, Computer Science (AI), University of Illinois; Dan Montello, Geography, Santa Barbara; Barry Smith, Philosophy, SUNY Buffalo; and Barbara Tversky, Psychology, Stanford.

The NCGIA Initiative 21 Specialist Meeting was held from October 31 to November 2, 1996, in San Marcos, Texas. This meeting, which was attended by 42 researchers from North America and Europe, was organized and led by David Mark (NCGIA-Buffalo) and Max Egenhofer (NCGIA-Maine). The Department of Geography, Southwest Texas State University

and UB Geography Graduate F. Benjamin Zhan served as its local hosts. There were 48 applicants for this meeting, the largest number ever to submit to an NCGIA Specialist Meeting, and the backgrounds of the attending participants included such diverse fields as psychology, philosophy, computer science, engineering as well as geography.

Initiative meeting sessions focused on: the role of modeling of common-sense knowledge in artificial intelligence, the nature and definitions of commonsense geography, the role of commonsense geography for GIS, and how to formalize the representations of commonsense theories.

The outcomes of the meeting include a technical report, currently in preparation, as well as the definition of a set of short and long term research goals. The research agenda defined by the specialist meeting included 49 researchable questions. The questions may be categorized under the following themes: GIS and other Applied Topics (17 researchable questions); Human Subjects, Developmental (9 researchable questions); and Geography/AI/Philosophy/Mathematics (23 researchable questions).

A more complete report on the meeting and the research agenda it established will appear in the Report on the Specialist Meeting.

A study is underway to relate collections of 'feature types', 'feature codes', or 'entity codes' from geocartographic data standards such as SDTS, and evaluate them as claims about geographic ontologies (Mark Smith, Barbara Tversky, and Stephen Hirtle).

# Conferences & Meetings

## Reports on Past Events

### Geographic Information Analysis and Human Capital Research Conference

July 10-12, 1995

Hotel Boulderado, Boulder, Colorado

In July 1995, approximately 35 researchers gathered in Boulder, Colorado to participate in the NCGIA workshop GIA and Human Capital Research. Organized by Munroe Eagles and Hugh Calkins of NCGIA Buffalo, the conference was supported by the National Science Foundation and the Department of Housing and Urban Development. Additional assistance was received from Environmental Research Systems Institute (ESRI). NCGIA participants in the workshop included Alex Anas, Sharmistha Bagchi-Sen, Meghan Cope, Michael Goodchild and Peter Rogerson.

The purpose of the meeting was to explore the use and limitations of geographic information analysis (GIA) and the rapidly developing technology and software of geographic information systems (GIS) in areas of human capital research. Three areas of research were used for case studies in conference discussions, namely violent crime, social and political discussion networks and demographic and neighborhood change. Geographic databases representing each of these areas, and also representing each of the three forms of data conventionally employed in geographic analysis, served as the bases of discussion.

The outcomes of the workshop included the identification of the intellectual and lo-

gistic contributions that GIA and GIS can make in multiple areas of human capital and other social research. These contributions, as well as a complete report on topic, are discussed in the report Geographic Information Analysis and Human Capital Research, available in hard copy by contacting the NCGIA at the University at Buffalo, or on the Web at <http://www.geog.buffalo.edu/humcap2/contents.html>.

Researchers at Buffalo have continued research in the area of human capital, using GIA and/or GIS in their analyses. Projects include: an investigation of the effects of the devolution of welfare from the federal level to states and localities; a study of the role information technologies can play in attracting economic development, fostering education and enhancing community participation in marginalized communities; and a study of the effect of block clubs on social capital formation, using neighborhoods in the city of Buffalo as a case study.

### Conference on Object Orientation in Navigable Databases

March 15-16, 1996

Santa Barbara, CA

In March 1996 the NCGIA and the California Department of Transportation (Caltrans) jointly sponsored a two-day conference in Santa Barbara, on the application of concepts of object orientation to navigable databases.

For the purposes of the conference, navi-

gable databases were defined as databases capable of supporting such ITS applications as in-vehicle map display, synthesis of navigation directions, and direction of vehicles to a given street address.

The goals of the conference included:

- evaluating the range of products currently available
- assessing the total experience to date of Object Oriented (OO) databases
- comparing OO and more conventional approaches with specific emphasis on distributed storage, processing, and maintenance

Coordinated by Danette Coughlan and Thomas Cova, the conference provided a setting for identifying the associated issues and potential solutions regarding OO database design and implementation for transportation applications.

Over 40 individuals attended the workshop, including:

- 1) Ten experts in the fields of OO theory, navigable databases, and OO GIS: François Bancilhon, O2 Technology; Kurt Buehler, Open GIS Consortium; Max Egenhofer, University of Maine, Orono; David Fletcher, University of New Mexico; Andrew Frank, Technical University of Vienna; Michael Franklin, University of Maryland, College Park; John Herring, Oracle Corporation; Shashi Shekhar, University of Minnesota; Alan Vonderohe, University of Wisconsin, Madison; and Michael Worboys, Keele University, UK

- 2) several Caltrans personnel
- 3) a number of NCGIA researchers and
- 4) other invited participants from industry and academia with knowledge and interest in the areas mentioned in (1)

Each of the ten experts provided a two-page position paper reflecting views on the theory and implementation of object orientation for navigable databases. These position papers, along with a synthesis of the meeting discussions, have been published as a monograph following the conference as *NCGIA Technical Report 96-9, Conference on Object Orientation in Navigable Databases: Report of the Meeting*.

### Buffalo Site Helps Local Community

Amherst is an affluent Buffalo suburb with a population of about 130,000 people and 1,100 White-tailed Deer. There is no legal hunting in Amherst, and the Town has experienced a great deal of development and population growth over the last couple of decades. Recently, the press identified "the Amherst Deer Problem". This problem, as reported, seems to have begun as deer damage to individual and commercial gardens but quickly switched to focus on deer-related vehicle accidents (DRVAs). In 1996, there were over 500 DRVAs reported to the police, constituting almost 10 percent of all reported collisions.

For over a year, Steven Parkansky (Ph.D. candidate) and David Mark (NCGIA Buffalo) have been assisting the Town of Amherst with its deer "problem". Parkansky will model deer population distributions and integrate the data with traffic and road data to model deer-vehicle collisions. In addition, a questionnaire distributed to 1200 residents focusing on the nature of the deer problem, personal experiences with and losses due to White-tailed Deer in Amherst and attitudes toward various prevention or mitigation solutions will aid in determining appropriate and acceptable control measures.

**Symposium Summary: Second International Symposium on Spatial Accuracy Assessment in Natural Resources and Environmental Sciences**  
May 21-23, 1996  
Colorado State University, Fort Collins, Colorado

Over 260 participants attended the three-day symposium, representing over 20 countries throughout the world. Each morning, one plenary speaker addressed accuracy issues in spatial data and analyses from either the geographic information system (GIS), spatial statistics, or remote sensing perspective. A total of ninety-four invited and contributed papers dealing with various aspects of these topics were also presented in 24 concurrent sessions throughout the three days. A closing discussion of current trends and research directions in the field was led by a ten-member panel. The 728-page proceedings is available at no charge from Publications Distribution, USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, 240 W. Prospect, Fort Collins, Colorado 80526-2098 USA. (Please reference RM-GTR-277 in your request.) The third symposium is tentatively scheduled to be held in Quebec City in May of 1998.

**Public Participation GIS Workshop (PPGIS)**  
July 10-13, 1996  
Orono, Maine  
<http://ncgia.spatial.maine.edu/ppgis/ppgishom.html>

This workshop provided an opportunity for careful attention to issues which accompany the promotion of effective public participation in GIS and other instruments and methods of spatial analysis, within the general frameworks of I-17 and I-19. Topics included examination of the obstacles which accompany present technologies, cognitive aspects, and current public problem-solving and conflict resolution processes. The workshop's goal was to produce specific suggestions and strategies to aid in making these methods and technologies useful to a wider general public.

A pre-meeting was convened during the NCGIA Board Meeting (June 20, 1996), gathering several representatives of NCGIA research initiatives who would not be attending the PPGIS workshop. Notes of the pre-meeting were distributed prior to the workshop.

The workshop is documented in ten two-hour videotapes, available on loan from the NCGIA-Maine site. A key to the tapes has been prepared for help in evaluating sessions which may be of interest. This key also summarizes the main topics of discussion in each session.

**7th Annual International Conference of the Atlantic Institute**  
September 19-21, 1996  
Orono, Maine  
[http://www.spatial.maine.edu/atl\\_inst/conference.html](http://www.spatial.maine.edu/atl_inst/conference.html)

The Department of Spatial Information Science and Engineering and the NCGIA at the University of Maine hosted the 7th Annual International Conference of the Atlantic Institute, September 19-21, 1996. The Atlantic Institute is an educational organization dedicated to advancing knowledge in the spatial information sciences for the effective stewardship of the Earth's resources. Through exchange of ideas and information, the Institute promotes the development of techniques and tools for the efficient handling of geographically related data. Its principal goal is to promote closer ties among the geomatics and spatial information engineering programs of the University of Maine, the University of New Brunswick, Canada, and Laval University, Canada. Next year's meeting is planned for the University of New Brunswick.

**Science-On-Line Antarctica Workshop**  
September 23-26, 1996  
Tahoe City, CA

The Science-On-Line Antarctica Workshop served to introduce GIS as an analytical tool that could be used by researchers working on projects involving the Long-Term Ecological Research (LTER) site at the McMurdo Dry Valleys, Antarctica. Approximately 40 persons participated in the four-day conference. Hugh Calkins (NCGIA Buffalo) designed and led the presentations on GIS requirements analyses, and database design methods and techniques for an LTER-wide GIS. The workshop was sponsored by a National Science Foundation grant to the Desert Research Institute, with a subaward to Hugh Calkins, SUNY at Buffalo.

For further information, please contact Hugh W. Calkins, NCGIA, SUNY Buffalo. [calkins@geog.buffalo.edu](mailto:calkins@geog.buffalo.edu)

**Deploying ITS Map Database Interoperability Standards**  
December 3-4, 1996  
Santa Barbara, CA

The NCGIA held a two-day workshop, December 3-4, 1996, coordinated by Jonathan Gottsegen, regarding standards to encourage interoperability of map databases used in Intelligent Transportation Systems (ITS). The meeting was co-sponsored by NCGIA, Caltrans and Oak Ridge National Laboratory (ORNL). The focus of the meeting was to examine the issues, requirements, and problems inherent in regional deployment of national and international standards for interoperable map databases for Intelligent Transportation Systems (ITS), and more specifically in implementing two standards being developed by ORNL. The first, the Location Reference Message Specification (LRMS), is designed to standardize the format of messages being passed from a central system, such as a traffic management center (TMC), to in-vehicle navigation systems or other systems. The second, the ITS Datum, provides a network of standard control points or nodes with accurate locations to assist

*continued on page 16*

**Useful URLs**

NCGIA

<http://www.ncgia.org>

The Varenius Project

<http://www.ncgia.org/varenius>

Alexandria Digital Library Project (ADL)

<http://alexandria.sdc.ucsb.edu>

National Center for Ecological Analysis and Synthesis (NCEAS)

<http://www.nceas.ucsb.edu>

VITAL - Vehicle Intelligence Testing & Analysis Laboratory

<http://www.ncgia.org/vital>

NCGIA Core Curricula

<http://www.ncgia.org/giscc>

<http://www.ncgia.org/cctp>

GIS in Higher Education Symposium

<http://www.ncgia.org/gishe>

Workshop on Interoperating GIS

<http://www.ncgia.org/conf/interop97>



matching and interoperability of road databases.

The meeting was held at the Radisson Hotel in Santa Barbara. Participants attended from the private and public sectors as well as from several universities. The meeting began with presentations on the LRMS and the ITS Datum and from researchers working on issues related to map database interoperability. The presentations included talks on methods of modeling and evaluating database accuracy and modeling linear data. The second day of the meeting consisted of discussions on the institutional and technical issues related to implementing the proposed specifications from ORNL. The NCGIA is now involved in a project testing the effectiveness of the specifications (see VITAL in this issue).

### History of the Concepts of Space

April 18-19, 1997

SUNY at Buffalo, Buffalo, NY

Barry Smith (Philosophy/NCGIA, SUNY Buffalo) organized the two-day conference "History of the Concepts of Space", which was held at SUNY Buffalo, April 18-19, 1997. The purpose of the conference was to bring together philosophers, geographers and others working on space in order to explore the ways in which concepts of space have evolved since the first written evidence of spatial theories in the time of the Ancient Greeks. A special focus was

on the evolution of concepts of space in the 20th century as a result of developments in the GIS field (see Initiative 21 in this issue).

A number of papers were presented at the conference, including: Istvan Bodnar (Philosophy, Buffalo/Budapest) *Ancient Theories of Space*; Paul Cornish (Political Science, Buffalo) *St. Augustine's Critique of Empire: A Defense of Small Republics*; Barry Smith and Leonardo Zaibert (Philosophy, Buffalo) *The State as Work of Art: Theories of Space in Baroque Philosophy*; Timothy Engstrm (Philosophy, Rochester Institute of Technology); *Virtual Art and the History of Space*; David Zubin (Linguistics/Cognitive Science, Buffalo) *Space in Language and Child Development*; David Mark (Geography and NCGIA, Buffalo) *Geographic Space in Cognitive Science*; Max Egenhofer (Computer Science and NCGIA, Maine) *The History of Concepts of Space in Geographic Information Science*; Adrijana Car (Geoinformation, Vienna/Pittsburgh) *The History of Spatial Hierarchies*; Achille Varzi (Philosophy, Columbia) *Theories of Space in Formal Philosophy*; David Koepsell (Philosophy, Buffalo) *The Metaphysics of Cyberspace*.

Approximately 25 people attended. Tapes of the presentations and further information may be obtained from Eileen Macnamara, Department of Philosophy, SUNY at Buffalo, Buffalo, NY 14260. Phone: 716-645-2444; Fax: 716-645-6139, E-mail: eam@acsu.buffalo.edu

### Land Use Modeling Workshop

June 5-6, 1997

Sioux Falls, South Dakota

(co-sponsored by USGS and NCGIA)

The NCGIA acted as joint host and organizer for the Land Use Modeling Workshop, convened in Sioux Falls, South Dakota at the EROS Data Center June 5th and 6th, 1997. Organizers were Keith Clarke of NCGIA/UCSB and Len Gaydos, USGS. Funding for the workshop was provided by the USGS National Mapping Division, under Dr. Keith Clarke's Gialopolis project. Thirty-two attendees were brought together from academia and the US federal government, invited due to their experience and expertise with modeling changes in land use. Both ecological and environmental, on the one hand, and human and economic geographical perspectives were represented, with a focus on common methods, techniques and data requirements.

A selected set of attendees gave lectures on their work in the field, and many contributed statements of interest and papers for the meeting Web site which can be found in the "Meetings" section of NCGIA's web site.

Discussions centered on setting a national agenda for land use modeling, and summary statements were produced that represent a survey of the state of the art of land use modeling in the United States. Meeting summaries covered the state of the art of modeling, developments in modeling, comparative modeling, data issues and needs, model applications, policy, social and economic factors in modeling, and research needs. Also considered were future follow-ups on the meeting, including the publication of the proceedings and papers by NCGIA.

### Upcoming Events

#### First meeting of the Varenius Advisory Board

August 18-19, 1997

The Varenius Advisory Board will hold its initial meeting August 18-19, 1997, in Santa Barbara. The members of this newly appointed board are: Jerome A. Dobson (Oak Ridge National Laboratory), Michael Dobson (Rand McNally and Company), Ron Abler (AAG), Karen Siderelis (NC Office of State Planning), Andrew U. Frank (Technical Univ. of Vienna), Doug

### Santa Fe CD-ROM Available

(Proceedings of the Santa Fe conference, January 21-25, 1996)

For the 1996 Third International Conference/Workshop on Integrating GIS and Environmental Modeling, much use was made of the NCGIA's web site to distribute information prior to the conference, and to give broader access to the conference papers. Rather than an edited volume, therefore, the organizers decided that it would be appropriate to publish the proceedings in the form of a CD; this would also have the advantage of cutting the time between conference and publication significantly.

Like the Web site, the CD has been organized as a complete record of the conference, including program, the full text of papers, abstracts of posters and workshops, and the list of attendees. The papers are published as submitted, and have not been edited to conform to any

standard style.

Copies of the CD are available for \$20 from:

NCGIA Publications Office  
3510 Phelps Hall  
University of California  
Santa Barbara, CA 93106-4060 USA  
email: ncgiapub@ncgia.ucsb.edu  
phone: 805-893-8224  
FAX: 805-893-8617

Submit payment by check, money order or purchase order. No credit cards accepted. Make checks payable (in US dollars) drawn on a US bank to: U.C. Regents/NCGIA. If you are interested in ordering this CD through the web, click "Ordering Information" under our "NCGIA Products" section.

Richardson (GeoResearch), Jack Dangermond (ESRI), Judy M. Olson (Michigan State Univ), David DeWitt (Univ of Wisconsin), Lawrence A. Brown (Ohio State Univ), and Annette Krygiel (National Defense Univ).

The two-day meeting will be based at UCSB and the Upham Hotel in Santa Barbara. The agenda will include a welcome and introductions followed by a project overview presented by Michael Goodchild, presentations by the three panel chairs (Max Egenhofer, David M. Mark, and Eric Sheppard), tours of NCGIA and other research-related units at UCSB, and presentations by other key personnel, allowing ample time for the Advisory Board to convene into Executive Session.

**Geographic Information Systems and Political Districting: Social Groups, Representational Values, and Electoral Boundaries**

*October 24-26, 1997  
SUNY at Buffalo, Buffalo, NY*

The purpose of the NCGIA's conference on GIS and Political Districting is to bring together political scientists, philosophers, geographers, electoral cartographers and legal experts to discuss current controversies in the process of political redistricting. Recent advances in GIS have revolutionized the process of drawing district boundaries, and have opened new possibilities for both the achievement of representational goals and for potential abuse. The conference will be led by Munroe Eagles (Political Science/NCGIA, SUNY Buffalo) at SUNY Buffalo.

For further information, please contact: Munroe Eagles, NCGIA, SUNY Buffalo. eagles@acsu.buffalo.edu

**International Conference & Workshop on Interoperating Geographic Information Systems**

*Santa Barbara, California  
December 3-4 & 5-6, 1997*

The National Center for Geographic Information and Analysis and the Open GIS Consortium Inc. announce an International Conference on Interoperating Geographic Information Systems to be held in Santa Barbara December 3-4, 1997, and to be followed December 5-6 by an invitational Workshop. Topics to be addressed at the

conference include the current state of research in related disciplines concerning the technical, semantic, and organizational issues of GIS interoperation; case studies of GIS interoperation; theoretical frameworks for interoperation; and evaluations of alternative approaches. The program will include invited keynote presentations and contributed papers; limited space will also be available for posters, demonstrations, and exhibits.

See front cover for more details.

**Applied Ontology: A Marvin Farber Conference on Law and Institutions in Society**

*April 24-25, 1998  
SUNY at Buffalo*

Barry Smith (Philosophy/Cognitive Science/NCGIA, SUNY Buffalo) and David Koepsell (Cohen and Lombardo PC, Buffalo) will be directing a conference on the topic of applied ontology, with special reference to the law and social institutions. The event is scheduled to be held in Buffalo on April 24-25, 1998. Examples of areas which may be addressed at the conference include: what is ontology?; the ontology of laws, norms and rules; the ontology of speech acts; the ontology of international law, the ontology of land and real estate; the ontology of crime and punishment; the ontology of environmental law; the ontology of cyberspace and of intellectual property; the ontology of the human genome project.

Papers are invited, with a submission deadline of January 1, 1998. Further information is available from:

Farber Conference  
Department of Philosophy  
SUNY at Buffalo  
Buffalo, NY 14260  
Phone: 716-645-2444 ext. 707  
Fax: 716-645-6139  
ontology@acsu.buffalo.edu  
<http://wings.buffalo.edu/philosophy/farber>

**NCGIA Update**  
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NCGIA

Department of Geography

University of California

3510 Phelps Hall

Santa Barbara, CA 93106-4060

Tel (805) 893-8224

Fax (805) 893-8617

[ncgia@ncgia.ucsb.edu](mailto:ncgia@ncgia.ucsb.edu)

*Chair of the*

*Executive Committee:*

Michael F. Goodchild

*Editor:*

LaNell Lucius

*Design:*

Britt Andreatta

*Distribution:*

Abby Caschetta

Sandi Glendinning

*Printing:*

Alternative Printing and Imaging

Goleta, CA

Please submit material

for publication to:

LaNell Lucius (805) 893-8504

[lanell@ncgia.ucsb.edu](mailto:lanell@ncgia.ucsb.edu)

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# Publications

## Recent Technical Papers Published

- 95-1:** *Framework Data Sets for the NSDI*. Steven M. Frank, Harlan Onsrud, Jeffrey Pinto, U. Maine; and Michael Goodchild, UCSB.
- 95-2:** *Two Papers on Triangulated Surface Modeling*. Carlos Felgueiras, INPE, and Michael Goodchild, UCSB.
- 95-3:** *Multiple Roles for GIS in US Global Change Research: An Annotated Bibliography*. Compiled by Ashton Shortridge, UCSB.
- 95-4:** *A Comparison of Strategies for Data Storage Reduction in Location-Allocation Problems*. Paul A. Sorensen and Richard L. Church, UCSB.
- 95-5:** *Color Your World*. Compiled by Paul Sutton, Paul Van Zuyle, and Steve Palladino, UCSB.
- 95-6:** *The Global Demography Project*. Waldo Tobler, Uwe Deichmann, Jon Gottsegen, and Kelly Maloy, UCSB.
- 95-7:** *Formalizing Behavior of Geographic Feature Types*. Robert D. Rugg and Max J. Egenhofer, U. Maine, and Werner Kuhn, Tech. Univ. Vienna.
- 95-8:** *Naive Geography*. Max J. Egenhofer, U. Maine, and David M. Mark, SUNY-Buffalo.
- 95-9:** *Direction Relations and Two-Dimensional Range Queries: Optimization Techniques*. Theodoridis Yannis, Emmanuel Stefanakis, Timos Sellis, Technical National University of Athens; and Dimitris Papadias, U. Maine.
- 95-10:** *Research Initiative 15: Multiple Roles for GIS in US Global Change Research, Report of the First Specialist Meeting*. Michael Goodchild and John E. Estes, UCSB; Kate Beard, U. Maine; Tim Foresman, University of Maryland Baltimore County; and Jenny Robinson, SUNY-Buffalo.
- 95-11:** *Geographic Information/GIS Institutionalization in the 50 States: Users and Coordinators*. Lisa Warnecke, GeoManagement Associates, Syracuse, New York.
- 95-12:** *On Information Modeling to Support Interoperable Spatial Databases*. Nectaria Tryfona and Jayant Sharma, U. Maine.
- 95-13:** *Understanding Guidance on GIS Implementation: A Comprehensive Literature Review*. Roberto Ferrari and Harlan J. Onsrud, U. Maine.
- 95-14:** *Collaborative Spatial Decision-Making: Scientific Report for the Initiative 17 Specialist Meeting*. Paul J. Densham, U. College London, Marc P. Armstrong, U. Iowa, and Karen K. Kemp, UCSB.
- 95-15:** *NCGIA Research Initiative 8 Formalizing Cartographic Knowledge: Scientific Report for the Specialist Meeting*. Barbara Buttenfield, U. Colorado, and Catherine Dibble, UCSB.
- 96-1:** *Image Registration using Multi-quadric Functions, the Finite Element Method, Bivariate Mapping Polynomials and the Thin Plate Spline*. David N. Fogel, UCSB, and Larry R. Tinney, DOE Las Vegas.
- 96-2:** *Algorithms for Hierarchical Spatial Reasoning*. Dimitris Papadias and Max Egenhofer, U. Maine.
- 96-3:** *A Review of Spatial Population Database Design and Modeling*. Uwe Deichmann, UCSB.
- 96-4:** *Creation of a Comprehensive Managed Areas Spatial Database for the Conterminous United States (Summary Project Technical Report NASA-NAGW-1743)*. R. Gavin McGhie, UCSB.
- 96-5:** *Research Initiative 15: Multiple Roles for GIS in US Global Change Research, Report of the Second Specialist Meeting*. Michael Goodchild and John E. Estes, UCSB; Kate Beard, U. Maine; and Tim Foresman, University of Maryland Baltimore County.
- 96-6:** *Critical Issues in GIS-Based Educational Module Development: NCGIA's ArcView-based Color Your World Module*. Steve Palladino and Paul Van Zuyle, UCSB.
- 96-7:** *GIS and Society: The Social Implications of How People, Space, and Environment are Represented in GIS, Scientific Report for the Initiative 19 Specialist Meeting*. Compiled by Trevor Harris and Daniel Weiner, West Virginia University.
- 96-8:** *Spatial Theory for the Integration of Resolution-Limited Data (a thesis)*. Beat (Bud) P. Bruegger, dipl. Ing. ETH, Swiss Federal Institute of Technology, U. Maine.
- 96-9:** *Conference on Object Orientation and Navigable Databases: Report of the Meeting*. Richard Church, Thomas Cova and Michael Goodchild, UCSB; and Ramez Gerges, Caltrans.
- 96-10:** *Spatial Technologies, Geographic Information, and the City: a Research Conference Report*. Compiled by Helen Couclelis, UCSB.
- 96-11:** *Modeling Behavior of Geographic Objects: An Experience with the Object Modeling Technique*. Nectaria Tryfona and Dieter Pfoser, U. Maine, and Thanasis Hadzilacos, Univ of Patras, Greece.
- 96-12:** *GIS Laboratory Exercises: Introduction to GIS, 2nd edition*. Jeremy Taylor, Jane Fletcher and Karen Kemp, UCSB.
- 97-1:** *Multipurpose Land Information Systems Development Bibliography: A Community-wide Commitment to the Technology and its Ultimate Applications*. David L. Tulloch, Bernard J. Niemann, Jr., and Stephen J. Ventura, Univ of Wisconsin - Madison; and Earl F. Epstein, The Ohio State University.

## Recent books published by NCGIA Researchers

Aldenderfer, M. and H.D.G. Maschner, editors (1996) *Anthropology, Space and Geographic Information Systems*. New York: Oxford University Press.

Clarke, K. C. (1997) *Getting Started With Geographic Information Systems*. Upper Saddle River, NJ: Prentice Hall.

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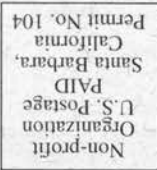
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The Maine NCGIA includes (l to r): First row — Kate Beard, Peggy Agouris; Second row — Blane Shaw, Nectaria Tryfona, Troy Jordan, Doug Flewelling, and Harlan Onsrud; Third row — Max Egenhofer, Tony Stefanidis.



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National Center for Geographic Information and Analysis  
Department of Geography  
University of California  
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spread adaptation to the handling of geographic information, has led to dramatic changes in the roles played by geographic information in society. Digital computers are picky—they prefer precise information that can be expressed in the form of numbers, or crisply delineated areas on maps, over information that is fuzzy, ambiguous, or vague. But much geographic information is just that. While GIS databases work with clean geometric lines, real features on the Earth's surface are often hard to define and delineate. In that sense, computers are filters of geographic information, and fitting advanced concepts like 'sense of place' into the harsh new world of copper and silicon is not always easy.

The three strategic areas of the project are fashioned around the roles played by the individual, the machine, and society, in this new world of digital geography. David Mark's panel on cognitive models of geographic space focuses on the individual, and how the human mind learns, communicates, and reasons about geographic surroundings. Max Egenhofer's panel focuses on the tensions that develop when this world encounters the digi-

tal, in its examination of computational implementations of geographic concepts. Eric Sheppard's panel on geographies of the information society looks at the implications for society as a whole, the impacts that digital geographic information technologies will have, and the longer-term social consequences of the digital transition. More information on each of these areas, including the full project proposal and other documents, can be accessed via the NCGIA web site.

In putting the research proposal together, we looked for research issues that were truly fundamental and forward-looking, and likely to influence technology as many as ten or even fifteen years ahead. The Varenus project is in many ways 'blue-sky' research. But the field of GIS moves so quickly that what may appear to be cutting-edge today can be old hat tomorrow—and the results of 'blue-sky' research done this year may show up in products as little as two years from now. So we make no apologies—we believe that forward-looking research is absolutely essential if the GIS industry, and particularly the US GIS industry, is to continue to evolve and compete effectively in world markets.

## The 'Apex' Meeting

The third strategic area, on geographies of the information society, is both the largest and the most difficult to define. So as the first Varenus meeting, we convened a multidisciplinary group of about 30 invited people in Santa Barbara, February 28-March 1 to map out the area in greater detail. The group helped us to identify nine high-priority research areas for the Varenus project, and the makeup of the panel that would oversee the area during the project's life. Full details of the meeting and the results can be found on the NCGIA web site.

## First Varenus Panel Meetings

Following the 'Apex' meeting, the members of the geographies of the information society panel were appointed, and Eric Sheppard (University of Minnesota) accepted an invitation to chair the panel. With the other two panels already in place, the first meetings of the three panels were held in Santa Barbara, May 2-4. The results will be presented to the upcoming meeting of the Varenus Advisory Board August 18-19. A full schedule of upcoming meetings will be announced shortly thereafter.