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Varenius Initiatives (1995-1999)

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Varenius—NCGIA's Project to Advance Geographic Information Science: 1997 Annual Report

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*Varenius:
NCGIA's Project to Advance
Geographic Information Science*

**VARENIUS: NCGIA'S PROJECT TO ADVANCE
GEOGRAPHIC INFORMATION SCIENCE
ANNUAL REPORT AND INCREMENT REQUEST,
DECEMBER 1997**

Summary

The National Center for Geographic Information and Analysis is funded through its University of California, Santa Barbara, site to carry out a new program of research and agenda-setting in the area of geographic information science. Funding is provided by the National Science Foundation under Cooperative Agreement SBR 96-00465. This report summarizes progress from the inception of the project, February 15, 1997, through the end of November 1997, a period of just over nine months, and is submitted in accordance with the requirements of the cooperative agreement. It requests the second increment of funding for the project, for the period 2/1/98 through 1/31/99.

The first section summarizes the progress made in setting up the project, recruiting members for the Strategic Area Panels, setting topics and dates for the Specialist Meetings, and initiating the Advisory Board.

The second section reports on activities of the National Center for the period 1/1/97 through 11/30/97, a period of transition between activities under the cooperative agreement which had funded NCGIA since its inception in 1988 (SBR 88-10917) and the Varenius project. The appendices to this section include reports of publications, visitors, courses taught, and degrees granted.

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ANNUAL REPORT FOR VARENIUS: NCGIA'S PROJECT TO ADVANCE GEOGRAPHIC INFORMATION SCIENCE

Introduction: the Varenius project

Geographic information science is an increasingly popular term for the complex set of issues and fundamental questions that arise in creating, storing, analyzing, displaying, and otherwise handling geographic information. Like most types of information, the handling of geographic information is rapidly undergoing a transition to a digital world of high interconnectivity, low cost, and new potential. The geographic information technologies—geographic information systems (GIS), Earth imaging systems, the Global Positioning System (GPS)—have experienced enormous popularity and growth in recent years, but their widespread use is stimulating a need for basic research. Geographic information science is a multidisciplinary field, bringing the expertise of geographers, cartographers, computer scientists, statisticians, cognitive scientists, and many others to bear on common and substantive problems. The level of interest in geographic information science is demonstrated by the recent establishment and growth of the University Consortium for Geographic Information Science (www.ucgis.org), a group of close to 50 universities with substantial multidisciplinary research activities in the field.

The Varenius project seeks to stimulate greater collaboration and focus among scientists interested in these issues, and to recruit others whose expertise may be relevant. The project is named for Bernhard Varenius, a 17th Century Dutch geographer and author of the *Geographia Generalis*, a work that had significant influence on early geographic thought and on the work of the Newtonians. Additional background information on the project will not be reviewed here, as it is available on the project's Web site www.ncgia.org.

The project is structured around three Strategic Areas, as follows:

Cognitive Models of Geographic Space

Theories and models of human spatial cognition have included both general and particular components. There seem to be some universals of human spatial cognition, and these appear to arise from the physics of human environments, from the nature of human bodies and senses, and especially from the ways people interact with and are influenced by their environments, both physical and social. But there are also many aspects of human spatial cognition that seem to vary across individuals. Some of these variations may be correlated with factors such as culture, language, or gender, while others may be truly individual differences. Of particular interest here is that GIS-using professionals from different fields may have systematic differences in their cognitive models for geographic phenomena and processes. Work on cognitive aspects of GIS user interfaces has emphasized spatial cognition by 'spatially aware professionals' who made up the bulk of the GIS user community in the early 1990s. However, as information systems come 'on line' to the general public through home Internet access and other means, we will need to know a great deal more about spatial cognition in general. Current geographic information systems are difficult to use without extensive education and training that is

generally unavailable to the public. Even academic researchers find it difficult to identify available training opportunities, or to fit them into their already full professional schedules. Making the technology truly easy and natural to use will empower new communities of users, thus increasing the value of the software and databases being built now and in the future by government and the private sector.

Computational Implementations of Geographic Concepts

Most current methods in geographic information science were designed from the perspectives of the computer scientist and the cartographer, aiming at efficiency in capture, storage, and processing of cartographic features. The state of the art in formalizations of geographic knowledge, as reflected in most current GISs, requires that certain constraints be fulfilled before a user is allowed to perform any analysis. They include:

- positions must be recorded in absolute terms in a Cartesian coordinate space;
- geographic objects must be described by precisely defined boundaries, and
- all geographic data sets must be complete.

Our goal is to overcome some of these and other limitations, and to find formal representations that come closer to human practice, capture more complex geographic concepts, and better match cognitive processes. Computational models based in sound theory promote interoperability between systems, another component of ease of use. Fundamentally, every digital representation of geographic space and concepts requires that knowledge be expressed in an alphabet of two characters, 0 and 1. To date, geographic information technologies have done much better at representing simple, mathematically-based concepts, such as distance or direction, than more qualitative and more complex concepts such as sense of place, opinion, or vague classification. Given the objectives expressed above, we need to know whether the transition to a digital world fundamentally filters our ability to understand the world around us, and communicate that understanding to others.

Geographies of the Information Society

The third strategic area for NCGIA research is the emerging geographies of the information society where our proposed basic research will identify positive and negative impacts of technology on individuals, organizations, and society, and examine the new geographic structures of the information age. The widespread development and adoption of the geographic information technologies is occurring simultaneously, and many debates about geographic information mirror broader debates about information generally, particularly in areas such as ownership of data and invasion of privacy. New, more efficient techniques are emerging for collecting and processing spatial data and for communicating geographic knowledge from the field to the consumer, all driven by the changing economics of information creation, dissemination, and use. The use of geographic information technologies is providing to users substantial economic, legal, and political advantages. The world of the National Spatial Data Infrastructure (NSDI), in which everyone can be a producer as well as a consumer, will be very different from the one we are used to, with its linear flow of data from producing agency to consuming public. It will require research to develop measures of fitness for use, based on metrics

that take producers' descriptions of data available, and consumers' descriptions of data required, as operands. More profoundly, however, it raises fundamental questions about how information is described between one person and another, and about the processes by which semantic meaning is communicated.

The Varenus project will sponsor a series of Specialist Meetings at which topics under these three broad Strategic Areas will be discussed, and developed into concrete research agendas. Although the project does not include funding to carry out the research, a program of small Seed Grants will be used to further stimulate activity, particularly through the development of proposals for major funding. The project also includes funding for a program of Visiting Scholars.

Establishing the project structure

During the first nine months the various components of the project structure were put in place. These included appointing the three Panels who are responsible for overseeing activities in the three Strategic Areas, appointing an Advisory Board, beginning the work of these groups and the Executive Committee, and establishing topics and timetables for the Specialist Meetings.

Executive Committee

The Executive Committee includes the Director (Michael Goodchild, UC Santa Barbara, project PI); the Assistant Director (Karen Kemp, UC Santa Barbara); the three Panel Chairs (David Mark, SUNY Buffalo, Chair of the Panel on Cognitive Models of Geographic Space; Max Egenhofer, University of Maine, Chair of the Panel on Computational Implementations of Geographic Concepts; and Eric Sheppard, University of Minnesota, Chair of the Panel on Geographies of the Information Society); and one member of the Advisory Board (Karen Siderelis, State of North Carolina).

The Executive Committee meets monthly, mostly by conference call. It oversees all day-to-day activities of the project. The committee began meeting at the start of the project; Eric Sheppard joined in March when his appointment as Panel Chair was confirmed by NSF, and Karen Siderelis joined in August following her appointment by the Board, and its approval by NSF.

Advisory Board

The Advisory Board oversees all aspects of the project. It will normally meet in February/March, but held its 1997 inaugural meeting August 18–19, in Santa Barbara. The membership of the Board is as follows:

Ronald F. Abler, Executive Director, Association of American Geographers, Washington, DC (co-chair)

Annette Krygiel, National Defense University, Washington, DC (co-chair)

Lawrence A. Brown, Department of Geography, The Ohio State University, Columbus, OH

Jack Dangermond, Environmental Systems Research Institute, Redlands, CA

David J. DeWitt, Department of Computer Science, University of Wisconsin, Madison,

WI

Jerome E. Dobson, Oak Ridge National Laboratory, Oak Ridge, TN; President,
University Consortium for Geographic Information Science (ex-officio)

Michael W. Dobson, Rand McNally and Company, Skokie, IL

Andrew U. Frank, Department of Geoinformation, Technical University Wien, Vienna,
Austria

Judy M. Olson, Department of Geography, Michigan State University, East Lansing, MI

Douglas Richardson, GeoResearch, Inc., Bethesda, MD

Karen C. Siderelis, Office of State Planning, Raleigh, NC

The minutes of the Advisory Board's meeting are included as Appendix 1.

Strategic Area Panels

Within the Varenius project structure, each Strategic Area is overseen by a Panel, consisting of a Chair and four to six members, drawn from the international ranks of the most productive and best-known scholars in the field. Appointments to the Panels were made in February and March. The Panels held their first meetings May 2–4 in Santa Barbara; full reports of these meetings and subsequent activities are included in this report.

Seed Grants

The Varenius project will offer small grants in order to stimulate proposal-generation and research immediately following each Specialist Meeting. Funds amounting to approximately \$15,000 will be available to cover travel, hiring of assistance, and other costs. The program will be given its first test in connection with the first Specialist Meeting, due to be held in Santa Barbara December 5–6. Guidelines for the Seed Grants program have been submitted to NSF, revised following advice, and are awaiting approval. The draft guidelines are included as Appendix 2 of this section.

Specialist Meetings

As noted earlier, the main activity of the project in the coming months will center on the Specialist Meetings, of which nine are currently planned (see the Panel reports below for the status of these plans). General guidelines to aid in planning Specialist Meetings have been developed, and are available via the Varenius web site at www.ncgia.org.

Visiting Scholars

The project includes funding for a program of Visiting Scholars. 1997 was a transition year from the previous NCGIA Visiting Scholar program, to the new Varenius structure which is expected to be in full operation following the first Specialist Meeting in December. This report includes a full report on the Visiting Scholars accommodated by NCGIA during the period 1/1/97–11/30/97.

PANEL REPORT: COGNITIVE MODELS OF GEOGRAPHIC SPACE

Panel chair and members

David M. Mark, Geography, State University of New York at Buffalo, Chair
Christian Freksa, Artificial Intelligence, University of Hamburg, Germany
Stephen Hirtle, Information Science, University of Pittsburgh
Robert Lloyd, Geography, University of South Carolina
Barbara Tversky, Psychology, Stanford University

1. Summary of the goals of Varenius in this area as abstracted from the NCGIA NSF proposal (October 1995):

Knowledge about how people think about geographic space is fundamental to many of our activities. Geographic databases are built so that they can be used by people, and their utility depends on their content making sense to their users. To make this more likely, we must know how members of the expected user community conceptualize the phenomena being represented in the database, whether they are using an information system or not. Sound cognitive models are perhaps even more important at the level of the human-computer interface. In a sense, the interface is all the end users ever see of the system, and if the interface does not match human intuition, the system and the database are difficult to use, or even useless.

Spatial and geographic cognition are fundamental to the advancement of geographic information science. For this reason, “Cognitive Models of Geographic Space” was identified as one of the three Strategic Research Areas under the Varenius project.

2. Non-Varenius events related to Cognitive Models of Geographic Space, since October 1995

The following sections identify events that have taken place since the writing of the Varenius proposal in October 1995, and that represent significant developments in the domain of the Panel.

Specialist meeting of NCGIA Initiative 21, October 1996

(www.geog.buffalo.edu/ncgia/i21/)

Initiative 21, “Formal Models of Commonsense Geographic Worlds”, held its Specialist Meeting in San Marcos, Texas, October 30–November 3, 1996. A report on the meeting has been published as NCGIA Technical Report 97-2, and is on the web, linked to the above Web page.

Other important events:

The major international event in geographic cognition and cognitive geography is now the series entitled “Conference on Spatial Information Theory” (COSIT). The third COSIT meeting was held at Laurel Highlands resort in western Pennsylvania in October

1997. The COSIT program is available on the Web at www.lis.pitt.edu/~cosit97. Four of the five members of the Varenius cognitive panel attended the meeting, as well as several Varenius initiative leaders. COSIT'97 had an excellent set of papers, and although attendance was lower than at the two previous European COSITs, the conference still drew many of the most important international figures in this research area. The COSIT'99 will be organized by Varenius cognitive panel member Christian Freksa, and will be held near Hamburg, Germany.

3. Progress within Varenius

Panel meeting, May 1997

The panel met in Santa Barbara, May 2–3, 1997. All panel members attended, and we had very constructive discussions of the overall goals of the Varenius project in general, and the cognitive models area in particular. The topic “Formal Concepts of Geographic Detail” had already been described in proposals and addenda to NSF, and thus the role of the cognitive panel was to confirm that it would be conducted. The panel confirmed that this is an important and high priority topic for a Varenius project research initiative.

The panel then turned to topics for two new initiatives, and developed the following list of topics worthy of consideration. In alphabetical order, these are:

- Categories of geographic entities
- Cognition of dynamic representations
- Cognitive agents for GIS
- Graphic displays and diagrammatic reasoning
- Multiple modes and frames of reference
- Navigation in virtual and real spaces
- Role of experience in the ability to use displays
- Semantics and structure of geographic space

After considerable discussion, “Multiple Modes and Frames of Reference” and “Cognition of Dynamic Representations” emerged as the two topics of highest priority, to join “Formal Concepts of Geographic Detail” on the list of initiatives to be conducted in the cognitive area under the Varenius project. Of the others, “Categories of Geographic Entities” also was viewed as a high priority for research, but in that case, it was felt that the topic would not benefit from a specialist meeting as much as the others, since research methodologies for determining category structures already are well established.

Formulation of proposed initiatives, and presentation to Advisory Board, August 1997

The following three initiatives were presented to the Advisory Board:

Scale and Detail in the Cognition of Geographic Information

Co-leaders - Reg Golledge and Dan Montello

Specialist Meeting - May 14-16 1998, Santa Barbara

Cognitive Models of Dynamic Geographic Phenomena and Representations

Co-leaders - Stephen Hirtle and Alan MacEachern
Specialist Meeting - October 1998, western Pennsylvania

Multiple Input Modes and Multiple Frames of Reference for Spatial Knowledge

Co-leaders - Scott Freundschuh and Holly Taylor
Specialist Meeting - January 1999, Santa Barbara

Details on these three initiatives are presented in the following sections.

SCALE AND DETAIL IN THE COGNITION OF GEOGRAPHIC INFORMATION

LEADERS: Reginald Golledge and Daniel Montello, Geography, UC Santa Barbara

Core planning group:

Christian Freksa, Department of Computer Science, Doctoral Program in
Cognitive Science, University of Hamburg

Michael F. Goodchild, Department of Geography, UC Santa Barbara

Timothy P. McNamara, Department of Psychology, Vanderbilt University

Stan Openshaw, School of Geography, University of Leeds

M. Jeanne Sholl, Department of Psychology, Boston College

Timeframe: May 14-16, 1998

Location: Santa Barbara, CA

Scale is one of the most fundamental yet poorly understood and confusing concepts underlying research involving geographic information. The term has multiple referents, including absolute size, relative size, resolution, granularity, and detail. This initiative focuses on explicating the multiple referents of scale and determining their consequences for thinking and decision-making involving geographic information. An emphasis will be placed on cognitive aspects of the scale problem as a complement to the traditional geographic and cartographic emphasis on scale in external representations. Basic questions to be pursued include: How do laypersons and experts conceptualize scale and scale-related phenomena, particularly given the multiple partially-related referents of the term? Do various geographic structures and processes come into existence at particular scales, and if so, how is this understood by users and consumers of geographic information? In what ways do laypersons and experts believe that phenomena are scale-independent or scale-dependent? What role does scale play in traditional arguments about form versus process? What are the difficulties inherent in communicating issues of scale, and what are more or less effective ways of accurately representing information about scale? Geographic information systems currently allow representing phenomena at multiple scales, and innovations in scale representation are constantly being developed. However, system developers do not pay much attention to issues of how scale communication impedes or facilitates valid communication of geographic phenomena; in particular, there is very little systematic research available to guide the development of

such systems. As society makes the transition to the digital environment, associated metaphors for scale and scale transitions are likely to change as well. Map scale or representative fraction, the metric for scale in the traditional cartographic world, has no well-defined meaning in a digital world of seamless perspectives in which the user is free to zoom in or out at will. Can we identify the fundamental, invariant aspects of the concept of scale that survive the transition to the digital world? Can we identify their mappings to the concepts and metaphors currently used in naive and expert geography?

Central Research Issues:

1. Difficulty of comprehending scale translations on maps and other representations.
 - single static view, multiple views (zooming in or out).
 - temporal scale in animations.
 - can Virtual Environments help overcome scale translation problems?
2. Psychological scale classes:
 - what is the evidence for their existence/nonexistence?
 - what is the role of orientation-specificity/flexibility?
 - are they related to a perceptual-cognitive shift?
 - are there specific cognitive processes linked to specific scale classes?
 - does knowledge precision vary with scale classes?
 - what are the implications of such scale classes for the use and interpretation of geographic information?
3. Variations in spatial language as a function of the scale class of geographic phenomena.
4. Effective maximization of presented detail in geographic representations.
5. Basic conceptual structure of scale, size, resolution, and detail as a function of user expertise.
 - how strongly are they correlated? may they be completely independent?
 - do the distinctions exist in a digital environment?
6. How does scale comprehension work in different sensory modalities?
7. Is knowledge derived at multiple scales combined or integrated, and if so, how?
8. Spatial knowledge from CRT vs. desktop VE vs. immersive VE.
9. Pattern extraction as a function of scale.
10. What is the relationship between scale and mental imagery?
11. Are there differences in the implications of scale of length, scale of width, and scale of height with respect to scene processing?

Proposals to participate in the workshop must be received by 20 January 1998 to ensure consideration. Information and updates about this meeting will be available on the World

Wide Web at www.ncgia.ucsb.edu/varenius/scale/.

COGNITIVE MODELS OF DYNAMIC PHENOMENA AND THEIR REPRESENTATIONS

LEADERS: Stephen Hirtle, Information Science, University of Pittsburgh; Alan MacEachren, Geography, Pennsylvania State University

Timeframe: October 1998

Location: Western Pennsylvania

The ability to manipulate, interpret, and store information about changing environments is a critical skill for human survival, and also is very important for geographic information science. Models of the cognitive aspects of dynamic spatial representations are necessary for understanding temporal and spatial changes in spaces or maps, for the manipulation of temporal geographic data, and for navigation through changing environments. Furthermore, the use of representational information may be dependent on the context of the problem, with different entity types resulting in the adoption of different spatial metaphors for reasoning and understanding. For example, land use change might be viewed as a series of changes in attributes of fixed locations, whereas an advancing forest fire may be thought of as a moving entity of changing shape and size. At a different temporal scale, the former process, involving no real motion, might be talked about, or reasoned about, as the 'spread' or 'sprawl' of development. Some other examples of dynamic geographic processes include navigation through changed environments, diffusion of diseases, and much slower processes such as glaciations, or continental drift and plate tectonics.

At a database level, we are concerned with issues such as forming discrete representations of continuous phenomena or continuous representations of discrete phenomena. Cartographically, the emphasis is on animation, but many methods have been used to show temporal phenomena in static maps. The use of dynamic and manipulable interfaces also must be investigated within the same conceptual framework used for observing dynamic phenomena in the real world.

This initiative takes a dual and parallel look at dynamic phenomena in geographic space itself, and at their representations in dynamic displays of geographic information. If research finds that there are systematic differences in human cognitive responses to various kinds of change and motion in geographic space, then different representations may be appropriate for the different situations. If different kinds of computer displays also trigger different kinds of human memory, reasoning, or decision-making, then the match between cognitive models for the phenomenon being represented and those for the display methods will influence how intuitive and usable the display will be.

MULTIPLE INPUT MODES AND MULTIPLE FRAMES OF REFERENCE FOR SPATIAL KNOWLEDGE

LEADERS: Scott Freundschuh, Geography, University of Minnesota, Duluth; Holly Taylor*, Psychology, Tufts University

Timeframe: January 1999

Location: Santa Barbara, CA

Space can be experienced directly, through vision, hearing, touch, and other modalities, as well as indirectly, primarily through language. Space can be viewed from many different perspectives, and conceived of from perspectives that have not or cannot be viewed. How do people interact with multiple modalities and multiple frames of reference? How do they integrate and reconcile the varied information, if and when they do? What are the relative advantages and disadvantages of each kind or source of spatial information? These are issues that have arisen in linguistics, philosophy, computer science, anthropology, and psychology, as well as in geography, in theoretical as well as in applied contexts. However, there are many open questions, especially with respect to human behavior and learning in natural situations. Understanding how people combine or juggle information from a variety of sources in a variety of forms is important to geographic information science and GIS in at least two ways. First, it is important in deciding how to provide additional information to system users, dependent in part upon what they already know. Second, the ways in which people represent and combine geographic information may help in the design of computerized systems to do the same thing.

Some specific topics serve as examples:

- relative, intrinsic, and absolute reference frames for describing locations
- heads-up and north-up maps in navigation systems
- mixing gaze, route, and survey perspectives in descriptions
- tactile, auditory, visual localization
- orientation-free vs. orientation-specific representations
- expressing differing modalities or frames through language
- cross-cultural differences in the use of reference frames.

Progress since August:

Since August, we have confirmed all Co-Leaders for the initiatives, and have exact or approximate dates and places for all three Specialist Meetings. The core planning group for 'Scale' has been appointed, and such groups are being formed for the other Initiatives. Core planning groups, sites, and dates for the other two Cognitive initiatives will be firm by February 1998.

**4. Assessment of research progress within and outside Varenius
pertinent to Cognitive Models of Geographic Space, relative to the
research agenda as set out in the NCGIA NSF proposal of October
1995**

Between now and February, members of the Cognitive Models of Geographic Space panel will be assessing progress in the area according to the following criteria:

- Which topics in the proposal are showing progress, and in which direction?
- Which new topics are emerging?
- Which topics in the proposal are not showing progress, and what do we, as Panel members delegated to review progress in the field, think about that?

We also plan to prepare a review paper on progress in the topic during the 1990s.

PANEL REPORT: COMPUTATIONAL IMPLEMENTATIONS OF GEOGRAPHIC CONCEPTS

Panel chair and members

Max Egenhofer, University of Maine (Chair)
Oliver Guenther, Humboldt University, Berlin
John Herring, Oracle Corporation
Ben Kuipers, University of Texas at Austin
Donna Peuquet, Pennsylvania State University

1. Summary of the goals of Varenius in this area as abstracted from the NCGIA NSF proposal (October 1995):

The term *Computational Implementations* is understood here in a broad sense, ranging from formalizations of geographic concepts to considerations about the development of effective software systems. Effectiveness includes the improved communication between users and systems, the availability of innovative GIS technologies tailored to the users' tasks, and the integration and interoperation of system components to best serve the analysis of novice users. Most current methods in geographic information science were designed from the perspectives of the computer scientist and the cartographer, aiming at efficiency in capture, storage, and processing of cartographic features. The state of the art in formalizations of geographic knowledge, as reflected in most current GISs, requires that certain constraints be fulfilled before a user is allowed to perform any analysis. They include that positions must be recorded in absolute terms in a Cartesian coordinate space, geographic objects must be described by precisely defined boundaries, and all geographic data sets must be complete. Our goal is to overcome some of these and other limitations, and to find formal representations that come closer to human practice, capture more complex geographic concepts, and better match cognitive processes.

2. Non-Varenius events related to Computational Implementations of Geographic Concepts, since October 1995

Fifth International Symposium on Large Spatial Databases

This bi-annual conference has become the most significant international meeting with respect to computational implementations. The fifth meeting of this series was held in July 1997 in Berlin with approximately 100 international participants. From among over 50 submissions of full papers, 19 were selected for the program. Three of the five panelists served on the program committee. The major topics included Spatial Similarities, Spatial Constraint Databases, Spatial Query Processing, Spatial Data Models, and Spatial Access Methods. SSD '99 will be held in Hong Kong. Since this year, the area of computational implementations has its own journal with the publication of *GeoInformatica* (Kluwer). The Panel Chair is a co-editor and two other panelists and the project Director are members of the editorial board.

3. Progress within Varenius

Within the realm of Computational Implementations, the Panel endorsed three initiatives, which will hold their specialist meetings between December 1997 and February 1999: Interoperating Geographic Information Systems, The Ontology of Fields, and Discovering Geographic Knowledge in Data-Rich Environments. Three of the five Panel members attended the Panel's meeting in Santa Barbara, May 2–3, 1997. Over the year, several *ad hoc* meetings with panel members were arranged at various conferences. At this point in time, the initiative on Interoperating Geographic Information Systems is close to its Specialist Meeting; the initiative on the Ontology of Fields is close to finalizing the core planning group and the call for participation; and we are actively recruiting the leaders for the initiative on Discovering Geographic Knowledge in Data-Rich Environments.

INTEROPERATING GEOGRAPHIC INFORMATION SYSTEMS

LEADERS: Mike Goodchild (UC Santa Barbara), Max Egenhofer (University of Maine), Robin Fegeas (USGS)

Core planning group:

Dave Abel (CSIRO)
John Herring (Oracle Corp.)
Cliff Kottman, Open GIS Consortium
Werner Kuhn (University of Muenster)
Richard Muntz (UC Los Angeles)
Terry Smith (UC Santa Barbara)
Agnès Voisard (Free University Berlin)

Timeframe: December 5–6, 1997

Location: Santa Barbara, CA

Interoperability offers one possible way of making GIS more useful and accessible to scientific research by making interactions between users and GISs easier and obviating the need for complex techniques to overcome incompatibilities between software systems and data sets. While much attention has been devoted to the question of GIS interoperability in recent years, less attention has been paid to the theoretical and methodologically sound basis for a new generation of component-based interoperating processes. Research topics under this initiative will include:

- Definition and investigation of alternative GIS architectures that would allow for open, distributed access to geographic information.
- Development of new methods (in addition to data exchange standards and current metadata approaches) that will better capture the semantic and cultural/linguistic particularities of geographic information in order to publish, share, and integrate geographic data.

- Design of abstract, high-level spatial data models and process models suitable for a wide range of application domains.
- Modeling the process of search for geographic data and geographic processes and defining metrics for assessing fitness for use.
- Investigation of fundamental granularities of geographic data.
- Development of benchmarks for current systems with respect to usability and level of semantic gaps.
- Examination of how an open GIS architecture will change the use of GISs.

This initiative's specialist meeting is coupled with the International Conference on Interoperating Geographic Information Systems (Interop '97), a 2-day meeting with four invited papers and 49 papers selected in response to a call-for-papers. The conference program is attached as Appendix 3. Proceedings are planned to be published after the conference in the form of an edited book. Negotiations with publishers are under way.

THE ONTOLOGY OF FIELDS

LEADERS: Donna Peuquet (Pennsylvania State University), Barry Smith (SUNY Buffalo)

Tentative core planning group: Kate Beard (University of Maine)
 Peter Burrough (University of Utrecht)
 Keith Clarke (UC Santa Barbara)
 Helen Couclelis (UC Santa Barbara)
 Noel Cressie (University of Iowa)
 Mike Hutchinson (ANU)
 Helena Mitsova (University of Illinois)
 Alan Saalfeld (Ohio State University)

Timeframe: June 10–13, 1998

Location: Coast of Maine

While much attention has been devoted to understanding the ways people conceptualize geographic phenomena as discrete objects, the alternative conceptualization as spatially continuous fields has received much less attention from a cognitive perspective. Fields are widely used as a scientific concept, particularly in mathematical physics, and many geographically distributed variables (e.g., elevation and temperature) are conceptualized as single-valued functions of location. In everyday discourse, however, we have a comparative paucity of terms to describe continuous variation, and appear to favor descriptions that replace fields with discrete objects (peaks, valleys, fronts). Computer representations similarly favor discrete objects, and force spatially continuous fields to be discretized. Is human cognition indeed less accommodating to field concepts? What are the functional interrelationships between object and field types of representations in human cognition? How can field representations be accommodated within contemporary paradigms of computing? How can the cognitive interrelationships be operationalized?

What methods can be devised to measure the effects of discretization? What options exist for representing uncertainty in fields, and are they meaningful from a cognitive perspective? To address these questions, input from the disciplinary communities of GIS, Philosophy, Mathematics, Cognitive and Developmental Psychology, Image Interpretation and Image Understanding, Spatial Statistics and example geographic domains (e.g., Climatology, Soils Science, Urban Geography) must participate and interact. Some specific topics include:

- cognitive dimensions of interpolation
- mapping cognitive categorizations into discrete computer representations
- relating representations of the mathematical modeling communities in various domains to cognitive categorizations
- measuring or representing inexactness
- specific vs. survey views of geographic space
- interrelationships between representation and the learning process

DISCOVERING GEOGRAPHIC KNOWLEDGE IN DATA-RICH ENVIRONMENTS

LEADERS: tba (from image processing, spatial statistics, spatial database systems, or digital libraries communities)

Core planning group: Peggy Agouris (University of Maine)
Art Getis (San Diego State University)
Oliver Guenther (Humboldt University Berlin)
Jiawei Han (Simon Fraser University)
Stephen Hirtle (University of Pittsburgh)
Yannis Ionnides (University of Wisconsin)
Ramesh Jain (University of California, San Diego)
Alan MacEachran (Pennsylvania State University)
Richard Muntz (UCLA)
Frank Olken (Lawrence Berkeley Lab)
Jayant Sharma (Oracle Corp.)

Timeframe: November 1998 or February 1999
Location: Santa Barbara, CA

Digital geographic datasets are growing exponentially and under such activities as the development of the National Spatial Data Infrastructure, the launching of new satellite systems with higher resolutions, and the day-to-day collection of digital imagery, video, and sound. Society has changed from being data-poor to data-rich, while our techniques for deriving knowledge from the data in an analytical context have remained inferential in nature. The problem has now become not finding the data, but filtering through large volumes of data to finding meaningful geographic knowledge. At the same time, the

types of datasets available are changing from the traditional vector and raster sets, to include such data types as video and audio, and the location of where these data were collected. We must overcome these limitations and develop new approaches and methods that focus upon separating the relevant from the irrelevant, the meaningful from the background noise. The goal of this initiative is to find new automated methods for filtering large amounts of raw geographic data into more user-consumable forms of knowledge. This includes:

- spatial data mining
- content-based and knowledge-based retrieval
- development of multi-media spatial data types
- on-line analytic processing
- refinement of non-parametric statistics

4. Assessment of research progress within and outside Varenius pertinent to Computational Implementations of Geographic Concepts, relative to the research agendas as set out in the NCGIA NSF proposal of October 1995:

Over the last two years, the area of computational implementations has gotten significant attention in GIS research and development, both within the academic research community as well as with industry. Probably the most significant changes are currently influenced by the formulation and implementation of the Interoperability Specifications of the Open GIS Consortium (<http://www.opengis.org>). The Varenius initiative on “Interoperating Geographic Information Systems” with the International Conference and the Specialist Meeting (both to be held in December 1997) will provide a complementary focus for activities that occur in relation to OGC's efforts.

In a similar vein, the development of the ISO Standard on Geographic Information/Geomatics (TC 211) has been moving forward, with many of its over 20 parts close to committee draft. Two members of this Varenius panel (Egenhofer and Herring) have been involved in the ISO work.

The GIS industry has seen a boost of support with new supporting products at the backend of GISs (mostly for data management) and many desktop products tailored to particular data processing tasks. The supporting products include the Spatial Data Engine from ESRI, the Spatial Data Option from Oracle, and Spatial Data Blades from Informix. This trend is significant as it gets additional new players such as Oracle and Informix into the broader field of GIS. Many of the desktop products come from small software companies.

We continue to observe a trend in the formalization of spatial concepts that are cognitively plausible. There have been several workshops with the goal to bring together formalists and cognitive scientists to develop research agendas (NCGIA's I-21, COSIT '97, AAAI workshops '96 and '97). These activities reflect the interests in computational implementations as they often provide the stimulating momentum for new approaches to research. The symbiosis at this time includes formal-methods people in GIS, cognitively-

oriented geographers, psychologists, and researchers from Artificial Intelligence.

PANEL REPORT: GEOGRAPHIES OF THE INFORMATION SOCIETY

Panel chair and members

Eric Sheppard, Geography, University of Minnesota, Chair
Helen Couclelis, Geography, University of California, Santa Barbara
John Goddard, Geography, University of Newcastle upon Tyne, UK
J.W. Harrington, Geography, University of Washington
Harlan Onsrud, Spatial Information Science and Engineering, University of
Maine

1. Summary of the goals of Varenus in this area as abstracted from the NCGIA NSF proposal (October 1995):

“The many debates about geographic information mirror broader debates about information generally, particularly in areas such as ownership of data and invasion of privacy. We...address the question of whether the geographic context is distinct and unique, and focus as far as possible on topics where the answer is at least in part affirmative. The information society is different from traditional societies, and particularly in its geographic organization. The ability to communicate with few geographic, economic, physical, or other resource constraints empowers the individual, facilitates the emergence of new invisible communities of interest, and undermines traditional sources of power...Geographic information has been produced for decades by a combination of the military, other government agencies, and the private sector. With the end of the cold war and the shrinking of government, the traditional roles of producer, distributor, and consumer must change...Increased emphasis on infrastructure, standards, and geographic data sharing in distributed networks is likely.

The use of geographic information technologies is providing to users substantial economic advantages, legal advantages, and political advantages. Possession of geographic information has also contributed to military power and even to U.S. western expansion and the political power of the colonizer. *We need to reflect on the potential significance of technological and institutional changes to the widening or lessening of social and economic gaps in society.*

...The world of NSDI, in which everyone can be a producer as well as a consumer, will be very different from the one we are used to, with its linear flow of data from producing agency to consuming public...*It raises fundamental questions about how information is described between one person and another, and about the processes by which semantic meaning is communicated...*

The ways in which we organize space, and construct communities and geographies, are profoundly influenced by changes in communication technology...Geographic proximity to traditional resources becomes much less of an issue in locating a site or forming a community...Analogies to geographic location must emerge on the net, if only in the minds of its users. How will people conceptualize or spatialize a geography-less net?

How significant is the trend to geographically-based Internet addresses (e.g., .us rather than .edu)? What language will emerge to describe virtual location? Will the net provide a unique laboratory for studying human concepts of space removed from geography and traditional distance-based impediments to interaction?

While the amount of digital spatial data collected at the local government level is dramatically increasing, much of it is not entering the public domain...Is diminution of the spatial information 'commons' detrimental or advantageous to the long term economic well-being of the nation? Are small innovative businesses harmed or helped in comparison to large businesses by the practice? Is the trend toward imposition of intellectual property rights in government spatial data detrimental or beneficial to the scientific and teaching communities and to what extent? What are the ramifications in lessening of the 'commons' for the sharing of scientific and technical information generally? What are the consequences relative to citizen oversight of government decision making?"

2. Non-Varenus events related to Geographies of the Information Society, since October 1995

Several significant events have occurred in the domain of interest of the Panel since the Varenus proposal was written in October 1995.

Specialist meeting of NCGIA Initiative 19, March 1996 (<http://www.geo.wvu.edu/i19/>)
Of all of the research initiatives undertaken by NCGIA since 1988, Research Initiative 19 bears the strongest similarity to the panel's strategic area. Commonly referred to as the GIS and Society initiative, its full title is "The Social Implications of How People, Space, and Environment are Represented in GIS". The Initiative 19 Specialist Meeting, held in Minnesota in early March 1996, identified several key directions for research:

- GIS, social practice and intellectual history
- Environmental justice and political ecology
- GIS in the community: local knowledge and multiple realities
- Public participation GIS (PPGIS)
- Data access, privacy and geodemographics
- Gender and GIS
- GI(S) and the human dimensions of global environmental change.

The full report of the meeting has been published in the NCGIA Technical Reports series (96-7).

Several research directions have been pursued within this agenda since the specialist meeting. They are described in detail in the I19 section of this report, and are summarized here because of their influence on the discussions of the panel:

- Environmental justice and political ecology: One workshop on GIS and risk assessment (10/97); EPA grant submitted (not funded but invited to resubmit); research underway at Minnesota, West Virginia, South Carolina; collaborative

- relations constructed with other researchers; special sessions at AAG, GIS/LIS, and Society for Risk Assessment; Special issue of *CAGIS*: 'GIS and environmental risk assessment' (24(3): 123–189, November 1997).
- GIS, social practice and intellectual history: Two workshops (9/96; 11/97); special sessions at two GIS conferences; one NSF proposal submitted (not funded); research underway on the development of TIGER system in the census and origins of TINs.
 - GIS in the community: local knowledge and multiple realities. Ongoing research in South Africa, Minneapolis, and in relation to PPGIS.
 - Public participation GIS (see below)

Initiative 19 represents in many ways a model for the Varenus initiatives. It was proposed and developed by leaders outside the NCGIA scientists, and had limited core funding for research subsequent to the specialist meeting. Yet it has been quite successful in catalyzing individual and collaborative research, particularly within the first, second, and fourth themes, including major requests for external funding, special sessions, special issues, and workshops. The format used in this meeting, and other factors that may have contributed to the apparent success of it as a catalyst in some areas, and not in others, may be worthy of examination as NCGIA seeks to develop a model for the Varenus initiatives.

Spatial technologies, geographic information and the city

In September 1996 an NCGIA-sponsored research conference on "Spatial Technologies, Geographic Information, and the City" took place in Baltimore, MD. The conference, organized on the model of a specialist meeting, brought together 30 scholars working on different aspects of urban modeling and analysis, geographic information research and applications, and the impact of telecommunication and information technologies on urban society. The conference report is available at

<http://www.ncgia.ucsb.edu/conf/BALTIMORE/opening.html>

Law, Information Policy and Spatial Databases

The closing event for NCGIA's Initiative 16 was held at GIS/LIS '97 (Cincinnati, November 1997) as a special session with the following papers: "A comparative analysis of information policy approaches among mapping agencies of several nations", Xavier Lopez, UC Berkeley; "A comparative analysis of citizen access and revenue generation approaches pursued by local governments in the U.S.", Jeff Johnson, Stanford University; "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", Yvette Pluijmers, Delft University of Technology; and "Ethical considerations in the use of geographic information", Harlan Onsrud, University of Maine.

Socio-economic research within the European Science Foundation's GISDATA program

The GISDATA Final Conference "Geographic Information Research at the Millenium", held in Strasbourg, France, 13–17 September 1997, included a panel on "Socio-economic research and GIS". The panel was chaired by Michael Wegener (Germany) and included Helen Couclelis, Munroe Eagles, Einar Holm, and Sture Oberg (Sweden). The panel addressed some of the ground covered by issues of democracy, equity, privacy, and

surveillance; the promise and threat of geodemographics; the emancipatory potential of grass-roots GIS; and the difference between academic and commercial views of GIS.

Public participation GIS

During the last eighteen months, this effort under I19 has introduced an innovative phrase and concept around which to gather many ongoing efforts both in the study of public process and institution building and institutional change, and in the realm of technological developments related to collaborative spatial decision making and on-line group work. Having a core concept has made it possible to share ideas. Most interesting is potential for international cooperation, and in parallel developments such as the conference “Public participation in local decision making: evaluating the potential of virtual decision making environments” at the University of Leeds. There is also intent to explore regional meetings in the US bringing academic researchers, commercial systems developers, public agency participants, and grass-roots leaders to explore issues related to implementation of GIS and related technologies in public domains.

A workshop on PPGIS was held in July 1996 at the University of Maine. A workshop home page (ncgia.spatial.maine.edu/ppgis/ppgishom.htm) and report (www.geo.wvu.edu/i19/report/public.html) are available, along with a report on proposed design criteria (ncgia.spatial.maine.edu/ppgis/criteria.html).

UCGIS Summer Retreat 1997

Several papers on themes in the panel’s domain were presented at this conference, and can be found at www.spatial.maine.edu/ucgis/testproc/: Ryznar and Marans, “The Greening of Detroit”; Murphy and Sader, “Training in Remote Sensing and GIS”; Coleman, “Applied and Academic Geomatics”; Nebert, “Supporting Search for Spatial Data”; Schmitt, “Community organizations and GIS Implementation”; Schroeder, “GIS in Public Participation Settings”; Bassett, “Modeling Biodiversity for Policy Makers”; Baxmann, “Online Consensus-Building through Web-Based GIS”; Patterson, “GIS and (Dis)empowerment Issues”; Sieber, “GIS in the Grassroots, Role for Universities”. Sarah Ellwood, “The Minneapolis Community GIS Project: A Report on the Challenges and Opportunities of Community-Based GIS Education” is not linked on-line.

URISA 1997

A special session on public participation GIS included the following presentations: Nancy Obermeyer, “HUD's Community Connection for Local Empowerment”; Michael Barndt, “Public Participation GIS Within an Urban Neighborhood”; Michael Shiffer, “Using Spatial Multimedia to Characterize Communities”.

CAGIS special issue

The first 1998 issue of *Cartography and GIS* will be devoted to the PPGIS theme (special editor Nancy Obermeyer); final review of papers is now underway.

Planned meetings 1998:

Sessions are being planned at URISA (July, 1998, Charlotte NC), and the panel will sponsor U.S. participation in an international workshop on “Groupware for Urban Planning” (Lyon, February 1998).

On-line working group:

PPGIS-SCOPE is a very active list devoted to many aspects of public participation GIS, sponsored jointly by the U.S. Department of Housing and Urban Development and Specialized teleCenters of Professional Education; details can be found at www.projectslope.org.

3. Progress within Varenius

Meeting of experts, March 1997

The cooperative agreement with NSF stipulated convening an expert panel to help specify the research themes to be pursued under this Varenius theme, prior to selection and convening of a Varenius panel. Approximately 30 experts were brought together for this purpose in Santa Barbara February 28–March 1. Ideas were exchanged on a wide variety of possible themes over the two-day period, before synthesizing and reducing them to the following eight topics (in ranked order):

- Moving beyond the map as metaphor
- Access to spatial data in networked environments/The geography of information poverty
- Modeling and simulating geographies in a digital world
- Social/geographic implications of information technologies
- Virtual geographies
- Accessibility in a wired world
- Institutions and GIS: emerging frameworks in the information age
- Emergent social forms

Selection of panel members.

Subsequent to this meeting, Michael Goodchild asked Eric Sheppard to chair this panel. Four other panel members were approached, all of whom agreed to serve: Helen Couclelis (Geography and NCGIA, UC Santa Barbara); John Goddard (Geography, Univ. of Newcastle upon Tyne, UK, unable to attend meeting); J.W. Harrington (Geography, Univ. of Washington); and Harlan Onsrud (Spatial Information Science and Engineering and NCGIA, Univ. of Maine). John Goddard resigned in November, and a replacement has been proposed to NSF.

Panel meeting, May 1997

Considerable discussion was devoted to the scope of activities that should be addressed by this panel. The given name suggests that all aspects of the geography of the information society are pertinent, but panel members wished to narrow this in order to focus on areas where NCGIA could most effectively stimulate new research. Appropriate topics for research initiatives (RIs) should meet at least the following criteria: Novelty and originality (i.e., little work is already underway, so an RI can stimulate new activities); feasibility (i.e., the topic is sufficiently timely and well-defined that an RI has reasonable promise of making a difference); relevance to the mission of NCGIA (i.e., the

topic draws on the GI Science-related expertise of the NCGIA community of scholars); and overlap with the other two corners of the 'Varenius triangle' (i.e., the topic contributing to the coherence of the Varenius project as a whole).

For example, it was agreed that the important topic of how the evolution of an information society is affecting the spatial organization of society is not appropriate for an RI. This already is a broad-ranging and active area of empirical and theoretical research, on which the limited resources of an RI could make little impact. Instead, it was agreed that appropriate RIs should focus on well-defined but fundamental conceptual problems posed by the evolution of an information society which have not yet received adequate attention, and which might benefit substantially from research in the spirit of Geographic Information Science. There was also discussion about renaming the panel, given its decision to exclude certain topics, but after much deliberation it was decided to retain the name.

Beginning with the list of suggestions from with the expert meeting, the panel sought through discussion to identify fundamental themes underlying these, according to the principles summarized above. Two topics, focusing on some of the fundamental and long-standing geographical ordering principles of human society which are now being challenged as those societies become networked, were proposed: "Measuring and representing accessibility in the information age" and "Remapping community and place in the information age". Each of these topics is represented in at least three of the themes suggested at the March workshop.

A third topic was not definitively decided on at this time, although the Panel considered four candidates for this slot: "Public Participation in GIS", "[Public] Access to Spatial Data", "Moving Beyond Map as Metaphor", and "Modeling and Simulating Geographies in a Digital World". In the closure meeting with the other two panels, the different initiative topics of the three groups were reviewed relative to one another, and complementarities and overlaps were identified in each case. In this discussion, there seemed to be a clearer sense of the relevance of the theme of public participation supported by GIS than the other three of these potential topics. Also the other three potential topics are partly covered in the initiatives selected.

Formulation of proposed initiatives, and presentation to Advisory Board (8/97)

The following two initiatives were presented to the Advisory Board:

MEASURING AND REPRESENTING ACCESSIBILITY IN THE INFORMATION AGE

LEADERS: David Hodge (Geography, U. Washington), Donald Janelle (Geography, Western Ontario)

Concepts of potential and realized interaction and accessibility are central to geographic theory and models. Current models are based, however, on physical notions of distance and connectivity that are inadequate for understanding new forms of structures and behaviors characterizing an information age. Accessibility and spatial interaction in the traditional physical sense remain important, but information technologies are

dramatically modifying and expanding the scope of these core geographical concepts. Through technological, structural but also social developments, an increasing range of transactions take place in virtual space, or in some new hybrid space combining the physical with the virtual. Of importance here also is the influence of new forms of communication on the use of and investment in traditional transportation infrastructure. Moreover, just as space breaks up so does time, as activity rhythms in one place become increasingly synchronized with those in distant places. Geographic information science and technology, themselves products of this new information age, have potentially a major role to play in helping reconceptualize, measure, represent, monitor and plan for the new emergent geographies.

Spatial accessibility is the geographic definition of opportunity. In addition to issues of accessibility within communications networks, the information age has raised vital issues about access to communications networks. The information age has not made the information society ubiquitous. At issue is not merely the restructuring of geographical space, but the institutional and other contingencies that influence who has access to whom, when, and where, via physical and especially via virtual contact. Differential hardware and software availability, inadequacies of education and training, cultural factors and the relevance of the Internet to everyday life all contribute to the exclusion of selected places and social groups from contemporary communications networks (thereby perpetuating 'information poverty'). Since humans communicate continually as a part of knowledge building, communication and social interaction, gaining access to a computer is equivalent to changing one's accessibility within the broader flux of society. Issues of inequality in access to geographic information in particular remain relatively unexplored.

This initiative will examine how geographic information science can assist research into the geographies of the information age by helping reconceptualize and provide appropriate representations of accessibility and inequality within expanded models of space (and time) that encompass both the physical and the virtual.

Key questions include:

- What are the information age counterparts to the accessibility and potential surfaces developed for interaction in physical space?
- What space-time topologies need to be developed to accommodate both the physical and virtual worlds?
- How can interactions and accessibility gradients within these new hybrid spaces (and space-times) be represented and visualized within GIS?
- What representations can highlight patterns of lack of access independently of the lack of interaction?
- What are the technical and societal impediments to network access in different social domains, particularly for geographic information?

REMAPPING COMMUNITY AND PLACE IN THE INFORMATION AGE

LEADERS: Michael Curry (Geography, UCLA) , Munroe Eagles (Political Science and NCGIA, SUNY Buffalo)

New information technologies are helping ‘re-write’ the ways in which people interact with one another and how social and geographical identities are constructed. Traditional place-based communities are increasingly being complemented by virtual ones where people ‘meet’ and become intellectually and emotionally engaged with others without regard to constraints of distance and place. The feasibility of ‘being’ electronically in more than one place at once can undermine our rootedness in particular places, and the depth of our attachment to any place. Traditional conceptions of boundedness (nation state, neighborhood, home) are being undermined; ideas of separateness/belonging are being reconstituted; and notions of place/space as a container and as belonging are shifting.

Placeless communities are far from new, but the immediacy of interaction promised by the Internet makes such communities more ‘real’, and facilitates their growth. Political scientists and technology theorists are concerned that the Internet is accelerating the detachment of individuals from the places within which social networks and senses of belonging to society are formed, undermining community and democracy. At the same time, the Internet gives individuals the opportunity to escape the exclusionary aspects of community, turning to interact with self-defined communities electronically in response to exclusion from local communities. As people transfer more of their time and loyalty from actual to virtual communities, so the balance between place-based and non-place based communities is shifting, with potentially wide-ranging implications both for places and communities, and for the influence of place on human identities and behaviors. There are also shifts in the geographic scale at which individual practices are regulated. The regulatory power and relevance of local legal standards and norms may be undermined by the proliferation of long distance and/or globalized standards and practices, but spatial and non-spatial localities may also be the places to escape from such influences.

Place is a basic and enduring geographical concept, and the prospect that it needs to be rethought because of these changes poses a basic research challenge. Key questions include:

- How can we enhance and expand the representation of place-based communities, especially aspects central to this initiative—sense of place and belonging?
- What is the geography of the formation of virtual communities and places within the Internet, and how can these be conceptualized and represented?
- What cognitive and institutional parallels and differences exist between place-bound and virtual communities? (for example, are there scale-based hierarchies in virtual communities analogous to the local, regional, and global scales of place-bound communities?)
- How can we represent and conceptualize the social and material relations between these two types of communities?
- What are the democratic implications of any substitution of virtual for place-bound communities; and what role can GIS play in democratization?

Progress since August: ‘Place’ and ‘Access’ initiatives

The following steps have been completed or are underway:

- Confirmation of leaders
- Selection of core planning groups for the specialist meeting
- Revision of proposal in light of comments from Advisory Board, Varenus Executive, and initiative leaders
- Selection of dates for meetings

Progress since August: PPGIS

The theme of PPGIS has been chosen as the third area for catalyzing research into Geographies of the Information Society within Varenus, in part because of interest within the Varenus panels but also because a community of researchers has identified itself to Varenus as interested in collaborating on research within the rubric of PPGIS. In the judgment of the panel, this is a high priority area for future research, and one where progress will require the kind of catalysis that Varenus can provide, but a more limited level of commitment is necessary. A small organizational meeting occurred in June 1996, so it does not seem appropriate to begin this initiative with a specialist meeting. Instead, it is proposed that Varenus facilitate a follow-up workshop, after URISA 1998, to bring together as broad a group of researchers as possible with the goal of refining the research agenda in this area into a proposal for external funding. In addition, Varenus will facilitate the participation of PPGIS researchers at international meetings such as the Groupware meeting to be held in Lyons, France.

GISOC '99

A large international meeting titled "Geographic Information and Society" is proposed, to be held in Minneapolis in Spring 1999, as the first of what is anticipated to be a biennial inter-disciplinary international meeting which will report on research within the area of this panel. This meeting will bring together prominent international researchers with students in order to involve new generations of scholars in this topic.

**4. Assessment of research progress within and outside Varenus
pertinent to Geographies of the Information Society, relative to the
research agenda as set out in the NCGIA NSF proposal of October
1995**

Between now and February, members of the Geographies of the Information Society panel will be assessing our progress according to the following criteria:

- Which topics in the proposal are showing progress, and in which direction?
- Which new topics are emerging?
- Which topics in the proposal are not showing progress, and what do we, as panel members delegated to review progress in the field, think about that?

REPORT ON OTHER ACTIVITIES OF THE NATIONAL CENTER FOR GEOGRAPHIC INFORMATION AND ANALYSIS

Summary

This section reports on activities of the National Center for Geographic Information and Analysis other than those directly associated with the new Varenus project. NSF's funding for 1997 under SBR 96-00465 included support for a transition from the previously funded activities under SBR 88-10917 to the new Varenus structure. These activities include efforts in research through the continuing NCGIA research initiatives; efforts in education; and outreach. The following sections report on these activities, and the appendices include summaries of publications, presentations, visitors, degrees granted, and courses taught.

Initiative 16: Law, Information Policy, and Spatial Databases

The closing session for Initiative 16 on Law, Information Policy and Spatial Databases was held as GIS/LIS '97 in Cincinnati, OH, in October, in a session titled *Law and Information Policy for Spatial Databases: Research Results and Future Needs*. The following papers were presented:

- "A comparative analysis of information policy approaches among mapping agencies of several nations", Dr. Xavier Lopez, School of Information Management and Systems (SIMS), UC Berkeley;
- "A comparative analysis of citizen access and revenue generation approaches pursued by local governments in the U.S.", Jeff Johnson, Stanford University Law School;
- "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", Yvette Pluijmers, Delft University of Technology, Netherlands; and
- "Ethical considerations in the use of geographic information", Dr. Harlan Onsrud, University of Maine.

Submissions of further book chapters and conference papers are continual and ongoing. A final report of the initiative is in preparation.

At Maine, Yvette Pluijmers, M.S. student, has spent the past year addressing the 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.

Initiative 17: Collaborative Spatial Decision Making

Leaders: Marc Armstrong (University of Iowa), Paul Densham (University College, London) and Karen Kemp (University of California, Santa Barbara)

In April, Densham met with Goodchild to discuss progress on the initiative and draft a program for its closing. This program was subsequently approved by the other two co-leaders of the initiative, Armstrong and Kemp. Discussions about the closing continued in October, when Armstrong met with Max Egenhofer in Maine.

Initiative 17 will close during the summer of 1998. The closing meeting will be at a European workshop on Collaborative Spatial Decision Making (CDSM). This workshop is being organized by R. Laurini, and Densham is on the advisory committee.

Several papers on CSDM topics were presented at GIS/LIS '97 in Cincinnati and at AutoCarto 13 in Seattle. For example, Armstrong and Densham co-authored a paper that was published in the *Proceedings of the Thirteenth International Symposium on Automated Cartography (Auto-Carto 13)*. This paper describes a new way to decompose solutions to locational problems into a set of analytical objects (vectors and matrices) that are then used to summarize collections of solutions to locational problems. This "network map algebra" is also used to support visualization of solutions to such problems. Armstrong presented a paper on the role that emerging technologies will play on work practices by groups using GIS.

Armstrong and Densham have published several papers that relate to I-17; some recent publications are listed in the publications section of this report.

Armstrong has been awarded two grants, one from NSF ILI and the Geography and Regional Science program, the other from NASA. These projects involve investigating different aspects of the use of immersive visualization technologies in education and research. A particular focus of these projects concerns their use by groups of individuals. With the acquisition of an "ImmersaDesk" a group of five users can visualize three-dimensional solutions to environmental and socio-economic problems.

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

Initiative 19 is in its second and final year. In this report activities for the first eleven months of 1997 are identified. Most activities for this year have focused on implementing the research agenda identified from the Specialist Meeting held in Minnesota in March, 1996. The I-19 steering committee includes eight people at six sites (Helen Couclelis, UCSB; Michael Curry, UCLA; Trevor Harris, WVU; Robert McMaster, U. of Minnesota; David Mark, SUNY-Buffalo; John Pickles, U. of Kentucky; Eric Sheppard, U. of Minnesota; Daniel Weiner, WVU). 1997 reports for each site are as follows:

State University of New York at Buffalo - David Mark

The Critical History of GIS (CHGIS) Project submitted a proposal to the National Science Foundation, but learned in June that NSF declined to fund the project. David Mark has interviewed two important figures in the history of GIS, Thomas Poiker (TIN) and Donald Cooke (DIME), and those interviews have been transcribed. Mark presented an overview of the project at the UCGIS Annual Assembly in Bar Harbor in June; the presentation was well-attended and seemed well-received, and the paper was published in the electronic proceedings of the meeting. There were two GIS history sessions at the GIS/LIS meeting in Cincinnati in late October, also very well attended. The first session involved paper presentations by John Pickles, Pat McHaffie, and David Mark; Mark's paper appeared in the proceedings. The second session, organized by Tim Foresman, was a panel discussion including two authors of chapters in his recent book on the history of GIS, Nick Faust and Don Cooke, plus Ian McHarg.

The Initiative 19 working group on the critical history of GIS met in Buffalo November 6–9. Michael Curry, Ken Hillis, John Krygier, David Mark, Pat McHaffie, John Pickles, and Dalia Varanka participated, and Pickles, McHaffie, and Mark presented material to the SUNY Buffalo geography colloquium. The project members met with Hugh Calkins to talk about early GIS developments at the University of Washington, and with Mike Woldenberg to talk about the Harvard lab. Plans were made for a workshop proposal and a specific research project.

University of California-Los Angeles - Michael Curry

Curry attended planning meeting for the critical history project in Buffalo in November. He is now in the process of writing a grant proposal (for a conference, to NSF) on “Representing Terrain: From Bird’s Eye View to Bosnia” based on discussions at that meeting.

Curry is continuing work on the project on “Ethics of Spatio-Visual Representation”. This fall, he continued collecting, analyzing, and sorting maps of health, crime, and environmental data, and looking at the literature on privacy, particularly with respect to groups, and expects to begin the next phase of the project in the spring. Curry received funding from the Academic Senate of UCLA to continue this project.

University of California - Santa Barbara - Helen Couclelis

Helen Couclelis participated in a panel discussion on “socio-economic research and GIS” as part of the GISDATA Final Conference, “Geographic Information Research at the Millenium”, held in Strasbourg, France, 13–17 September 1997. The panel was chaired by Michael Wegener (Germany). The other panel members were Einar Holm and Sture Oberg (Sweden), and Munroe Eagles (US).

The panel addressed some of the ground covered by I-19: issues of democracy, equity, privacy and surveillance; the promise and threat of geodemographics; the emancipatory potential of grass-roots GIS; and the difference between academic and commercial views of GIS. Helen Couclelis focused her presentation on some differences between Europe and the US in how academics have approached GIS in the three domains of applied research, applications-oriented research, and theoretical/critical research, arguing that for political and institutional reasons, there has been much less of the latter (addressing

theoretical issues of GIS and society) in Europe than in the US.

University of Minnesota - Robert McMaster and Eric Sheppard

The NCGIA Initiative 19 project at the University of Minnesota consists of two parts: (1) building a risk assessment model for the Twin Cities that integrates geodemographic, institutional, and hazardous materials information; and (2) determining how neighborhood organizations might utilize GIS technologies in decision making and conflict resolution.

Progress over the past six months has included the following for the risk analysis component of the project: (1) mapping of TRI toxic indices; (2) mapping of Petrofund, Superfund, and Land Recycling data (3) mapping of census and institutional data, including day care centers, schools, retirement homes, and homeless shelters; (4) city- and regional-level analyses; (5) Conversion of data from MapInfo to ARC format; (6) Spatial analysis; (7) Initial experimentation with simulation modeling, and (8) Submission of an Environmental Protection Agency proposal.

(1) Toxicity index. Using the Pratt Toxicity Index, developed at the Minnesota Pollution Control Agency, we have now mapped out all sites, given their relative toxicity. This provides a much different view of risk to these sites than a simple measure of proximity.

(2) Other hazardous materials now mapped for the City of Minneapolis include all Superfund, Petrofund, Land Recycling, and Pollution Permit Holder sites.

(3) Institutional/census data. We have now acquired, geocoded, and mapped all Day Care Centers, Schools, Retirement Homes, and Community Centers. Many census variables at the block, block-group, and census tract level have been mapped.

(4) Analysis. Analyses of TRI and both City and County level data have been completed. This analysis has been reported in the journal *Cartography and GIS*, and at several conferences. The results indicate that, in the City of Minneapolis, while there is not evidence of environmental inequity based on race, there is evidence based on class, where both TRI sites and lower income populations cluster together.

(5) Conversion to ARC format. In order to integrate plume-dispersion and other modeling techniques, all boundary files, census data, institutional data, and environmental data were converted to ARC format. We now have the ability to take our project on the road for demonstration purposes, yet complete higher-end analysis in a Unix computing environment.

(6) Spatial analysis. We are now computing the geodemographic characteristics around the buffered TRI sites at a variety of distances to establish the population characteristics of these regions. This type of analysis is in contrast to (4) above that looks at the characteristics of the enumeration units near each site.

(7) Simulation of TRI sites. A problem typically encountered in this type of equity work is in establishing what is equity. We are now generating a set of simulated TRI sites to establish a sampling distribution of random TRI sites. The question being addressed is: What would equity look like if TRI (and other) sites were randomly distributed?

(8) Submission of EPA Environmental Justice proposal. Last February we submitted a \$350,000 proposal to the EPA's Environmental Justice Program. Although the proposal

was not accepted, it was ranked highly and, after discussions with EPA, we were encouraged to resubmit in early 1998. We plan on doing so.

Report on NCGIA-Sponsored Workshop, Geographical Methodologies for Technological Risk Assessment

Robert McMaster, Susan Cutter (co-leaders)

On September 6–9, 1997, a group of experts on environmental risk assessment gathered together at SUNY Buffalo to hold a small workshop on geographical methodologies for technological risk assessment.

On Day 1 (Sunday), the participants discussed and debated an array of topics, including:

- Review of research in risk assessment; critique of existing themes;
- Conceptual models
- Data sources and error in data sources; missing types of data
- Local sources of knowledge; community involvement
- Issues of scale and resolution
- Methods of analysis (statistical, spatial, GIS, qualitative)

Day 2 was spent in two breakout groups, conceptualizing and designing an idealized risk assessment, and then coming together to discuss the two different approaches. The group was also given a tour of several Superfund sites, including a detailed look at the Love Canal site.

A series of issues and questions were raised at the workshop, including:

1. What is the geographic pattern of risk at the local level and what are the underlying processes that amplify or attenuate the risk?
2. Can a comparable index be developed? What are some comparative methodologies?
3. How do time, scale, and resolution affect the measurement of risk and their spatial representation?
 - Measurement and representation of acute vs. chronic
 - Measurement and representation of static vs. dynamic
 - Measurement and representation of perceived and actual risk
4. How can a composite measure of risk designed to differentiate areas be created? How can it be represented spatially? How can risk as exposure be represented?
5. What should an idealized risk map be like? What set of maps are needed?
6. What is the place of local knowledge and neighborhood activities in the production of spatial information?
7. How do we incorporate the multiple perspectives of interested and affected parties, technical specialists, policy and decision makers into spatial methodologies for risk assessment?

Future action items identified by the participants included:

1. Completion of a report on the workshop.
2. Look into the potential for a broader Workshop on Spatial Methodologies for Hazard Exposure and Risk Assessment, funded by EPA, NIH, or NSF
3. Identify 3–4 four areas for possible comparative risk assessment research
4. Acquire sample data sets for testing spatial methodologies
5. Develop a comprehensive bibliography
6. Establish a mechanism for an internal Web-based review of papers
7. Created design guidelines for risk maps (collection of risk maps)
8. Review paper for *GeoInfo Systems*
9. Create a draft document, perhaps for NSF, that would address the following topics:
 - What can geographers contribute to risk assessment?
 - Specific types of tasks
 - Issues about spatial variation and exposure
 - Issues of equity
 - Place, histories of places
 - Issues of local knowledge
 - Issues of scale
 - Comparative case studies
 - Need to model environmental processes
 - Issues of representation
 - How to integrate these on the NRC paradigm.

University of Kentucky - John Pickles

Most of John Pickles' activities this past year have focused on completing two books on Eastern European transitions and not on Critical History of GIS (CHGIS) matters. However, parts of this work are related, and there are several projects tied directly to CHGIS. Most of the latter deal with epistemological and methodological issues related to the project, rather than work on the case studies. Publications from this work are listed in Appendix 4.

West Virginia University - Trevor Harris and Daniel Weiner

Activities during 1997 at WVU have focused on administration, networking, and research. During the year the I-19 Web Page was further enhanced and developed (<http://www.geo.wvu.edu/I19/>). This was the second and final year of the NCGIA project entitled "Local knowledge, multiple realities, and the production of geographic information: South Africa and West Virginia case studies". Early work focused on the Kanawha site which led to an AAG presentation and participation at the technological

risk assessment workshop in Buffalo (see Minnesota report). However, the acquisition of a major NSF grant for the South Africa work, and the loss of Philip Burkhart to a teaching position, forced us to re-prioritize and focus on the South Africa research. Harris and Weiner hope to return to the Kanawha case study in the future.

On January 1st 1997 Weiner and Harris began a 30 month and \$150,000 NSF-funded GIS and Society research project on South Africa. As a result, a graduate student was appointed to the project and summer field work was undertaken in Mpumalanga Province. Within South Africa, the project has been located within the Department of Land Affairs which is the agency responsible for the implementation of land reform. It is also a primary user of GIS technology. The major accomplishments of this work this year include: a research team of South African participants was identified; two field sites were selected; data and source materials were identified; appropriate institutional contacts at the local level were made. Furthermore, an experimental 'community-integrated' GIS is being developed for the central Lowveld District of Mpumalanga. Work is currently focused on traditional data coverages in preparation for field work in 1998. In addition conceptual development of a multi-media-GIS-WWW platform has been ongoing.

Public Participation GIS

An extensive report on this I-19 topic appears under the report of the Panel on Geographies of the Information Society.

Initiative 21: Formal Models of Common-Sense Geographic Worlds

Co-leaders: David M. Mark and Max J. Egenhofer

The objectives of I-21 are: to identify basic elements of common-sense conceptualizations of geographic space, entities, and processes, and to develop an integrating framework; and to investigate GIS users' reactions to intuitive geographic inferences, and compare the inferences with the results obtained with current GIS technology. The Specialist Meeting was held 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 up to that time, and the backgrounds of the attending participants included such diverse fields as psychology, philosophy, computer science, and engineering, as well as geography.

The multidisciplinary Steering Committee for the Initiative included the following: 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 research agenda defined by the specialist meeting included 49 researchable questions. The report summarizing these was published in the NCGIA Technical Reports

series in October 1997.

A paper summarizing the initiative goals and the Specialist Meeting findings was presented at the GIS/LIS'96 meeting in Denver (November 1996), and a lively panel discussion session on the topic was held at the Association of American geographers' meeting in Fort Worth, Texas (April 1997).

Discussions at the I-21 Specialist Meeting and in the Panel Session at the Association of American Geographers meeting led to considerable progress toward clear definitions of the differences between 'Naïve', or common-sense, (N-) and 'Scientific', 'Scholarly', or 'Sophisticated' (S-) versions of knowledge areas. The differences between N-Physics and S-Physics are fairly obvious, but the analogy does not so easily hold when trying to define S-Geography in contrast with N-Geography. Mark, Egenhofer, and Barry Smith are working to develop these ideas into a paper for publication.

David Mark (Geography) and Barry Smith (Philosophy) at Buffalo have been working toward establishing an "ontology of geographic entities", and testing the cross-cultural universality of such an ontology. A collaborative research proposal is being developed by Smith and Mark with Varenus Cognitive panel members Barbara Tversky (Stanford) and Stephen Hirtle (Pittsburgh). In the fall of 1997, considerable progress was made on the identification of an ontology of geographic water bodies.

Several student research projects at Maine (see next section) are pushing forward our knowledge of formal underpinnings for spatial representations. Several projects focus on image-schemata, which are expected to be at the core of cognitive universals for space.

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. Approximately 25 people attended, including Mark, Egenhofer, Smith, Adrijana Car (Pittsburgh and Vienna), Martin Raubal (I-21 participant and Maine graduate student), and Neil Pickard (another graduate student at Orono). A list of the papers presented at the conference is included under the conference section.

At the University of Maine, several master's and Ph.D. theses are under way in the area of common-sense reasoning. Kathleen Hornsby is working on her Ph.D. dissertation in the area of spatial reasoning and GIS. Her thesis on "A Change-Based Representation of Spatio-Temporal Phenomena" focuses on developing a classification of change based on object identity—a concept familiar in database and programming languages—and the operations that either preserve or change identity. The identification and formalization of the basic components of change lays the foundation for a new generation of formal data models that capture the semantics of change and lead to improved interoperability between GISs and process models or simulation software. Preliminary results of her research were reported at the UCGIS annual assembly in Bar Harbor, ME and she presented a paper at the COSIT '97 Conference in Laurel Highlands, PA; the latter paper was published in the refereed proceedings volume for the meeting.

Martin Raubal is working on his Master's Thesis at Maine in the area of human wayfinding and spatial cognition. This thesis presents a methodology based on image schemata and affordances to structure people's wayfinding tasks. Image schemata are recurring mental patterns (e.g., the CONTAINER or PATH schema) that people use to understand a spatial situation. They are highly structured and grounded in people's experience. Affordances, offered by space and spatial objects, generate different human activities (e.g., a pathway affords moving). Airport space is used as a case study. We compare two selected airports in regard to the ease of performing a common wayfinding task. As a metric for comparing the two, the number of image schemata and the number of affordances that occur within the task in each of the airports are taken. Our assumption is that a passenger's wayfinding performance in an airport increases when the number of image schemata and affordances per task decreases. Preliminary results of this work were reported at the COSIT '97 conference.

Also at Maine, M. Andrea Rodriguez completed her Master's thesis in June 1997 in the area of spatial reasoning. Based on a case study of a room space, she formally specified spatial relations derived from the behavior of objects associated with the image schemata container and surface. Preliminary results have been reported in the paper "Spatial relations based on Image Schemata" presented at the UCGIS annual assembly in Bar Harbor, ME and the paper "Image-Schemata-Based Spatial Inferences: The Container-Surface Algebra" also was presented at COSIT'97 and published in the refereed proceedings. She has continued working on this area focusing on the composition of spatial relations and a journal article is in preparation. Andrea is continuing as a Ph.D. student, working on Spatial Similarity funded by a grant from the National Imagery and Mapping Agency.

Roop Goyal is doing his Ph.D. dissertation at Maine on models of direction relations for extended spatial objects and reasoning about their similarities. Common models for direction relations, which are either point based or use the approximation of minimal bounding rectangles, are counter-intuitive particularly for non-convex objects. Roop has designed a formalism that captures the semantics of direction relations at different levels of detail and has developed a formalism to derive the composition of such direction relations. This work will be extended to compare direction relations not only for equivalence, but also for similarity. A paper on some early results was published in the electronic proceedings of the UCGIS annual assembly in Bar Harbor, ME and a journal article is under preparation.

John Florence finished his Master's thesis at Maine on the estimation of the frequency of topological relations in spatial data sets. Such estimations are invaluable meta-information for the optimization of spatial query processing. He distinguished between complete partitions, hierarchically structured regions, and overlapping regions and compared for three regular space partitions (triangular, square, and hexagonal) the frequencies with those of a wide range of datasets. The result is a set of equations with which the estimated distribution of the frequency of topological relations is calculated. The frequencies converge with large data sets, but may be significantly different for small (< 50 objects) datasets.

At Buffalo, Leo Zaibert continues to work toward his Ph.D. in the Department of Philosophy under the direction of Barry Smith. In the summer of 1997, Zaibert was

funded by the Varenus project to work on “Landed Property, Cadastral Registration, and Geographic Information Science”, a component of his dissertation work. The work includes, in part, cultural differences in concepts of ‘land’, a key element of Naive Geography.

With Zaibert's help and David Mark as a co-PI, Barry Smith submitted a proposal entitled “Land As a Social Artifact: A Cross-Disciplinary Study in Law and Geography” to the National Science Foundation. Unfortunately, NSF declined the grant, but aspects of the work continue. Smith is working on a book on this topic, tentatively entitled “The Metaphysics of Real Estate”.

Barry Smith is involved in two other projects under Initiative 21. One is being conducted with Roberto Casati (CNRS/CREA, Paris), an I-21 workshop participant, on universals of spatial cognition and formal models of spatial objects, relations and processes, leading toward a book to be called “Space: A User's Guide”. With Achille Varzi (Columbia University), Smith is working on axiomatic theories of mereotopology, and especially dealing with various kinds of geographic boundaries.

Also at Buffalo, Smith and Mark also have continued to work on geographical oddities, such as the non-contiguous towns of Baarle-Nassau and Baarle-Hertog in the Netherlands and Belgium, in relation to the limits of possible geographic ontologies.

I-21 will likely continue until a 1-day closing workshop just before or after COSIT '99, in the vicinity of Hamburg, Germany. At this time, the workshop is expected to be self-financed by the participants, based on their travel money to COSIT. We are planning to use this workshop as a key stage in the production of an edited book on Naive Geography.

Collaborative projects

Under SBR 88-10917, NCGIA initiated a series of collaborative projects with institutions outside the immediate three-site consortium. Three of these projects remained active in 1997; their activities are reported below.

Gulf of Maine Data and Information Management System

Kate Beard, University of Maine, PI.

The Regional Marine Research Program (RMRP) for the Gulf of Maine has been working toward a suite of models that collectively simulate how the Gulf of Maine ecosystem and its interacting components function naturally and under stress. Given the complexity of the research, its scope and duration, the need for real time interaction among disciplines, institutions, and PIs the RMRP felt the need for a carefully designed approach to data management and information flow. In 1995 the Gulf of Maine RMRP funded a collaborative team to develop a Data and Information Management System (DIMS) for the Gulf of Maine that would ensure timely and easy distribution of both new and archived data, the highest standards of quality assurance, feedback to the field program, and permanent archiving of a large volume of new RMRP data and information.

The purpose of the DIMS was to allow RMRP researchers to determine what information is available, to acquire data or subsets of data easily, and to analyze the data

without regard to where it resides and in what form. The goal of the NCGIA collaboration on this project was to work with the PIs and other marine scientists on the DIMS project on issues specifically relevant to spatial data/information distribution and analysis. The objectives were to address some of the unique issues of searching, browsing, retrieving, and analyzing geographically referenced data sets. Specifically the collaboration:

- assisted the DIMS team with development of geographic data viewing tools
- developed a set of spatial metadata specifications for marine data consistent with the Federal Geographic Data Committee's Content Standards for Digital Geospatial Metadata.

One component of the project involved development of a Java based user interface to access marine data sets. Java allows use of vector graphics and the ability to make interactive query selections from a geographic base. The bulk of the interface development was completed by early summer 1997. We received feedback on the interface design from marine researchers at the University of Maine throughout the summer and our collaborative partners at Dartmouth, University of New Hampshire, and Woods Hole Oceanographic Institute at a meeting in August 1997 in New Hampshire. As a second phase we have been building the metadatabase of marine data, developing a connection from the Java interface to the metadatabase, and expanding the interface to visualize and interact with spatial result sets. One Master's student research project is near completion on this work. A paper on a method to rank spatial query response was generated as a result of this work and appeared in the *International Journal of Digital Libraries*. A second paper "Management of Spatial Result Sets" has been submitted to IEEE ADL '98. Two visiting researches (Virginia Ragoni and Marisa Da Motta) from INPE (Brazil) have been collaborating on development of this project.

Predator-Prey Modeling of Fish Populations within Three-Dimensional GIS:

Ling Bian, Hugh Calkins, Joseph DePinto, PIs. Stephan Brandt, Collaborator

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 set. 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. A manuscript describing the work has been submitted to a journal.

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 were 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 were presented at the GIS/LIS '97 conference. One manuscript documenting the work has been prepared, and a second is in preparation.

The project concludes on December 31, 1997.

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 interpretation in terms of interacting with complex nonspatial information databases.

Currently, the PI has submitted a manuscript (same title as the project) to the refereed journal *Cartography and GIS*, and is working on the followup paper to the one presented at the Bar Harbor assembly.

Other research projects

The Amherst Deer Problem: Nature and Society in the Suburbs

David Mark has been involved in studying nature–society conflicts involving White-tailed Deer in a suburban community (Amherst, NY), and the role that geographic information plays in decision-making and public participation. The deer problem is also the Ph.D dissertation topic of Steven Parkansky, who is working under Mark's supervision. Amherst is an affluent Buffalo suburb with a population of about 130,000 people and about 1,100 White-tailed Deer. There is no legal hunting in the Town, which has experienced a great deal of development and population growth over the last couple of decades. “The Amherst Deer Problem”, as reported in the local press, began as concern for deer damage to individual and commercial gardens, but quickly switched to a focus on deer-related vehicle accidents (DRVAs). Geographic information is playing an important role in the debates over methods for reducing the chance of DRVAs. In 1996, there were over 500 DRVAs reported to the police, almost 10 percent of all the vehicle collisions reported to the Amherst police. Parkansky obtained deer population survey data from the New York State Department of Environment and Conservation, DRVA data from the Amherst police, deer warning sign data from the Amherst highways department, and deer carcass locations from the contractor who picks up road-killed deer for disposal. All of these data were digitized or geocoded, integrated in ARC/INFO, and moved to ArcView. Biogeography students also prepared a detailed land cover map from air photos, and that also was integrated into the GIS. In April 1997, the Town Supervisor (‘mayor’) invited Mark to serve on the “Deer Management Task Force”, which has been charged with advising the town of deer population targets and means of reducing numbers if necessary. One meeting of the Task Force was held in UB’s Geographic Information and Analysis Laboratory, and was attended by the Supervisor, as well as by two members of the Information Systems department of the town. The politicians and other task force members seemed to be surprised by many aspects of their own organization’s data, when shown in a geographic context. One task force member stated: “At least now we know there really is a deer problem”. Parkansky's dissertation will model deer population distributions, then use that output plus traffic and road data to model deer-vehicle collisions. He also will analyze the 240 questionnaires (out of 1200 mailed) that asked questions about the nature of the deer problem, respondents’ personal experiences with and losses due to White-tailed Deer in Amherst, and their attitudes toward various prevention or mitigation solutions.

Human capital research

Research at Buffalo in the human capital area has followed on from the NSF/NCGIA sponsored workshop Geographic Information Analysis and Human Capital Research, held in 1995, and led by Munroe Eagles and Hugh Calkins. Focusing primarily on the issue of “building strong neighborhoods”, research is currently being conducted by Eagles and Calkins on the impact of block clubs and other police outreach activities on neighborhood safety and stability. A currently funded project under the Community Oriented Policing Services (COPS) program is investigating the potential for geographic information technologies to assist in the reduction of crime and community disorder problems in neighborhoods.

Another research project, led by Ezra Zubrow, is developing a broad-based GIS crime analysis application. The use of GIS greatly enhances the ability of law enforcement agencies to visualize patterns of criminal incidents, and makes possible the optimization of police resources given community goals. The design of the software provides predictive modeling and algorithms to facilitate proactive policing. The software is being developed in collaboration with various police departments and the Environmental Systems Research Institute, a leading GIS software vendor. The tools include computerized beat books, gang territory demarcators, drug market analyzers, beat optimization, officer safety monitors, and others.

Spherekit

Spherekit is a spatial interpolation software toolkit developed at NCGIA as part of Initiative 15: Multiple Roles of GIS in U.S. 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 digital elevation model (DEM) is included with the package for this purpose.

Error analysis is an integrated component of Spherekit 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.

Spherekit 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 Spherekit. The package is available through the 'Products' section of the NCGIA web site www.ncgia.org.

VITAL

The Vehicle Intelligence Testing & Analysis Laboratory (VITAL) was established at NCGIA in January 1997, as a testbed for spatial data interoperability in Intelligent Transportation Systems (ITS). Startup funding for the lab was provided by the Testbed Center for Interoperability (TCFI) of the California Department of Transportation. Continuing funding is imminent, from the Federal Highways Administration (FHWA) through Oak Ridge National Laboratory (ORNL).

The mandate of the lab is to examine theoretical and industrial issues in GIS as they relate to ITS. Of immediate concern is the ITS community need for solutions to spatial data interoperability problems. Vehicle and incident location are central data items in ITS. In a world of competing vendors of street network data—and inevitable discrepancies and errors in position, street naming, addressing and classification—the success of ITS hinges on the ability to communicate a location message unambiguously across dissimilar map bases. Prototype vehicle tracking and navigation systems have been in circulation for several years; what is new about the current set of problems is communication of location *between* systems, i.e. interoperability.

There are two components to this research. First, at the industrial level, datum and messaging standards are being proposed by organizations such as the Society of Automotive Engineers (SAE) and the International Organization of Standards (ISO). These need to be tested comprehensively in laboratory and field simulations—this is becoming a requirement for national standards.

Second, there are research questions raised by ITS problems, e.g. methods for interpreting locational messages so as to reduce ambiguity; minimization of the cost of infrastructure such as coordinate datums. Over the first half of 1997, with TCFI funding, VITAL created a testing infrastructure consisting of moving map software running on a laptop computer carried in a vehicle, with continuous location readings from differential GPS, a Distance Measuring Instrument (DMI), and two-way wireless communications

with a fixed server using Cellular Digital Packet Data (CDPD) exchange. Six commercial databases of street centerlines were acquired for Santa Barbara county for the purpose of cross-vendor comparison. In terms of this infrastructure alone, VITAL is a unique facility. Since August 1997, VITAL has been engaged in contract research funded by Viggen Corporation, Tennessee, to test the Cross Streets Profile of the Location Reference Messaging Specification (LRMS), a standard under consideration by SAE. The test has required field surveys using the test infrastructure, and lab simulations, to identify the types of error, and measure their severity, when transmitting a location from one database to another using the Cross Streets Profile. On the academic front we are studying positional discrepancies between centerline databases, to develop means of measuring and visualizing error. This will lead to methods for real time correction of this error with a minimal set of control points. This project currently involves four graduate students and three faculty—Goodchild, Church, and Clarke—with specialties in GIS, operations research and cartography. There are commonalities between this and other research in spatial error, for which the Department of Geography has recently received funding from the National Imagery and Mapping Agency (NIMA). Further details on VITAL research are posted on our web site, <http://www.ncgia.org/vital>.

Visiting scholars

The NCGIA sites offer numerous opportunities for visitors for periods from a few hours to many months. Reports on the role of visitors can be found at many places in this document, notably in Appendix 7, and in the sections below.

Santa Barbara

Phaedon Kyriakidis, a Ph.D. student in geostatistics at Stanford University, was a Visiting Researcher at NCGIA from 06/16/97 to 08/22/97. He worked with several NCGIA faculty and graduate students, and participated in the NIMA-funded project Uncertainty in Geospatial Information Representation, Analysis and Decision Support. Other long-term visitors included Sachio Kubo, Keio University, Japan; Lola Gulyamova, Tashkent State University; Val Noronha, Digital Geographics; William Albert, Boston University; Wilmar Amaya, IPC, Ecopetrol, Colombia; Masatoshi Arikawa, Hiroshima City University, Japan; Kurt Brassel, University of Zurich; Germana Manca, Centre for Advanced Studies, Research & Development, Sardinia, Italy; Micha Pazner, University of Western Ontario; and Tapani Sarjakoski, Finnish Geodetic Institute.

Several visitors worked with Hugo Loaiciga during 1997. They included Dr. Ramanaran Yadava, Regional Research Laboratory, Bhopal, India; Eli Skop, National Environmental Research Institute, Copenhagen, Denmark; Dr. Jong Dae Kim, Department of Mining and Mineral Engineering, Dong-A University; Dr. Takeshi Sato, Department of Civil Engineering, Gifu University, Japan; Dr. Kyoo-S. Lee, Department Landscape Architecture, Sung Kyung Kwan University, Suwon, Korea; Shih Hsing Yang, Department of Geography, National Technical University, Taipei, Taiwan; Dr. Igor Zektser, Fulbright Scholar, Russian Academy of Sciences, Moscow; and Dan Rogers, Clayton Environmental, Detroit, Michigan.

Buffalo

The following individuals visited the Buffalo site in 1997 as participants in the Visiting Fellows Program:

Nik Theodore, Chicago Urban League, March 1997
Jacob Bendix, Syracuse University, April, 1997
Susan Hanson, Clark University, April 1997
Achille Varzi, Columbia University, April and October, 1997
Saskia Sassen, Columbia University, September, 1997
David Stea, Southwest Texas State University, November, 1997
Marc Armstrong, University of Iowa, November 1997.
Michael Curry, University of California, Los Angeles, December 1997
Luc Anselin, West Virginia University, December 1997

Maine

Long-term visitors funded by the visiting scientists program included Dr. Robert Rugg, Virginia Commonwealth University and Dr. Carol Bult from the The Institute for Genomic Research. Dr. Rugg worked during summer 1997 on the formalization of attribute similarity. Based on his work, he is organizing a special session at the AAG in Boston with papers by Werner Kuhn, Andrea Rodríguez, and Linda Hill. Dr. Bult worked with NCGIA researchers Beard and Egenhofer on the application of GIS modeling techniques to genome data. She was successful with a proposal to NSF's Biological Infrastructure program and organized a 2-day workshop on Spatial Genomics (see description elsewhere in this report). Other Maine visitors are listed in Appendix 7.

Education

NCGIA continues to provide leadership in GIS education through sponsorship of GIS education conferences and the development of GIS curriculum-building materials. Over the years NCGIA has supported GIS education efforts at all levels. In recent years the focus has primarily been on the rapidly expanding area of GIS in the community colleges. Flexibility in these institutions has led to a number of imaginative approaches to GIS education including merged transfer/technical programs, short courses, contract education, and distance learning. The NCGIA education program has been working closely many of the colleges attempting to provide GIS-based education opportunities.

The Secondary Education Project, which has worked with early K-12 adopters of GIS, continues to function, though at a more limited level. Hardware cost reductions, software ease-of-use improvements, and the option for GIS functionality served up over the Internet, are all increasing the possibility of widespread use of GIS in the schools. There are still needs for curriculum-sensitive GIS learning materials and teacher training. The NCGIA is collaborating in the early stages of design of a potential project in this area.

Additional information about NCGIA education projects can be found below and on our education World Wide Web home page (<http://www.ncgia.org/education/ed.html>).

The NCGIA Core Curriculum in Geographic Information Science

Progress on the GISCC in 1997 has been slow. The outline listing 170+ units, the editorial structure, website, formatting guidelines and editorial assignments were all

completed in 1996. Most editors had identified the authors for the individual units in their sections by early 1997. Progress in the current phase of unit writing is dependent upon a great many very busy academics around the world. Unfortunately, we have found it very difficult to encourage these authors to move the GISCC to the top of their priority lists. While the GISCC is envisioned as a GIS community project, NCGIA faculty have produced a few units which we hope will encourage the rest of the community to get working. As well, we have significantly relaxed the formatting requirements for submitted units—rather than requiring contributors to submit HTML-formatted materials, we now accept any text format, including ASCII, which we now convert to HTML and edit to match our standard GISCC format. We believe we have now managed to move the project higher on priority lists and reportedly should receive a flood of completed units in the new year. In November 1997, completed units are arriving at a rate of about 2 per week. We now hope to have a well-filled website by Spring 1999. At that time, a number of related projects such as developing the navigation and curriculum builder tools will be revived. The GISCC can be found on the web at <http://www.ncgia.org/giscc>.

The Core Curriculum for Technical Programs

NCGIA has continued its work begun in July, 1996 under a two-year grant from the National Science Foundation Advanced Technological Education (ATE) Program. The grant funds the development of a core curriculum in GIS for two-year colleges. This GIS Core Curriculum for Technical Programs (CCTP) is related to the Core Curriculum in Geographic Information Science, but is focused more towards technician training in the community colleges. It approaches the information from the perspective of what the practitioner needs to be able to do, rather than just what they need know.

Like the other Core Curriculum, it is World Wide Web-based and includes access to a number to resources for GIS instructors in technical programs. Currently the CCTP is beginning its testing phase. Curriculum units are being posted to the Web site and will be used by evaluators/resource developers to create resource materials for the CCTP such as lesson plan sets, student exercises, short course outlines, example applications, web tutorials, and multimedia leaning meaterials. The CCTP also is collecting and referencing various resources for GIS instruction in the community colleges such as model course outlines, lists of available text and lab materials, and links to useful Web sites. The CCTP is on-line at <http://www.ncgia.org/cctp>.

GIS education conferences

The Third International Symposium on GIS in Higher Education GISHE'97 was held in Chantilly VA, Oct 30–Nov2, 1997 with almost 200 GIS educators from all education levels and from 15 countries attending. This conference was co-sponsored by Towson State University (who handled all logistical details) and NCGIA (who organized the program). Over 60 papers were presented on topics ranging from “Teaching GIS across the Curriculum” to “GIS education and the Internet”, “Capacity building in developing countries”, “Designing GIS courseware”, “Foundations for GIS education”, “GIS in Community Colleges” and “Teaching GIS in K-12”. Scholarships provided by ESRI, Intergraph, UNIGIS and FGDC covered travel expenses for 6 international educators and one community college instructor. The conference was structured to include indepth discussion sessions. On Sunday morning a final plenary and working groups produced a

conference summary. The conference program and summaries with action items can be seen at <http://www.ncgia.org/conf/gishe97>.

The NCGIA helped organize and present a one day meeting on GIS in the community colleges at the University of California, Los Angeles. This meeting was for college instructors interested in GIS education at their institutions. The meeting led to a California state grant administered by the North Orange County Community College District which provides 4 day GIS training sessions for a total of 120 college faculty around the state.

Although UCGIS is an activity beyond the NCGIA, members of NCGIA played significant roles in this summer's UCGIS meeting. Harlan Onsrud (UMaine) and Karen Kemp (UCSB) were the co-chairs for the conference which combined paper presentations on research in GIScience with working sessions on GIS education. Dr. Onsrud was successful in obtaining funding from NSF to provide limited travel support for 45 graduate students at US institutions who actively participated in the program. He also organized a series of short workshops on fundamental GIScience themes. Dr. Kemp, working with Richard Wright of San Diego State University, organized the plenary and working sessions which culminated in the development of the UCGIS's education agenda.

Community College Project

As noted above, 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 hundreds of 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, especially the CCTP. In addition, Steve Palladino, the NCGIA Education Projects Manager, in conjunction with partners at ESRI, is keeping a master list of community colleges with GIS instruction and parties interested in community college GIS. NCGIA-Santa Barbara members have provided advisory support in the development of a GIS Program at the local community college, Santa Barbara City College. The lessons learned in this exercise have benefited the CCTP development efforts.

Computational Methods for Watershed Analysis CD

A related project, not funded under Varenus but mentioned in our original proposal, is a course on "Computational Methods for Watershed Analysis", prepared by Prof. Leal Mertes of UCSB with support from UCSB Instructional Development. This course uses GIS (ARC/INFO) as a tool to support the instruction of watershed analysis. Extensive student laboratory materials have been developed and tested in the classroom. Discussions on collaboration with ESRI to produce a CD containing all of the necessary data and AML files are currently underway.

Other education activities

The Buffalo site has been working with faculty at Erie Community College (ECC), a regional two-year SUNY institution, to develop a program to teach GIS courses. In May of 1997, Hugh Calkins and David Mark helped ECC's Jason Steinitz prepare a proposal for external funding to develop a GIS curriculum and teaching program. This proposal,

which was submitted to the National Science Foundation's Education and Human Resources directorate, includes Hugh Calkins and NCGIA Buffalo as a participants in the project.

At UCLA, Michael Curry has developed a new course, entitled "Place, Identity, and the Networked World," that grows out of I-19. Curry is also working with Larry Smith (Geography, UCLA) to revise the introductory GIS course, to include weekly discussion sections (led by Curry) on social/cultural/ethical issues.

Outreach: Conferences

Geographical Methodologies for Environmental Risk Assessment, September 6–8, 1997, SUNY at Buffalo, Buffalo, NY

NCGIA Buffalo hosted the invitational workshop "Geographical Methodologies for Environmental Risk Assessment", September 6–8, 1997. This workshop, which was led by Robert McMaster (Geography, University of Minnesota) and Susan Cutter (Geography, University of South Carolina), explored the state of current research in risk assessment and the ways that GIS use and mapping can influence risk assessment and public perceptions of risk from hazardous materials. The outcomes of the workshop, which was part of NCGIA's Initiative 19 (The Social Implications of How People, Space and Environment are Represented in GIS), are discussed in the Research section of this report. Robert McMaster delivered a public lecture on the outcomes of the meeting on September 9.

Visiting Fellow participants included Marc Armstrong, University of Iowa; Susan Cutter, University of South Carolina; Trevor Harris, West Virginia University; Robert McMaster, University of Minnesota; Mark Monmonier, Syracuse University; Timothy Nyerges, University of Washington; Jeffrey Osleeb, Hunter College-CUNY; Michael Scott, University of South Carolina; Eric Sheppard, University of Minnesota; and Daniel Weiner, West Virginia University. SUNY Buffalo participants included Professor John Krygier, and PhD candidate Elizabeth Kent.

First Annual Assembly of the NCGIA Consortium, Oct 10–13, 1997, SUNY at Buffalo, Buffalo, NY

This gathering brought together researchers from the three NCGIA sites to discuss their research projects, share information and approaches, and make plans for future consortium activities.

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 NCGIA's conference on GIS and Political Districting was 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 was led by Munroe Eagles (Political Science/NCGIA, SUNY Buffalo). Co-sponsorship was received from NCGIA-Buffalo, SUNY Buffalo's

Conferences in the Disciplines, the Faculty of Social Sciences, the Office of the Provost, and the Department of Political Science. More than 60 persons attended, and over 25 papers were presented in the eight sessions of the conference.

Visiting Fellow participants included Kimball Brace, Election Data Services; Bruce Cain, UC Berkeley; Carmen Cirincione, University of Connecticut; Michael Curry, UCLA; Chandler Davidson, Rice University; David Ely, PacTech; Jonathan Entin, Case Western Reserve University; Christian Grose, University of Rochester; Winett Hagens, Norfolk State University; Lisa Handley, Election Data Services; Richard Katz, Johns Hopkins University; Jonathan Leib, Florida State University; James Lennertz, Lafayette College; Karin MacDonald, UC Berkeley; Richard Morrill, University of Washington; Richard Niemi, University of Rochester; Timothy O'Rourke, University of Missouri St. Louis; Mark Rush, Washington and Lee University; Harold Stanley, University of Rochester; Edward Still, Edward Still Law Firm; Donley Studlar, West Virginia University; Jon Taylor, University of Kentucky; Ronald Weber, University of Wisconsin, Milwaukee; Jerry Webster, University of Alabama, Rudolph Wilson, Norfolk State University.

Qualitative Research in Human Geography, November 6–9, 1997, SUNY at Buffalo, Buffalo, NY

Led by Geography Assistant Professor Meghan Cope, this small discussion group involving Lynn Staeheli of the University of Colorado, Boulder and Victoria Lawson of the University of Washington, Seattle, who met to discuss the development of curriculum materials and potential workshops to train geographers in qualitative methods. Professors Lawson and Staeheli were Visiting Fellow participants.

GIS History Project Workshop, November 6–8, 1997, SUNY at Buffalo, Buffalo, NY

The GIS History Project is a multi-investigator study of the history and development of GIS and related technologies. Key innovations will be related to social, economic, and institutional contexts, and to contemporary development of computing technologies more generally. The project is described in more detail in the I-19 research section of this report. The objective of the project workshop was to assess progress on the project and to plan and prioritize future activities. The workshop was led by David Mark (NCGIA Buffalo) and involved John Krygier of Buffalo. Visiting Fellow participants were Michael Curry (UCLA), Ken Hillis (University of North Carolina), Patrick McHaffie (DePaul University), John Pickles (University of Kentucky), and Dalia Varanka (Independent Scholar).

On November 7, the panel delivered an open colloquium on the Critical History of GIS.

GIS in Epidemiology, November 14–16, 1997, SUNY at Buffalo, Buffalo, NY

Professor Michael Woldenberg led this NCGIA-sponsored workshop, which featured presentations on research in Breast Cancer, Lead Poisoning, and Asthma, and the role GIS could play in furthering these efforts.

Visiting Fellow participants included Cynthia Brewer, Pennsylvania State University; Susan Cutter, University of South Carolina; Erin O'Leary, SUNY at Stony Brook; Linda Williams Pickle, Center for Disease Control and Prevention; Gerard Rushton, University of Iowa; David Stea, Southwest Texas State University; Deborah Thomas, University of

South Carolina; Dan Wartenberg, Environmental and Occupational Health Sciences Institute; and Carmelle Cote, ESRI. A number of people from SUNY Buffalo's Department of Geography, Department of Social and Preventative Medicine, and Department of Medicine also participated. The meeting also featured a public lecture by Erin O'Leary and Gerard Rushton. There were also presentations from Cindy Brewer and Linda Pickle

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). Approximately 25 people attended.

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".

NCEAS Workshop on Uncertainty in Spatial Data for Ecological Models, September 29–October 1, 1997, Santa Barbara

This workshop was part of a longer term project directed by Carolyn Hunsaker of the Oak Ridge National Laboratory, and funded by the National Center for Ecological Analysis and Synthesis. Approximately 20 people—ecologists, geographers, and statisticians—met at the NCEAS facility in downtown Santa Barbara to discuss issues related to the impacts of spatial data uncertainty in ecology. The purpose of the workshop, which was co-organized by NCGIA and represents the most significant collaboration between the two centers to date, was to develop plans for a book, to be published later in 1998. Further information on the project is available at the NCEAS web site, www.nceas.ucsb.edu.

UCGIS 1997 Annual Assembly and Summer Retreat, June 15–21, 1997, Bar Harbor, ME

NCGIA-Maine and the College of the Atlantic hosted the "UCGIS 1997 Annual Assembly and Summer Retreat", June 15–21, 1997, Bar Harbor, ME. Organized by

Harlan Onsrud and Karen Kemp, with the assistance of Blane Shaw, the conference attendance exceeded 160 participants. Two primary goals of the meeting were (1) to disseminate advanced knowledge on geographic information science and technology topics among leading researchers, professors, and graduate students in the field, and (2) to identify the nation's highest priority education needs for advancing geographic information science and develop initiatives to respond to those needs. The assembly began with a full day session devoted to identifying high priority geographic information science education needs and creating working groups to work on those needs throughout the week. During the remainder of the week, morning sessions began with a plenary paper session followed by concurrent paper sessions on a range of geographic information science topics. The paper sessions were presented by graduate students, faculty and researchers from across the nation. Working group sessions addressing high priority education issues also occurred during the mornings. Afternoon sessions were dedicated to attending optional advanced workshops or enjoying the outdoors, Acadia National Park, and island life in general with fellow attendees.

Workshop on Spatial Genomics, October 23–25, 1997, Northeast Harbor, ME

NCGIA-Maine and the Asticou Inn hosted the “Workshop on Spatial Genomics”, October 23–25, 1997, Northeast Harbor, ME. Organized by Carol Bult and Kate Beard, with the assistance of Blane Shaw, the purpose of the meeting was to broaden the discussion of the idea of spatial genomics by bringing together a small group of scientists from the genome and GIS domains. The goals of the Spatial Genomics Workshop were to refine theoretical concepts related to the GenoSIS project (NSF funded “Application of Spatial Concepts for Genome Data” project) and to lay the groundwork for the path from concept to application.

Other outreach activities

At Buffalo, Hugh Calkins continues his work with a working group of the New York State Legislature to look into GIS standards and development for New York State. Calkins is chair of the committee on Standards. The following NCGIA publications appeared in 1997 to date:

Technical Papers published

97-1: Multipurpose Land Information Systems Development Bibliography: A Community-wide Commitment to the Technology and its Ultimate Applications, by David L. Tulloch, Bernard J. Niemann, Jr., and Stephen J. Ventura, Univ of Wisconsin - Madison; and Earl F. Epstein, The Ohio State University, brings together literature covering the many aspects of MPLIS development, including initiation, implementation, operation and maintenance.

97-2: Formal Models of Commonsense Geographic Worlds: Report on the Specialist Meeting of Research Initiative 21. Edited by David M. Mark, SUNY-Buffalo, and Max J. Egenhofer and Kathleen Hornsby, U. Maine, documents the discussions held during the meeting in San Marcos TX, 30 Oct–3 Nov, 1996. It includes a set of researchable questions that forms the basis for future research in this area.

97-3: Report of the ICA Workshop on Map Generalization (Gävle, Sweden, 19-21

June 1997) by W.A. Mackaness, Univ of Edinburgh; R. Weibel, Univ of Zurich; and B.P. Buttenfield, Univ of Colorado-Boulder, reports on the discussions and key findings of a workshop held in Gävle Sweden, 19–21 June 1997. Discussion focused on impediments to automated map generalization, the current state of knowledge and progress on specific problem areas.

Other NCGIA publications added

Annual Report Year 8 (January 1, 1996–December 31, 1996)

Management

Santa Barbara

Abby Caschetta began employment with NCGIA Santa Barbara as the Publications Coordinator on June 18, 1997, filling the job vacated by Elan Sutton.

Michael Goodchild was appointed Chair of the National Research Council's Mapping Science Committee.

Buffalo

Faculty members joining the NCGIA Buffalo during 1997 were: Barry Lentnek, Department of Geography; Christopher Rump, Department of Industrial Engineering; and Aidong Zhang, Department of Computer Science

Dawn Becker, NCGIA Secretary, left the department in May, 1997. In July, Linda Doerfler joined the NCGIA staff as part-time Secretary.

In July, Martin Camacho, GIS and Workstation Support Specialist, was promoted to oversee Unix operations for the Faculty of Social Sciences, which includes but is not limited to the Geographic Information and Analysis Laboratory. In September, Jian [Justin] Fan joined the staff of the Geographic Information and Analysis Laboratory as a Programmer/Analyst and GIS specialist in residence.

Maine

Carol Bult has been appointed Project Manager with the NCGIA, effective July 1, 1997. She will oversee the management of the recent NSF-awarded project "Application of Spatial Concepts for Genome Data".

Douglas Flewelling has been appointed Project Manager with the NCGIA, effective June 1, 1997. He is responsible for the management of the research projects "Heterogeneous Geographic Databases" and "Similarity Assessments Based on Spatial Relations and Attributes".

Scott Overmyer, Assistant Professor in Business Management, accepted a new position at Drexel University as of September 1, 1997.

Tony Stefanidis has been appointed Project Manager with the NCGIA, effective January 1, 1997. He is responsible for the management of the research project "Spatial-Query-by-Sketch".

Nectaria Tryfona, Post-doctoral Research Associate, accepted a position as Assistant Professor in Computer Science at the University of Aalborg, Denmark, as of June 1,

1997.

APPENDIX 1: MINUTES OF THE VARENIUS ADVISORY BOARD

August 18-19, 1997

Attending: Ronald F. Abler, and Annette Krygiel, Co-chairs; Lawrence A. Brown; Jack Dangermond; David DeWitt; Jerome E. Dobson; Michael W. Dobson; Andrew U. Frank; Judy M. Olson; and Karen C. Siderelis. Excused: Douglas Richardson.

(**Note:** these minutes must be read as draft; the enclosures mentioned in the text are not included)

Monday, 18 August 1997

Michael Goodchild, Project Varenium Director, welcomed the board to Santa Barbara and the University of California. He reviewed the evolution of the National Center for Geographic Information and Analysis (NCGIA) and Project Varenium. Varenium is funded by the National Science Foundation (NSF). Its purpose is to engage in research agenda-setting in the Geographic Information Sciences specialties (his viewgraphs are provided as Enclosure1). He stressed that one of the principal distinctions between Varenium and its predecessor, the NCGIA, was that Varenium's primary objective is to provide a series of specialist meetings. These are specific mechanisms, endorsed by the National Science Foundation, to accomplish research agenda setting.

Specialist meetings draw from the entire scientific community in efforts to define a problem's domain, and to identify the researchable topics within that domain. After the specialist meetings, researchers throughout the community are encouraged to submit proposals based on the agenda-setting that occurs in the specialist meetings to the NSF and other funding agencies. Varenium can also make small seed grants to individuals. The time frame of Varenium is three years, over the period February 1, 1997 through January 31, 2000. All specialist meetings must be completed by June 1999 so that there will be six months for seed funding.

The project is structured using three panels each with individual but complementary thrusts, i.e., Cognitive Models of Geographic Space (chaired by David Mark); Computational Implementations of Geographic Concepts (chaired by Max Egenhofer); and Geographies of the Information Society (chaired by Eric Sheppard). These three panel chairs, and Karen Kemp, with Mike Goodchild as Chairman, constitute an Executive Committee for Varenium. The committee will be supplemented with a Board member, the election of whom should be completed at this meeting.

A panel structure sits atop the specialist meeting mechanism. Panels should review progress in the field, and panelists will receive an honorarium. Support is also provided for a research assistant to assist with meetings. Panel chairs sign a subagreement with Varenium in order for funds to flow through Santa Barbara. There are funds for seed grants, and proposal generation to bridge the gap between the specialist meeting and actual research. There are also funds for visitors. NSF expects proposals will be generated

after the panel meetings. Proposals will just begin to achieve funding when Varenius reaches its last days, so there will be a gap. The three panels will integrate their findings. Discussion ensued about the need to capture and publish the panels' results.

The Varenius Advisory Board's responsibilities are to oversee project activities, comment on all aspects, including direction and progress, assess scope and quality of participants in specialist meetings, publicize the project, and function as a project proponent when feasible. Of particular importance is assistance in technology transfer. One elected Board member will confer with the Executive Committee on a monthly basis to maintain a more current cognizance. The Advisory Board's principal deliverables consist of minutes of the meetings, focused deliberately on questions keyed to the specific phases of the project. This report will go both to the Executive Committee, and the NSF. This Advisory Board meetings will focus on planning. The February 1998 meeting will assess progress, and the February 1999 meeting on the future, that is, what should follow Varenius. More specifically, at this meeting the Board should endorse the topics selected if it believes they are adequately formulated and on the nature and quality of the participation in the scheduled specialist meetings.

With respect to NCGIA, Goodchild commented that the NCGIA has a no-cost extension through next year. In contrast to Varenius, it is still committed to actual GIS research. The Varenius Board should address NCGIA initiatives 20 and 21, but does not need to approve their continuation.

In response to several questions from Board members about funding, Goodchild explained that the total funding for the Varenius project is \$2.3 million from 1997–2000. This funding is distributed as follows: 1997, \$1.1 million to wind down NCGIA research; 1998, \$0.6 million Varenius operations; 1999, \$0.6 million Varenius operations.

The leaders of each of the three Varenius components then presented an overview of the topics for which they were responsible: Cognitive Models of Geographic Space (David Mark); Computational Implementations of Geographic Concepts (Max Egenhofer); Geographies of the Information Society (Eric Sheppard), addressing the scope, schedules, participants, and locations for events (their viewgraphs and notes provided as Enclosures 2, 3, and 4).

In response to a question from Tom Leinbach, Max Egenhofer clarified that NCGIA Initiative 20 and the Varenius Interoperating Geographic Information Systems Initiative are the same. While discussing this initiative, much encouragement was provided from Board members for industry involvement. During Eric Sheppard's presentation, many more questions on implementation arose than in the preceding two panel interactions. Brown felt that there was still much to do in communicating with the social science community. Also mainstream geographers outside the GIS community are not adequately familiar with NCGIA and Varenius research; outreach is still very much needed. This observation led to a discussion on the need for expanding the composition of the panels. Frank expressed difficulties in seeing the connection between these initiatives and the interactions between GIS technology and its effect on society. Sheppard responded that GIS may be useful in ameliorating social problems and accessibility issues.

The Board of Directors met in executive session from 11:00 to noon to discuss its preliminary reactions to the presentations by Varenius staff. The afternoon was spent

viewing graduate student projects on the UCSB campus and in demonstrations of VITAL by Valerian Noronha).

Tuesday, 19 August 1997

Jerome Dobson, President of the University Consortium for Geographic Information Sciences (UCGIS) updated the board in that organization's activities. UCGIS has been in place over two years. It has been successful in setting the research agenda and in resource procurement. The research agenda consists of ten significant priorities of UCGIS members, and is available for viewing at the website www.ucgis.org. Dangermond questioned the sufficiency of research funding for GIS. UCGIS should set a goal of a hundredfold increase in funding for GIS/GIA over the next decade. First though, we need to know how much is now being spent. The importance of GIS in U.S. international competitiveness should be stressed—the U.S. leads the world. There was much discussion and interaction from many board members on this topic, and some questioning as to how to come to terms with this understanding. It was noted that one forum that would afford more opportunity to discuss the way forward would be presented by the Mapping Science Committee workshop in January 1998.

Karen Kemp, Assistant Director of NCGIA, reported on the center's education and outreach activities. Varenius publications will appear in a separate series. The respective merits of publication, World Wide Web, CD-ROM, and other media were also discussed.

The board received reports from the directors of the three NCGIA sites. David Mark described Buffalo's multidisciplinary organized research unit, of which he is director. The organization has two full-time staff; twenty or so members on campus (of which ten or eleven are in geography). There is a campus push for fewer doctoral programs. Geography is targeted for growth and a new Geographic Information Science Institute has been proposed. Four new faculty have been hired in geography to replace departures and a senior scholar in geographic information science is being recruited. Several conferences and workshops are scheduled for the next six months with residual NSF funds. The department has about 150 graduate students in residence with sixteen faculty. During the NCGIA period approximately 25 PhDs in GIS-related topics and 60-70 masters degrees have been awarded. Brown inquired about external funding and Mark noted that it has been about \$1.5 million, excluding Varenius.

Max Egenhofer reviewed recent events at the University of Maine. Core members of NCGIA are drawn from spatial science and engineering, with others from business and mathematics. Many are interested in the uses to which GIS can be put in forestry, wildlife management, ecology, etc. Funding at \$2.5 million has been won by the core group from NSF and other sources, including NIMA and the CIA. These funded projects complement more basic research done within the NCGIA organization. Two new research faculty and project managers are on board. There are 50 graduate students and six faculty. A master's program in information technology may be established, to be led by Harlan Onsrud in collaboration with the business school and other units. More space (3,000 square feet) has been acquired within Boardman Hall. Numerous visitors have come to Maine for periods from a few days to six weeks. Kate Beard is the new department chair.

Keith Clarke updated the board on the Santa Barbara program. In addition to Clarke's recent appointment, other new faculty appointments are pending, and new staff are being

added. NCGIA Santa Barbara has hosted 236 visitors over the life of project, and Clarke presented highlights of recent visitors. NCGIA cooperates closely with Project Alexandria and with the ecology center the board visited yesterday, and also with engineering and geology. A number of products of NCGIA meetings have been disseminated, including a CD-ROM from Sante Fe meeting. The website has been revamped. If all goes well, the department may be consolidated in 1998, after the department undergoes an external review. Several funded projects are under way, including VITAL, a NIMA effort, a metadata project with EcoPetrol in Columbia, and a multimedia education initiative. The program hosts 110 graduate students about a third of whom are GIS-involved. The NCGIA budget runs about \$1.2 million. Dangermond asked whether visitors are energy sinks or energy sources. Clarke responded that some are high-maintenance and others are not.

The board met in executive session for two hours at the conclusion of the meeting. It addressed the following questions with the answers indicated: Q—Is the effort well launched? A—Yes. Q—Have important questions been overlooked, or are blind alleys being followed? A—No, with the exception of Frank's observation on the Cognition formulation that data quality or error is intrinsically linked to detail and that the connection is not stressed sufficiently. Frank also recommends that the leaders of the Computation component stress computation more, in cooperation with the OGC and industry; it should be made clear that computational aspects are the theoretical core. The Ontology of Fields focus should incorporate more international and global participants—overseas representation seems token at this point. Also, someone from remote sensing/image processing should be invited to participate, and representation from the University of South Carolina is desirable. Krygiel will suggest some NATO points of contact, which should be supplemented by government participation from NIMA and DARPA, and from state governments and the user community if possible (Siderelis will try to identify some individuals).

In a parallel observation, Dangermond noted that a major impediment to progress currently is the limited number of good GIS software engineers—he would like to see the program at Maine multiplied by ten fold. More strong universities that focus on GIS software engineering with strong computer science and strong geography are needed, and a curriculum should be formulated and disseminated.

As regards the Information and Society component, the board thought it would be worth re-examining the two foci. The board asked that the Information and Society module be brought to the same level of refinement as the other two by the end of November with a written report to the board at that date. The board needs details on the framework by which agenda-setting will occur in outline form before the February meeting. The National Academy of Public Administration section on GIS and Society by Lisa Warnecke may offer some help. Brown argued strongly that more stress should be laid on the interface of spatial analysis and GIS, probably under the purview of the Information and society group. He suggested modifying the existing module or creation of a new one to focus on that topic. Subsequent to the Board meeting, Dr. Brown contributed an essay previously published in the AAG Newsletter, pertinent to the discussions (Enclosure 5). Frank stressed the importance of a focus on GIS within information technology as the center of the effort. Brown favored more migration into

substantive problems and other disciplines. The value of GIS should be demonstrated and promoted. Abler suggested adding Mitchell of City of Bits fame or someone else from the MIT laboratory to the oversight group. Greg Biging at Berkeley was suggested as someone who can bridge the gap between analytical methods and GIS, which are usually taught separately by different individuals in geography departments; Morton O'Kelly or Peter Rogerson were also mentioned in that connection. The Board concurred with recommending the accelerated schedule for the Information Society panel.

Q—Has Varenius identified the most effective people? A—generally, yes with particular suggestions for membership provided above. Where possible, industry and international participation in the Interoperability initiative should be augmented. Also stressed was the proper balance of government and industry representation at all specialist meetings.

Q—What should the board focus on at the February 1998 meeting? A—Focus clearly should be on the progress of the panels. However the Board members were concerned with achieving sufficient insight prior to holding its executive session. Accordingly, the board proposed a revised schedule with a Saturday joint panel meeting with voluntary board member participation. Sunday morning will be devoted to a recreational event, to be followed by a Sunday afternoon board meeting, and a Varenius personnel-board of directors dinner in the evening. The board will meet all day on Monday, with departure on Tuesday morning. This strategy should ensure that the necessary insights will be chieved.

The board understands that its deliverables are the approval of plans presented. All members are responsible for publicizing Varenius and its components. The co-chairs will disseminate the approved minutes to Varenius staff and the National Science Foundation. With the provision of an accelerated schedule for the Information Society, the additions of membership to several panels, and incorporation of the comments provided to panel chairs, the board is very satisfied with the Varenius project planning. The board raised no issues or recommendations beyond those already noted.

In the realm of logistics, the board requested a listserv or similar means of communication. It recommended that one or two board members be identified as liaisons with each module, and will make such assignments at the February 1998 meeting. The board asked that the briefing book be in its hands two weeks before each subsequent meeting, and that a brief overview of the intellectual progress in each module be refined at the next panel meeting.

The board elected Karen Siderelis to represent it on the Varenius Executive Committee.

In response to the board report of its recommendations and requests, Varenius personnel observed that the Information and Society module could incorporate a fast track workshop on public participation in GIS. Sheppard suggested that a third subcomponent effort could be organized focusing on strengthening the links between GIS and spatial analysis, and reported that he had already discussed that possibility with Thomas Leinbach at NSF. An international conference could also piggyback on one of the panel meetings. Board members noted the meeting on social science and GIS NCGIA held in the early 1990s. Goodchild thought a discipline-by-discipline approach would be more productive, citing the Eagles meeting on redistricting.

The meeting concluded as scheduled, having met its objectives. Appreciation was expressed by the board members for the quality of the interactions, as well as for the hospitality of the Varenius staff.

APPENDIX 2: GUIDELINES FOR PROPOSALS FOR SEED GRANTS UNDER THE VARENIUS PROJECT

Purpose

The purpose of seed grants is to sustain the momentum generated at the specialist meetings, and to promote the development of full proposals to NSF and other granting agencies. This program of small seed grants is in particular intended to stimulate and encourage research at a wide range of institutions, across disciplines, and with the involvement of young scholars, women, and minorities.

Amount

NCGIA anticipates making a total of \$15,000 available for small seed grants following each specialist meeting. These seed grants will be very small (order \$3,000 each) but we expect them to be useful for travel or the hiring of short-term assistants to help prepare more substantial proposals.

Eligibility

The PI on each proposal must have participated in the specialist meeting. Members of steering committees and science panels will be eligible to apply for seed grants, with the exception of science panel chairs, but will be subject to normal procedures for dealing with conflicts of interest. Applicants must be either a U.S. citizen or a U.S. resident, and affiliated with an academic institution. Researchers affiliated with the institutions of the Varenium panel chairs and director are not eligible.

Proposals

During each specialist meeting, the leaders will solicit applications for seed grants. Proposals must be submitted to a designated leader by email within three weeks of the close of the specialist meeting.

Proposals should include:

- the relationship between the proposed activity and the appropriate Varenium research initiative, with specific reference to the initiative's research agenda
- anticipated results of the funded activity (e.g. proposal prepared for submission to NSF)
- experience and qualifications of the proposing researchers (including abbreviated vitae)
- timetable
- budget, including details of any funds contributed to the project by the participants' institutions.

Proposals should not exceed two pages in length, and vitae should be abbreviated to one page. Budgets should estimate direct costs only, as the grants will be administered by direct payment from UC Santa Barbara. Approvals from university officials are not required.

Review procedure

Proposals will be circulated to all members of the initiative steering committee and the appropriate science panel, who will review and provide brief written evaluations of all submitted proposals to the science panel chair and meeting leaders. Following consultation, the science panel chair will present recommendations to the Varenius executive committee. Results will be returned no more than two months following the meeting.

Proposal evaluation criteria

The following criteria will be used:

- relevance to the core research activities of the Varenius project and the specific concerns of the sponsoring Varenius panel
- involvement of young scholars, women, and minorities
- degree to which the proposal leverages these funds from other sources
- likelihood of successful funding of subsequent proposals
- degree to which the proposed project involves collaboration between disciplines and between scholars who have not worked together before.

APPENDIX 3: INTEROPERATING GEOGRAPHIC INFORMATION SYSTEMS (INTEROP '97)

CONFERENCE PROGRAM

Wednesday, December 3rd

8:30 am: Opening and Welcome

Max Egenhofer, University of Maine, Michael Goodchild, University of California, Santa Barbara, David Schell, Open GIS Consortium

8:30-10:00 am: Session 1.1 Invited keynote presentations

The U.S. Defense Vision and its Implications for GIS Technology, Annette Krygiel, National Defense University

Semantic Interoperability in Infocosm: Moving Beyond Infrastructural and Data Interoperability in Federated Information Systems, Amit Sheth, University of Georgia

10:30-12:00: Session 2.1 - Panel Discussion: Ongoing Activities to Promote Interoperability

David Schell, Cliff Kottmann, Kurt Buehler, and Greg Buehler, Open GIS Consortium, Alan Gaines, National Science Foundation, Robin Fegeas, U.S. Geological Survey, Greg Smith, National Imagery and Mapping Agency:

1:30-3:00 - Two Concurrent Sessions: Session 3.1 - Theory of Interoperating GISs

Interoperability and Spatial Information Theory, Andrej Vckovski, University of Zurich, Switzerland

A Specification Language for Interoperable GIS, Andrew Frank, Technical University of Vienna, Austria, Werner Kuhn, University of Muenster, Germany

Session 3.2 The Institutional Context of Interoperation

Real-World Lessons in Organizational and Technological Interoperability for Geographic Information Infrastructures, John Evans, Massachusetts Institute of Technology

Planning in Spatial Internet Marketplaces, Volker Gaede, CSIRO, Australia

Probing the Concept of Information Communities: A Road Towards Semantic Interoperability, Y.A. Bishr, ITC, The Netherlands, H. Pundt and W. Kuhn, University of Muenster, Germany, M. Molenaar and M. Radwan, ITC, The Netherlands

Interoperability through Organization: The Role of Digital Libraries in Distributed Knowledge Management, Xavier Lopez, University of California, Berkeley

3:30-5:00 - Three Concurrent Sessions: Session 4.1 Semantic Interoperability

Accounting for the Semantic Differences between Various Geographic Information Systems, Mark Gahegan, Curtin University of Technology, Australia

Designing for Interoperability Overcoming Semantic Differences, Francis Harvey, EPFL-IGEO-SIRS, Lausanne, Switzerland

Development of a Global Conceptual Schema for Interoperable Geographic Information, May Yuan, University of Oklahoma

Session 4.2 Interoperation in the Transportation Domain

The Need for a Formal GIS Transportation Model, Stephen Bepalko, Sandia National Laboratories, Max Wyman, Terra Genesis, Tempe AZ, John Sutton, GIS/Trans Ltd.

Real-Time Data Exchange and Interoperability, Fred Latham and David Siegel, Viggen Corp, Knoxville TN, Demin Xiong, Oak Ridge National Laboratory

Interoperability Issues in Intelligent Transportation Systems: Testing the Cross Streets Profile, Val Noronha, University of California, Santa Barbara

Assessing Topological Similarity of Spatial Networks, John Nystuen, Andrea Frank, and Larry Frank, University of Michigan

Session 4.3 Systems Experiences I

GeoToolKit: Opening the Access to Object-Oriented Geodata Stores, Oleg Balovnev, Martin Bruenig, Armin Cremers, and Serge Shumilov, Institute of Computer Science III, University of Bonn, Germany:

Interoperability of Geographic Information: From the Spreadsheet to Virtual Environments, Pedro Pereira Gonçalves, Nelson Neves, João Silva, Joaquim Muchaxo, and António Câmara, New University of Lisbon, Portugal

A Virtual Geospatial Information Server (VGIS) Providing Transparent Access to Heterogeneous Sources, Changchu Wang, Liya Ding, and Jiankang Wu, National University of Singapore

Thursday December 4th

8:30-10:00: Session 5.1 Invited Keynote Presentations

Jeff Dozier, University of California, Santa Barbara

From GISystems to GIServices: Spatial Computing on the Internet Marketplace, Oliver Guenther, Humboldt University, Berlin

10:30-12:00 Three Concurrent Sessions: Session 6.1 Conceptual Design

A GIS Interoperability Approach Based on ISO RM-ODP and ISO CSMF, Arne-Jurgen Berre, Vidar Knudsen, and Jon Oldevik, SINTEF Telecom and Informatices Oslo, Norway

A Middleware for Transparent Access to Multiple Spatial Object Databases, Sang Cha, Kihong Kim, Changbin Song, Jookwan Kim, Jooyong Jun, and Yongsik Kwon, Seoul National University, Korea

Constraint-Based Interoperability of Spatiotemporal Databases, Jan Chomicki, Monmouth University, Peter Revesz, University of Nebraska, Lincoln NE

Session 6.2 Interoperation in the Environmental Domain I

Interoperable GIS Applications: Tightly Coupling Environmental Models with GISs, Hassan Karimi, NC Supercomputing Center, Research Triangle Park NC

Integrating Environmental Models and GIS in the Framework of GIS Interoperability, Ling Bian, SUNY Buffalo

Spatial Process Modelling and Interoperability, Andrew Marr, Stephen MacDonnell, and George Benwell, University of Otago, New Zealand

Interoperability with the Earth Science Remote Access Tool (ESRAT), Robert Raskin and Elaine Dobinson, Jet Propulsion Laboratory, Pasadena CA

Session 6.3 Systems Experiences II

The Geospatial Interoperability Problems: Lessons Learned from Building the GeoLens, Cliff Behrens, Bell Communications Research, Leon Shklar, Pencom Web Works, Chumki Basu, Bell Communications Research, Nancy Yaeger, NCSA, Edith Au, Pencom Web Works

Inteoperating GISs Using the Open Geospatial Datastore Interface (OGDI), Paul Morin, J2 Geomatics, Ottawa, Ontario, Canada, Denis Gouin, Defence Research Establishment, Val-Belair, Quebec, Canada, Gilles Clement and Christian Larouche, Logiciels et Applications Scientifiques Inc, Laval, Quebec, Canada

GEOLIB: A Software Component for Making GIS Tools Interoperable, Donatas Kvedarauskas, Patrice Boursier, University of La Rochelle, France, Xavier Culos, Thierry Deltheil, and Sylvie Iris, SILOGIC, Toulouse, France

1:00-2:30 Three Concurrent Sessions: Session 7.1 Interoperation in the Environmental Domain II

FRIEND: Framework for the Integration of Environmental and Geographical Data, Martin Brändli and Andreas Ernst, University of Zurich, Switzerland

Comparing Approaches to Cooperation between GIS and Simulation Models to Identify Criteria for Interoperation, Neil Stuart, University of Edinburgh, UK

Using Design Pattern to Define Interoperable GIS Models, F. Balaguer and S. Gordillo, UNLP, Buenos Aires, Argentina

Session 7.2 Distributed Processing

Implementation of the OGIS Simple Feature Interface, Scott Morehouse, ESRI, Redlands CA

Query Processing in Distributed Spatial Databases, Walid Aref, Panasonic Technologies Inc, Princeton NJ

A Spatio-Temporal Deductive System for Marine Ecosystem Monitoring, M.E. Carboni, F. Giannotti, and M.V. Masserotti, CNUCE-CNR, Pisa, Italy

Supporting Interoperation of GIS Objects, Silvia Nittel and Richard Muntz, University of California, Los Angeles

Session 7.3 Systems Experiences III

Hot Links as a New Way of Data Integration in a Distributed Computing Environment, Andre Hagehuelsmann, Free University of Berlin and Intergraph Germany

IRIS: A Tool to Support Data Analysis with Maps, Gennady and Nathalia Andrienko, German National Research Center for Information Technology, Sankt-Augustin

Information Brokers for a Web-Based Geographic Information System, Ian Finch and Eleanor Small, University of Liverpool, UK

3:00-4:30 Four Concurrent Sessions: Session 8.1 Theory of Interoperating GISs II
A Request Specification Language for Spatial Internet Marketplaces, Volker Gaede, Kerry Taylor, and Xiaofang Zhou, CSIRO, Australia

Interoperability by Exchanging Executable Content, or What Have PostScript and Java in Common? Andrej Vckovski, University of Zurich. Switzerland

The Use of Functional Programming in the Specification and Testing Process, Werner Kuhn, University of Muenster, Germany, Andrew Frank, Technical University of Vienna, Austria

Session 8.2 Interoperating GISs in Large Organizations

A Web-Based Scientific Data Server for Accessing and Distributing Earth Science Data, Liping Di, R. Suresh, K. Doan, and Doug Ilg, Hughes STX Corporation, Ken McDonald, NASA Goddard Space Flight Center, Greenbelt MD

Geospatial Modelling: A Case Study for a Statewide Land Information Strategy, David Pullar, University of Queensland, Kristin Stock, Queensland Institute of Technology, Australia

Spatial Database Design for GIS Interoperability, Lorri Peltz, Marianne August, and Rose Medina, U.S. Geological Survey

Session 8.3 Heterogeneous Environments of the Internet

A Framework for Geographical Modeling in a Heterogeneous Computing Environment, David Bennett, Raja Sengupta, and Greg Wade, Southern Illinois University:

Automated Metadata Interpretation to Assist in the Use of Unfamiliar GIS Data Sources, Brandon Plewe and Steven Johnson, Brigham Young University

Software Agent-Oriented Frameworks for the Interoperability of Geomatics Systems: From Fundamental Concepts to the SIGAL Project, Z. Maamar, B. Moulin, Y. Bedard, and G. Babin, Laval University, Quebec, Canada

Session 8.4 Systems Experiences IV

Using the Internet to Access Geographic Information: An Open GIS Interface Prototype, Frederico Torres Fonseca, and Clodoveu Augusto Davis Jr., PRODABEL, Belo Horizonte, Brazil

Some Examples of the Usage of Internet/Intranet Technology in GIS, Wolfgang Reinhardt, Institute for Geoinformation and Land Development, Neubiberg, Germany

Multi-Server Internet GIS: Standardization and Practical Experiences, Carel van den Berg, Frank Tuijnman, and Tom Vijlbrief, Professional GEO Systems, Amsterdam, The Netherlands, Co Meijer, Harry Uitermark, and Peter van Oosterom, Cadastre, Apeldoorn, The Netherlands

4:30-6:00: Session 9.1 Closing Panel: Building the Research Agenda

Michael Goodchild, University of California, Santa Barbara, Max Egenhofer, University of Maine, Andrew Frank, Technical University of Vienna, Austria, Derek Reeve, University of Huddersfield, UK, Cliff Kottman, Open GIS Consortium

APPENDIX 4: PUBLICATIONS BY NCGIA PERSONNEL

A. Articles published or formally accepted in refereed journals

- Agouris, P., A. Stefanidis, and K. Beard (in press) Digital photogrammetric techniques for transportation data acquisition and management. *Transportation Research Record*.
- Beard, K. and V. Sharma (1997) Multidimensional ranking for data in digital spatial libraries. *International Journal on Digital Libraries* 1(2): 153–160.
- Bian, L. (in press) Effects of watershed discretization on estimation of hydrologic parameters. *Transactions in GIS*.
- Bian, L. and E. West (1997) Modeling elk calving habitat in a prairie environment. *Photogrammetric Engineering and Remote Sensing* 63(2): 161–167
- Bjorke, J.T. and B. Smith (1996) Seriation: An implementation and case study. *Computers, Environment and Urban Systems* 20(6): 427–438.
- Bruns, T. and M. Egenhofer (1997) User interfaces for map algebra. *Journal of the Urban and Regional Information Systems Association* 9(1): 44–54.
- Chakraborty, J. and M.P. Armstrong(1997) Exploring the use of buffer analysis for the identification of impacted areas in environmental equity assessment. *Cartography and Geographic Information Systems* (24)3: 145–157.
- Church, R.L., D.M. Stoms, and F.W. Davis (1996) Reserve selection as a maximal covering location problem. *Biological Conservation* 76(2): 105–112.
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- Sato, T., J. Kojima, and H.A. Loaiciga. Macroscopic model for ground water analysis: the Ibi River Basin, Japan. *Ground Water*.
- Sheikholeslami, G., A. Zhang, and L. Bian. A multi-resolution content-based retrieval system for geographical images. *Geoinformatica*.
- Trice, M., and L. Bian. A comparison of spatial interpolators for water temperature and Chlorophyll-A density data collected with an optical plankton counter. *Transactions in GIS*.
- Wang, Q. and L. Bian. Effects of land use on residential house price: an empirical study of Lawrence, Kansas. *Papers in Regional Science*.
- Zhao, P. and R. Batta. Analysis of centroid aggregation for the Euclidean distance p-median problem. *European Journal of Operational Research*.
- Zhao, P. and R. Batta. An aggregation approach to solving the network p-median problem with link demands. *Networks*

APPENDIX 5: EXTRAMURAL SUPPORT

A. Research grants and contracts

US Department of Justice, “ICOPs Problem-Solving Partnership: Reducing Crime, Disorder and Fear Through Community Partnerships and Problem Solving. 9/1/97–8/31/98, \$67,900, Pamela Beal, Hugh Calkins, and J. Gymerah.

ESRI (subcontract from National Institute of Justice): “Response to National Institute of Justice Solicitation for Technology Research and Development Partnership Projects for Community Policing”. 12 mos, \$182,000, Ezra Zubrow, Hugh Calkins, Peter Rogerson, and S. Halpern.

Calspan UB Research Foundation (subaward from NYS Department of Transportation): “Intelligent Transportation Systems Benefits and Costs”. 18 mos, \$87,893, Jean-Claude Thill.

National Science Foundation: “High-Risk Research: OULU Finnish Russian Border Survey”. 24 mos, \$20,000, Ezra Zubrow

Central Intelligence Agency: “Heterogeneous Geographic Databases: Similarity Assessments, Year 2.” 5/1/96–4/30/97, \$209,677, Max Egenhofer

Office of Research and Development: “Image-Query-by-Sketch.” 7/1/96–6/30/97, \$79,694, Max Egenhofer and Peggy Agouris

United States Geological Survey: “Scale and Accuracy Issues in the Use of Orthoimagery within NSDI.” 7/1/96–6/30/97, \$34,325, Peggy Agouris, Kate Beard, and Anthony Stefanidis

National Science Foundation: “RIA: Formalization, Inference, and Query Processing of Spatial Relations in Geographic Space.” 9/1/1993–2/15/1998, \$97,300, Max Egenhofer

National Science Foundation: “National Partnership for Advanced Computational Infrastructure”. 1997–1998, \$250,000, PI: Smith.

National Imagery and Mapping Agency: “Uncertainty in Geospatial Information Representation, Analysis, and Decision Support”. 5/15/97–5/14/00, \$600,000, Goodchild, Montello, Beard, Clarke.

U.S. Geological Survey: “Project GIGALOPOLIS: Multiscale Calibration and Extension of a Predictive Land Transformation Model”. 8/15/96–9/30/97, \$62,000, Clarke.

Viggen Corporation: “Spatial Data Interoperability Testbed Support”. 8/1/97–11/30/97, \$42,200, Church, Goodchild.

California Department of Transportation: “System Integration Issues of Distributed Navigable Database Design and Implementation”, 7/1/94–12/31/2003, \$260,000, Church, Goodchild.

U.S. Forest Service: “Regional Ecosystems and Land Management Decision Support System”, 8/1/97–12/31/97, \$22,500, Church.

National Aeronautics and Space Administration: “Modeling and Prediction of Wildfire Hazard in Southern California, Integration of Models with Imaging Spectrometry”, 7/1/97–6/30/98, \$75,000, Roberts, Church.

U.S. Forest Service: “Extending Functionality on the Regional Ecosystem and Land Management Decision Support System”, 9/3/96–9/30/97, \$50,000, Church.

National Science Foundation: “Multi-Modal Spatial Querying.” 9/1/1996–8/31/2000, \$482,000, Max Egenhofer and Scott Overmyer

National Aeronautics and Space Administration (NASA): “Center of Excellence in Remote Sensing Applications.” 11/1/97–10/31/98, \$282,868, Steve Sader, Peggy Agouris, Kate Beard, Max Egenhofer, Anthony Stefanidis, Andrew Thomas

National Imagery and Mapping Agency: “Similarity Assessments Based on Spatial Relations and Attributes.” 5/15/97–5/14/2000, \$599,990, Max Egenhofer

National Science Foundation: “CAREER/EPSCoR: Geospatial Database-Driven Extraction of Information from Digital Aerial Imagery.” 8/15/97–6/30/2001, \$322,712, Peggy Agouris

National Science Foundation: “Application of Spatial Concepts for Genome Data.” 7/97–7/99, \$329,049, Kate Beard, Carol Bult, and Max Egenhofer

National Science Foundation: “UCGIS Summer Assembly and Retreat: Support for Graduate Student Travel.” 1/1/97–12/31/97, \$10,000, Harlan Onsrud

National Science Foundation: “Data and Information Management System for the Gulf of Maine.” 1/1/96–2/31/97, \$35,000, Kate Beard

United States Geological Survey: “Public Educational Access to resources on Lakes in Maine.” 9/1/97–8/31/99, \$78,628, Kate Beard and Steve Kahl

National Imagery and Mapping Agency (subcontract through University of California at Santa Barbara): “Uncertainty in Geospatial Information Representation, Analysis and Decision Support.” 5/15/97–5/14/2000, \$129,357, Kate Beard

Central Intelligence Agency, “Heterogeneous Geographic Databases: Qualitative Spatio-Temporal Inferences.” 6/1/1997–5/31/1998, \$220,000, Max Egenhofer

B. Equipment and software acquisitions

Santa Barbara

Ext. 23GB Subsystem
 Quickstream Pro Server
 Apple PowerMac Computer
 Intel Pentium Computer
 Intel Pentium Computer
 ESRI Support License Renewal

Maine

Macintosh Powerbook 1400c/117
 Power Macintosh 7600/132
 Epson Stylus Color 1520 printer
 Wacom Artz 12x12 Tablet for PC
 Macintosh Powerbook 3400c/200 (4)

Color Stylewriter 6500 printer
Microsoft Powerpoint 4.0
Adobe PageMill 2.0.1
Digital Unix Alpha Media & Documentation, Version 4.0C
Macromedia Director Studio 6.0
Micrografx Graphics Suite 2.0
Macromedia Freehand v7.0
Claris Home Page v2.0
Mac x 1.5
MS Office 4.21 for Macintosh (2)
Norton Utilities v3.5 for Macintosh (2)
Microstation Academic Suite
Virtual PC v1.0 w/Windows 95
Visual Cafe v2.0
Visual Studio 97 pro
Corel Draw v7.0
Frontpage 97

APPENDIX 6: PRESENTATIONS BY NCGIA PERSONNEL

January: Barry Smith delivered the talk “The Metaphysics of Real Estate” at the Department of Economics, New York University; gave the talk “Libertarianism, Monarchy, and Property Rights” at the Department of Philosophy, Rochester Institute of Technology, Rochester, NY; spoke on “The Geometry of War” at the University of Malta Foundation for International Studies, Valletta, Malta; and delivered the talk “Common Sense: A Guide for Robots”, at the Philosophy Club, University of Malta.

January 13–15: Anthony Stefanidis attended the annual conference of the Transportation Research Board and gave a presentation “Digital Photogrammetric Techniques for Transportation Data Acquisition and Management”.

January 15–16: Peggy Agouris and Anthony Stefanidis were invited by Intergraph Corporation to the Huntsville, AL headquarters, for the presentation of their new softcopy photogrammetric workstations.

January: Karen Kemp presented three lectures on Geographic Information Science at the Regional Workshop on Integrated Environmental Information Systems, in Cairo, Egypt.

January: Michael Goodchild presented “Environmental Information Management—A Learned Perspective” at Royal Roads University, Victoria, BC.

Jan. 29: David Mark and Michael Goodchild participated in the UCGIS Congressional Breakfast, Capitol Hill, DC.

February: Michael Goodchild presented “Modern Geographic Information Systems and Model Linking” at Wageningen Agricultural University, Netherlands; and gave a keynote presentation “Geographic Data and the New Information Profession” at the annual conference of ALISE, Washington DC.

February: Karen Kemp made a presentation on NCGIA's Core Curricula at GIS '97, in Vancouver.

February: PhD Candidate Valerie Hartung presented “Inter-Firm Collaborative Efforts in the GIS Industry: Canadian and U.S. Comparisons” at the 2nd Annual “Crossing Borders” student conference, sponsored by the Golden Horseshoe Alliance, Niagara University, Niagara Falls, NY.

February 14: Karen Kemp made a presentation to the Rotary Club of Nanaimo, British Columbia, entitled “GIS - What's it all about?”

February 24–25: Max Egenhofer, Peggy Agouris, Tony Stefanidis, and Doug Flewelling attended a Heterogenous Geographic Databases project meeting, Washington, DC.

Feb. 28–March 1: The NCGIA Workshop “Geographies of the Information Society”, Santa Barbara, CA, was attended by John Krygier, David Mark, and Munroe Eagles of NCGIA-Buffalo. Max Egenhofer, Harlan Onsrud, and Paul Schroeder attended from Maine.

March 1: Steve Palladino assisted in the organization of and made a presentation on “GIS in the Community Colleges” at a meeting of Southern California Community

College Geographers at UCLA.

March: Barry Smith visited the Department of Philosophy, Turku University, Turku, Finland and gave the lecture “New Directions in Applied Metaphysics”.

March: Barry Smith delivered the lecture “Prolegomena to a Metaphysics of Real Estate”, Society for Philosophy and Geography, Session at the American Philosophical Association Pacific Division Meeting.

March 24–25: Paul Densham attended the International Workshop on GIS in Spatial Population Analysis and Regional Economic Development, Chinese University of Hong Kong, Hong Kong. He was invited to give the paper “The Role of GIS in a European Migration Information System” with J. Salt. Peter Rogerson presented his paper “The Geography of Elderly Minority Populations in the United States”.

March 24–25: Max Egenhofer attended a program committee meeting of the Fifth International Symposium on Large Spatial Databases, Paris.

March 25–27: Doug Flewelling attended the Advanced Information Processing Application Symposium, McLean, VA.

April: Barry Smith spoke on “The Political Economy of Geography” at the Austrian Scholars Conference, Ludwig von Mises Institute, Auburn University, Auburn, AL.

April 1–5: The Annual Meetings of the Association of American Geographers were held in Fort Worth, TX. Presentations included: Marc Armstrong and J. Chakraborty, “Geographical Constraints on Environmental Equity Assessment”; Ling Bian and M. Trice, “Spatial Interpolation of Lake Ontario Fisheries Data”; Emil Boasson and Sam Cole, “Object Oriented Spreadsheet GIS: Spatial Decision Support System for Location Analysis in Aruba”; Sam Cole, “Living with Uncertainty, Disasters, and Acts of God”; Valerie Hartung, “Sources of Innovation in the GIS Industry: The Role of Inter-Firm Collaboration”; David Howes and Athol Abrahams, “Modeling Water Sediment and Nutrient Fluxes in a Desert Shrubland Ecosystem”; Laura Kracker, “Spatial Modeling of Fish Growth Rates: A 3-Dimensional View of Lake Ontario”; David Mark, “Varenius: The NCGIA's Project to Advance Geographic Information Science”, “UCGIS: Results of a Year of Coordinated Effort”, and “Naive Geography: Formal Models of Common-Sense Geographic Worlds”; J.-C. Thill, “Non-Work Travel Behavior and Urban Land Use Patterns: A Study of Constraints on Activity Spaces in Minneapolis-St. Paul”, and “Teaching and Learning with SimCity 2000”. Karen Kemp served as a panel member on the Varenius Project panel and the UCGIS Virtual Seminar panel. On April 3, Lola Gulyamova presented the paper “Using the Geographical Images for Study of the Population in Central Asia”. Kevin Curtin, graduate research assistant at NCGIA Santa Barbara, gave a Poster Presentation entitled “Georeferencing of Landsat Scenes and Hydrologic Network Generation”. Steve Palladino presented a paper entitled “A GIS Core Curriculum for the Community Colleges”.

April 4: Munroe Eagles gave the talk “The Political Ecology of Local Party Organization in Canada” at the Regional Research Institute, West Virginia University, Morgantown, WV.

April: Steve Palladino was a featured speaker for American River College's “GIS Day” and presented “The NCGIA CCTP Project”.

April 4: Munroe Eagles gave the talk “The Political Representation of Representation in Canada” to the Department of Political Science, West Virginia University, Morgantown, WV.

April 6–9: Hugo Loaiciga was a speaker presenting “Methods for sustainable management of ground water resources with a case study”, at the 24th Annual Conference of the Water Resources Planning and Management Division, American Society of Civil Engineers, in Houston, Texas. Loaiciga also presented “Specification of ground water recharge in sustainable ground water management models” at that same conference.

April: Karen Kemp participated in and presented two papers at the Joint European Conference and Exhibition on Geographical Information in Vienna. The papers presented were “Varenius: NCGIA's Project to Advance Geographic Information Science” and “The new on-line NCGIA Core Curriculum in Geographic Information Science”.

April 7: J.-C. Thill attended the Third Conference of the Intelligent Transportation Society of New York, “Technologies and Applications for ITS at International Borders”, University at Buffalo, Buffalo, NY

April 7–13: PhD candidate Andre Skupin attended AutoCarto 13, Seattle, WA. He presented the paper “Spatial Metaphors for Visualizing Information Spaces” (co-authored with B. Battenfield). Two of Marc Armstrong’s co-authored papers were presented, and also appeared in the proceedings of the conference: “Toward a network map algebra” with Paul Densham; and “Linking geographic models with 2D genetic algorithms to explore semi-structured spatial problems” with D.A. Bennett and G. Wade. Max Egenhofer, Kate Beard, and Paul Schroeder attended from Maine. Karen Kemp presented the paper “Integrating Traditional Spatial Models of the Environment with GIS”.

April 7-10, Peggy Agouris, Tony Stefanidis, and James Carswell attended the ASPRS 1997 meeting, Seattle, WA. Agouris presented “Scale and Accuracy Issues in the Use of Orthoimagery within NSDI” and Stefanidis presented “Digital Image Retrieval Using Queries on Shape Information.”

April 8: Lola Gulyamova, Fulbright Scholar and visiting researcher with NCGIA Santa Barbara, made a presentation entitled “Rural population of Central Asia and Environmental Problems” to the Bureau of Oceans and International Environmental and Scientific Affairs, Department of State, in Washington, DC.

April 9–10: Paul Densham was an invited participant at the Expert Group Meeting on Planning Support Systems at Environmental Systems Research Institute, Redlands, CA. His presentation was “Small Scale Models”. Helen Couclelis was an invited participant and speaker.

April 11: Lola Gulyamova made a presentation “Geography of Population in Uzbekistan” at Hunter College, in New York, NY.

April 15: Lola Gulyamova made a presentation “Changes in the Urban/Rural Population Distribution in Uzbekistan” at Clark University, Worcester, Massachusetts.

April 17: Lola Gulyamova made a presentation entitled “Study of the Rural Population in Central Asia: Uzbekistan” at State University of New York in Buffalo.

April 17–19: Max Egenhofer and Martin Raubal attended the Workshop on the History of

Space, Buffalo, NY.

April 23–May 3: Hugo Loaiciga was a guest lecturer at the seminar “Quality and Quantity of Ground Water Estimated from Macroscopic Model in the Ibi river Basin, Japan”, at the 5th Scientific Assembly of the International Association of Hydrological Sciences, in Rabbat, Morocco. Loaiciga also presented “Sustainable Management of Aquifers” and “Investigating Catchment Hydrology and Low-flow Characteristics Using GIS” at that same assembly.

May: Michael Goodchild presented “The GIS Research Agenda” at University College, London, Centre for Advanced Spatial Analysis and Department of Photogrammetry and Surveying; “From GIS to Geographical Information Science” at the London School of Economics; and “Research and Development: What has been achieved so far?” and “Spatial Information and Its Impact on Society” at the Conference: 10 Years After Chorley: The future for geographic information at The Royal Society, London.

May: Peter Rogerson’s paper “The Demography and Geography of the Baby Boom” was presented at the Conference on Migration and Restructuring, University of Georgia.

May: Michael Goodchild presented “NCGIA's Varenus Project: Advancing Geographic Information Science” at the University of Newcastle-upon-Tyne.

May 3–8: Rajan Batta and PhD candidate Vedat Agkun attended INFORMS, San Diego. The following papers were presented: V. Akgun, R. Batta and C.M. Rump, “Routing a Truck with Hazardous Materials in the Presence of a Weather System” (presented by Akgun), and L. Ma and R. Batta, “Dynamic Single Facility Location with Movement Restrictions” (presented by Batta).

May 4–8: Peggy Agouris attended the Workshop on Automatic Extraction of Man-Made Objects from Aerial and Space Images, Ascona, Switzerland.

May 15–21: Harlan Onsrud attended the European Research Conference “Socio-Economic Research and Geographic Information Systems,” Lucca, Italy, and presented “Geographic Information and Ethical Issues”. Michael Goodchild presented “GIS, Spatial Analysis, and the Geographical Key”.

May: Harlan Onsrud presented “Dissemination Policies and Liability for Government Spatial Data,” Lausanne, Switzerland.

June: J.-C. Thill visited the NAFTA Intermodal Institute to discuss possible cooperative between NAFTA and NCGIA in developing the GIS capability of the NAFTA Institute.

June: John Krygier attended the Virtual Geography Dept. Workshop in Austin TX and gave a presentation on World Wide Web page design

June 5–6: Keith C. Clarke organized and served as the co-chair of the Land Use Modeling Conference, held in Sioux Falls, South Dakota. Clarke also attended the first Technical Review Meeting of the USGS Urban Retrospectives and Urban Dynamics Initiative, in Denver, CO.

June 8–10: Munroe Eagles attended the meetings of the Canadian Political Science Association, Memorial University, St. John's, Newfoundland, and presented the paper: “The Political Ecology of Representation in English Canada: MPs and Their

Constituencies”.

June 15–21: UCGIS Annual Assembly and Summer Retreat, Bar Harbor, ME. Mark Trice presented the paper with L. Bian “Comparison of spatial interpolators for mapping optical plankton counter data collected in Lake Ontario”; Jean-Claude Thill presented “Spatial Reasoning, Spatial Behavior, and Decision Tree Induction” (co-authored with Aaron K. Wheeler); Valerie Hartung presented her paper “An Economic Perspective of the GIS Industry”; David Mark presented the paper (co-authored) “The GIS History Project”. Karen Kemp served as Conference Co-chair. Paul Van Zuyle attended and made a presentation entitled “A Cognitive Model for Data Reduction in Map Displays”. Michael Goodchild presented “Views from the U.S. Mapping Science Committee: Past, present, and future”.

June 20–21: Peggy Agouris and Tony Stefanidis attended the IEEE Workshop on Content-Based Access of Video and Image Libraries, San Juan, Puerto Rico.

June 23–27: Tapani Sarjakoski, former visiting researcher at NCGIA Santa Barbara, presented a paper entitled “Networked GIS for Public Participation in Spatial Planning and Decision-Making”, at the 18th ICA/AC International Cartographic Conference ICC97, in Stockholm, Sweden.

June 27–28: Harlan Onsrud attended the “U.S. Geographic Information Resources” meeting, Washington, DC.

June: Michael Goodchild spoke on “The New Generation of Scholars: Do They Really Need Us?”, an invited presentation at the Association of College and Research Libraries, American Library Association, San Francisco. At ESIG '97 in Lisbon he presented “An Update on the US National Center for Geographic Information and Analysis” and “GIS and Its Impacts on Organizations: Effects of New Technologies”. At SCANGIS '97 in Stockholm he gave the keynote presentation “The GIS Research Agenda”.

July 7–11: Hugh Calkins and Martin Camacho attended the Environmental Systems Research Institute’s 17th Annual Conference, San Diego, CA. Karen Kemp served as a panel member for the report on UCGIS Education Priorities.

July 8–10: Doug Flewelling attended the Joint Workshop on Metadata Registries, Berkeley, CA.

July 15–18: Max Egenhofer attended the Fifth International Symposium on Large Spatial Databases, Berlin, Germany.

July 21–23: Harlan Onsrud attended the 1997 URISA meeting and presented “GIS and Privacy: A U.S. Perspective”, Toronto, Canada.

July 27–28: Max Egenhofer attended the annual meeting of the American Association for Artificial Intelligence and participated in a panel discussion in the Workshop on Spatial and Temporal Reasoning, Providence, RI.

July 27–29: Helen Couclelis served as the Co-chair for the NSF Workshop on “Urban Interactions” in Arlington, Virginia.

August 18–19: David Mark and Max Egenhofer participated in the Project Varenus Advisory Board meeting in Santa Barbara.

August 19–21: Max Egenhofer visited Oracle Corporation, San Jose, CA, to discuss potential research collaboration.

August 24–28: Tim Hodson, UMaine graduate student, attended the conference “iKusasa - Surveying Tomorrow's Opportunities - Consas 97,” Durban, South Africa.

September: Michael Goodchild presented “New Directions in the Information Sciences” at the University of Wyoming, and spoke in the “GIS and Geography: Presidential Session”, Association of Pacific Coast Geographers, Spokane, WA.

September: Barry Smith spoke on “Paradoxes of Contact and Separation” at the Department of Philosophy, University of Helsinki.

Sept. 9–10: David Mark represented UCGIS at the FGDC monthly meeting and retreat, Washington, DC.

Sept. 13–16: Munroe Eagles presented “Socio-Economic Research and GIS” at the “Geographic Information Research at the Millennium” GISDATA Final Conference, Le Bischenberg, France. Harlan Onsrud attended from Maine. Helen Couclelis served as a Panel member for GIS and Society. Michael Goodchild was an invited discussant of the paper “Geographic Information Research at the Millennium”.

September 16–17: Kate Beard attended the IEEE 2nd Metadata Conference, Bethesda, MD.

September 18–20: Hugo Loaiciga presented “Water conservation, water pricing, and droughts in Central California: a historical perspective” at the Southern California Environment and History Conference at California State University in Northridge, California.

September 21–27: Hugo Loaiciga presented “Sustainable management of a coastal urban aquifer” at the XXVII Congress of the International Association of Hydrogeologists in Nottingham, United Kingdom.

Sept. 26: David Mark delivered an invited lecture to the Department of Geography, Rutgers University.

September 29: Hugo Loaiciga was a speaker at the seminar “Global Issues on Sustainable Ground Water Resources Management” at the Department of Geology, University of Copenhagen, Copenhagen, Denmark. Loaiciga also made the presentation entitled “Mathematical model for renewable ground water withdrawal in a coastal aquifer”, at a seminar at the National Environmental Research Institute, Roskilde, Denmark.

October: Michael Goodchild presented “Cartography and Geographic Information Systems” at the National Academy of Sciences, Academy Industry Program, Forum on Imaging and Visualization, Newport Beach; gave the keynote presentation “The Future of Spatial Data and Society”, Geomatics Atlantic '97, Halifax, Nova Scotia; presented “Geographic Information Technologies Transform the Information Professions” at Dalhousie University; and gave the keynote presentation “Conference Assessment and Future Trends for GIS” at the Third GIS Asia Pacific Conference, Jakarta.

October: At the National Council for Geographic Education Annual meeting in Orlando, Steve Palladino presented a paper titled “Developing a GIS Core Curriculum for

Technical Programs: Progress Report” and was a panelist in a session titled “GIS in the Community Colleges: Ideas for Implementation”.

October: Rajan Batta presented the paper “Improved Police Car Allocation in the City of Buffalo” (co-authors: S.J. D’Amico, R. Batta and C.M. Rump), INFORMS, Dallas, TX.

October: Barry Smith delivered a Public Lecture (as Distinguished Visiting Scholar) at James Madison University, Harrisonburg, VA, “The State as Work of Art”.

October 6: Hugo Loaiciga served as a Panelist at the White House Global Change Regional Conference held at the University of California, Los Angeles (sponsored by the United States Environmental Protection Agency, Region IX).

October 10–13: Max Egenhofer, Peggy Agouris, Kate Beard, Tony Stefanidis, and graduate students Sotirios Gyftakis, Aparna Yerragudi, Martin Raubal, James Carswell, and NCGIA-Maine visitors Tom Bittner and Marisa da Motta attended the NCGIA Annual Assembly, Buffalo, NY. From Santa Barbara, Violet Gray, Mike Goodchild, Dan Montello, Keith Clarke, and Karen Kemp attended.

Oct. 15–18: COSIT ‘97, Pittsburgh, PA; David Mark, who was co-chair of the conference, attended and chaired a session; Barry Smith, who was a member of the program committee, presented “Fiat and Bona Fide Boundaries (co-authored with Achille Varzi). From Maine, Max Egenhofer, Doug Flewelling, and graduate students: Andreas Blaser, Roop Goyal, Kathleen Hornsby, Joao Paiva, Martin Raubal, and Andrea Rodriguez and NCGIA visitors Thomas Bittner and Isolde Schlaisich attended. Helen Couclelis presented the paper co-authored by Jon Gottsegen, “What maps mean to people: denotation, connotation, and geographic visualization in land-use debates”. Violet Gray gave a paper presentation entitled “Classification as an Impediment to the Reliable and Valid Use of Spatial Information: A Disaggregate Approach”.

Oct. 27: David Mark and Ling Bian attended the UCGIS Meetings in Cincinnati Ohio.

Oct. 28–30: GIS/LIS, Cincinnati, Ohio. Presentations included: Marc Armstrong, “Emerging technologies and the changing nature of work in GIS” with J. Chakraborty; “Assessing the impact of segregation on environmental equity using GIS” with B. Cramer, and “Evaluating parallel approaches to the interpolation of spatially inhomogenous data”; David Mark, “The History of Geographic Information Systems: Invention and Re-Invention of Triangulated Irregular Networks (TINS)”; Jian Fan, “Using GIS to Study Effects of sub-watershed size on stream chemistry” (Co-authored by Fan with David Wolock and Gregory Lawrence); Ling Bian, “Modeling mobile objects in three-dimensional aquatic system using object-oriented design”. Harlan Onsrud attended from Maine.

October 30: Karen Kemp served on the Steering Committee and was the Conference Chair of the Third International Symposium on GIS in Higher Education in Chantilly, Virginia, October 30–November 2 (co-sponsored by NCGIA). Steve Palladino participated as a Steering Committee member, track organizer, presenter, and discussion leader at this Symposium.

October 30: Paul Van Zuyle presented “A Cognitive Model for Data Reduction in Map Displays” to a group at NASA Langley Research Center in Hampton, Virginia.

Oct. 30–31: David Mark was a Participant, Workshop on “Social Science Collaboratories”, National Science Foundation, Arlington, Virginia.

Oct. 30–Nov. 2: Emil Boasson attended the Third International Symposium on GIS in Higher Education, Chantilly, VA. He presented “A spreadsheet approach to teaching object oriented GIS”.

November: Michael Goodchild spoke on “New Directions in Geographic Information Science” at the University of Wisconsin, Madison; on “National Science Priorities in Geoinformatics” at a conference titled Networking Resources for Competitive Earth Systems Science sponsored by the American Association for the Advancement of Science, Sioux Falls, SD; and gave the University Harris Lecture on “From GIS to Geographic Information Science: New Directions in Geographic Research” at Texas A&M University.

November: Steve Palladino attended as the NCGIA representative and contributed a poster at the Principal Investigators meeting for the National Science Foundation Advanced Technological Education Program in Washington, DC.

Nov. 6–8: Munroe Eagles presented “GIS and Political Research” at the Southern Political Science Association annual meeting, Norfolk, VA.

Nov. 6–9: North American Meetings of the Regional Science Association, Buffalo, NY. Presentations by NCGIA included Xiaobai Yao, “A Decision Support System for land use planning and management: a case study in Shanghai” (co-authored with Jean-Claude Thill); Jean-Claude Thill, “Travel-Time Constraints as Limiting Factors in Non-Work Travel: Evidence of Inter-Personal Variations”, “Model Development of Hazardous Material Routing in a GIS” (J.C. Thill, W. Frank and R. Batta); Valerie Hartung, “Vertical Disintegration in the GIS Industry: A Discriminant Analysis”.

November: Meghan Cope delivered the talk “Re/Placing Welfare? Personal Responsibility and Work Opportunities in Buffalo NY” at the Department of Geography, Syracuse University and the talk “Keeping the Poor in Place: Geographies of Welfare Reform” at Vassar College.

November 18: Steve Palladino made a presentation on the “Core Curriculum for Technical Programs project “at the CC3GIS.net meeting at LAX.

December: David Mark is scheduled to present “Geographic Information - What Everybody Needs and Why” at Scientific and Technical Data Exchange and Integration: A Conference on Data Sharing, U.S. National Committee for CODATA, Bethesda, Maryland.

APPENDIX 7: VISITORS TO NCGIA SITES

Santa Barbara

Ronald Abler, Association of American Geographers
William Albert, Boston University
Wilmar Amaya, IPC, Ecopetrol, Colombia
Masatoshi Arikawa, Hiroshima City University, Japan
Richard Berg, NIMA
Luis Bojorquez, Arizona State University
Marcello Braghin, State University of Campinas, Brazil
Kurt Brassel, University of Zurich
Lawrence Brown, Ohio State University
Gary Comer, Maptech
Ed Cornell, University of Alberta
Jack Dangermond, ESRI
David DeWitt, University of Wisconsin
Hemalatha Diwakar, Research Institute of India
Jerome Dobson, ORNL
Michael Dobson, Rand McNally and Company
Jason Dykes, University of Leicester
Andrew Frank, Technical University Wien
Christine French, NSF
Len Gaydos, USGS/Eros Data Center
Lola Gulyamova, Fulbright Scholar, Tashkent State University, Uzbekistan
Cecil Goodwin, Vigen Corporation
Don Heth, University of Alberta
Carolyn Hunsaker, ORNL
Shin-yi Hsu, SUNY, Binghamton
Keiko Inagaki, Yokohama National University
Kindness Israel, Arthur Temple College of Forestry, Texas
Jong Dae Kim, Department of Mining and Mineral Engineering, Dong-A University
Milan Konechzy, Brno, Slovakia
Annette Krygiel, National Defense University
Sachio Kubo, Keio University, Japan
Phaedon Kyriakidis, Stanford University
Kyoo-S. Lee, Sung Kyung Kwan University, Suwon, Korea
Tom Leinbach, NSF
Megan Lewis, University of Adelaide, Australia
William MacMillan, Oxford University
Germana Manca, Centre for Advanced Studies, Research & Development, Sardinia, Italy
Reuben Mavima, University of Zimbabwe
Kavuri Murty, United Nations
Judy M. Olson, Michigan State University
Micha Pazner, University of Western Ontario

Anne C. Petersen, Vice President Kellogg Foundation
Dan Rogers, Clayton Environmental, Detroit, Michigan
Simon Ronald, University of Adelaide
Karen Rutberg, Hunter College
Philip Sallis, University of Otago, New Zealand
Tapani Sarjakoski, Finnish Geodetic Institute
Takeshi Sato, Department of Civil Engineering, Gifu University, Japan
Karen C. Siderelis, NCCGIA
Eli Skop, National Environmental Research Institute, Denmark
Greg Smith, NIMA
Hiroaki Takeshita, Yokohama National University
Go Urakawa, Yokohama National University
Ramanaran Yadava, Regional Research Laboratory, Bhopal, India
Shih Hsing Yang, National Technical University, Taipei, Taiwan
Paul Yoshitomi, ESRI
Igor Zektser, Fulbright Scholar, Russian Academy of Sciences, Moscow.

Buffalo

January 29–31: Mike Batty, Professor of Spatial Analysis and Planning, Centre for Advanced Spatial Analysis, University College London. Colloquium Address: “Virtual Geography”.

February 7: Pavlos Kanaroglou, Department of Geography, McMaster University, Ontario, CA. Colloquium Address: “Evaluation of Emissions from Mobile Sources in Urban Areas with an Integrated Transportation and Land-Use Model.”

February 14: Jacob Bendix, Department of Geography, Syracuse University. Colloquium Address: “Success Determinants of Small and Medium Public Accounting Firms: Proactivity and International Orientation”.

February 20: John Felleman, Coordinator, Environmental Studies Program, SUNY College of Environmental Science and Forestry. Met with Hugh Calkins, David Mark, John Krygier. Colloquium Address: “Modeling and Environmental Planning: Reconciling Predictions and Mistrust” (sponsored by UB’s Master of Urban Planning Program).

March 14: John Lordi, Ed Starosielec, and Joe Elias, Calspan, Buffalo, NY. Met with Pete Rogerson, Rajan Batta, Jean-Claude Thill and Christopher Rump. Viewed demonstrations by Pete Rogerson, Jean-Claude Thill, and Vedat Akgun.

March 14: Nik Theodore, Chicago Urban League. Colloquium Address: “Trading ‘Warm Bodies’: Processing contingent labor in Chicago’s temporary help industry”.

April–June, 1997: Laercio Namikawa, Brazilian National Institute for Space Research (INPE). Sponsored by the Brazilian National Research Council as a visiting scholar, NCCGIA, SUNY Buffalo.

April 17–18: Lola Gulyamova, Associate Professor, Tashkent State University and Fulbright Scholar, University of California, Santa Barbara. Colloquium Address: “Study of the Rural Population in Uzbekistan”.

April 18: Susan Hanson, Department of Geography, Clark University (Visiting Fellow).

Colloquium Address: “Assessing the Impact of Local Context on Women’s Employment”.

April 18–19: SUNY Buffalo hosted the workshop “History of the Concepts of Space”, organized by Barry Smith, Philosophy/Cognitive Science/NCGIA, SUNY at Buffalo. Participants sponsored by NCGIA-Buffalo were: Achille Varzi, Department of Geography, Columbia University, “Theories of Space in Formal Philosophy”, and Adrijana Car, School of Information Sciences, University of Pittsburgh, “The History of Spatial Hierarchies”. Other participants included David Mark (NCGIA Buffalo) and Max Egenhofer (NCGIA Maine).

April 24: Take Our Daughters to Work Day. Activities and tours hosted in the Geographic Information and Analysis Laboratory.

April 25: Deryck Holdsworth, Pennsylvania State University. Colloquium Address: “Downtown offices in the transition to corporate capitalism: Insights from Buffalo, NY.”

May 6: Dean Kristal, Associate Vice President Beachley, Vice President Landi, Provost Headrick. Viewed demonstrations: Peter Rogerson, “Automated Collision Notification Project”; Ling Bian, “Modeling Fish Populations”; Steven Parkansky, “Deer in Amherst”.

July–December, 1997: Mr. Zhai Yi, Associate Professor, Department of Photogrammetry and Remote Sensing, Zhengzhou Institute of Survey and Mapping, PR China spent six months in residence at NCGIA-Buffalo as a visiting scholar.

July 14: Stephan Krygsman and Emil Schnakenberg, CSIR, South Africa visited NCGIA Buffalo to discuss potential academic exchange programs. He met with David Mark, Jean-Claude Thill, Sam Cole and William Page (Planning and Design).

Sept.–Dec. 1997: P.S. Acharya, Sr. Scientific Officer, Ministry of Science and Technology, Government of India spent the Fall, 1997 semester as a visiting scholar at NCGIA-Buffalo, under sponsorship from the United Nations Development Program. Mr. Acharya worked with Hugh Calkins on topics related to the use of GIS for local level development planning.

Sept. 9: Robert McMaster, Department of Geography, University of Minnesota delivered the talk “Geographical Methodologies for Technological Risk Assessment” to an audience from the NCGIA and Dept. of Geography at SUNY Buffalo.

Sept. 16–19: Saskia Sassen, Professor of Urban Planning, Columbia University. Prof. Sassen delivered the talk “The State and the New Geography of Power” on Thursday, Sept. 18.

Oct. 8–13, Achille Varzi, Dept. of Philosophy, Columbia University.

Oct. 23–24: Jiankang Wu, Manager, ISS Real World Computing Laboratory, Institute of Systems Science, National University of Singapore, visited NCGIA-Buffalo. Hugh Calkins hosted the visit.

October 24: Professor Richard Morrill, Dept. of Geography, University of Washington and Professor Ron Johnston, Department of Geography, University of Bristol delivered the NCGIA/Dept. of Geography Colloquium. Dr. Johnston’s talk was “New Labour victory: new Labour geography”, and Dr. Morrill’s talk was titled “Republican

Revolution? Analysis of Congressional races in Washington State, 1992-1996”.

Nov. 7: Professors Patrick McHaffie (Geography, DePaul University), John Pickles (Geography, Kentucky) and David Mark were included on a panel of speakers delivering the NCGIA/Dept. of Geography Colloquium address. The topic of the discussion was the Critical History of GIS.

Nov. 10–16: Dr. David Stea, Department of Geography, Southwest Texas State University. Prof. Stea delivered the colloquium “From kids to farm workers: Environmental cognition and participatory planning” on Thursday, Nov. 13.

Nov. 14: Erin O’Leary (Dept. of Preventative Medicine, SUNY Stony Brook) and Dr. Gerard Rushton (Dept. of Geography, University of Iowa) delivered the NCGIA/Dept. of Geography Colloquium. Ms. O’Leary spoke on “Environmental Exposures and Breast Cancer on Long Island” and Dr. Rushton spoke on “Spatial Analysis of Changes in Infant Mortality Rates.

Maine

January 24: Jayant Sharma, Oracle Corporation, gave a talk on Oracle's Spatial Data Option project. He obtained his Ph.D. from UMaine's Dept. of Spatial Information Science and Engineering and the NCGIA, in 1996.

March 18–April 3: Claire Beasley, doctoral candidate, Dept. of Information Science, City University, London

March 24: Ambassador Andreas Van Agt, The Netherlands

March 29–June 29: Marisa da Motta, System Analyst, National Space Research Institute (INPE), Sao Paulo, Brazil

April 14: Christian Heipke, Christian Wiedemann, Willi Mayr, Albert Baumgartner, Ruediger Brandt, Photogrammetry and Remote Sensing, Technical University of Munich, Germany

June 10: Randy Paul, Office of Research and Development, Washington, DC

June 11: Michael Vazirgiannis, Research Associate, Dept. of Electrical and Computer Engineering, National Technical University of Athens, Greece

June 24: Beth Driver, National Imagery and Mapping Agency, Bethesda, MD

August 2–10: Robert Rugg, Professor, Dept. of Urban Studies and Planning, Virginia Commonwealth University, Richmond, VA

August 25–November 25: Thomas Bittner, Ph.D. candidate, Department of Geoinformation, Technical University of Vienna, Austria

September 2–November 30: Marisa da Motta, System Analyst, National Space Research Institute (INPE), Sao Paulo, Brazil

Arthur Hoyle, University of Melbourne, Australia

October 14: Bas Kok, Secretary of EUROGI, Delft, The Netherlands

October 23: Michael Blakemore, University of Durham, United Kingdom

November 20: Peter Hoff, President of the University of Maine, and fourteen Maine State Senators

APPENDIX 8: COURSES TAUGHT BY NCGIA FACULTY

Santa Barbara

Physical Geography, Winter 1997, Terry Smith
Introductory Human Geography, Winter 1997, Michael Costanzo
Introduction to Environmental Optics in Physical Geography, Winter 1997, Dar Roberts
Introduction to Spatial Decision Making and Behavior, Winter 1997, Reginald Golledge
Introduction to Meteorology, Winter 1997, Joel Michaelsen
Geographic Remote Sensing Techniques, Winter 1997, Leal Mertes
Groundwater Hydrology, Winter 1997, Hugo Loaiciga
Forms, Process and Human Use of Rivers, Winter 1997, Edward Keller
Geography of the United States, Winter 1997, John E. Estes
Regional Oceanography Around the World, Winter 1997, Thomas Dickey
Ocean Circulation, Winter 1997, David Siegel
Introduction to Geographical Data Analysis, Winter 1997, Daniel Montello
Technical Issues in Geographic Information Systems, Winter 1997, Keith Clarke
Geography Planning and Policy Making Issues, Winter 1997, David Lemberg
Geography of Information Society, Winter 1997, Helen Couclelis
The Idea of Nature, Winter 1997, James Proctor
Introduction to Optimization Models for Geographic Problems, Winter 1997, Richard Church
Introduction to Geographic Research, Winter 1997, Michael Goodchild and Daniel Montello
Seminar in Geography, Winter 1997, Joel Michaelsen
Remote Sensing and Environmental Optics, Winter 1997, Dar Roberts
West United States Field Work, Winter 1997, John Estes, Joel Michaelsen and Frank Davis
Earth Systems Science: The Hydrologic Cycle, Winter 1997, Hugo Loaiciga
Upper Ocean Physical Processes, Winter 1997, Thomas Dickey
Seminar in Oceanography, Winter 1997, David Siegel
Seminar in Geographical Information Systems, Winter 1997, Michael Goodchild
Spatial Environmental Modeling, Winter 1997, Dar Roberts
Advanced Topics in Pedology, Winter 1997, Oliver Chadwick
Physical Geography, Spring 1997, Dar Roberts
Introductory Human Geography, Spring 1997, Daniel Montello
Soil Genesis and Classification, Spring 1997, Oliver Chadwick
Intermediate Geographic Remote Sensing Techniques, Spring 1997, Leal Mertes
Analytical Computer Cartography, Spring 1997, Keith Clarke
Earth System Science, Spring 1997, Catherine Gautier
California, Spring 1997, Michael Costanzo
Behavioral Geography, Spring 1997, Reginald Golledge
Great Cities of the World, Spring 1997, Helen Couclelis
Water Pollution, Spring 1997, Hugo Loaiciga
Jet Stream Climatology, Spring 1997, Charles Jones

Application Issues in GIS, Spring 1997, Micha Pazner
 Location and Environmental Issues in Planning, Spring 1997, Richard Church
 The Ethics of Human-Environmental Relations, Spring 1997, James Proctor
 Seminar in Geography, Spring 1997, Dar Roberts
 Seminar in Environmental Geography, Spring 1997, James Proctor
 Pedology, Spring 1997, Oliver Chadwick
 Digital Techniques in Remote Sensing, Spring 1997, Leal Mertes
 Seminar in Remote Sensing, Spring 1997, John E. Estes
 Scientific Reasoning in Geography, Spring 1997, Helen Couclelis
 Seminar in Cartography, Spring 1997, Keith Clarke
 Cognitive Issues in Geographic Information Science, Spring 1997, Daniel Montello
 Field Seminar in Snow Science, Spring 1997, Jeff Dozier
 Earth Systems Science: Ocean-Atmosphere Dynamics, Spring 1997, Thomas Dickey
 Seminar in Oceanography, Spring 1997, Libe Washburn
 Introduction to Geographical Data Analysis, Spring 1997, Joel Michaelsen
 Geographical Time Series Analysis, Spring 1997, Libe Washburn
 The Ethics of Human-Environmental Relations, Spring 1997, James Proctor
 Advanced Topics in Location and Transportation Systems, Spring 1997, Richard Church
 Physical Geography, Summer 1997, Heidi Dierssen
 Introductory Human Geography, Summer 1997, Kevin Curtin
 Physical Geography: Oceanic and Atmospheric Processes, Fall 1997, Carl Sundbeck
 Introductory Human Geography, Fall 1997, Daniel Montello
 Introduction to Geographical Computing, Fall 1997, Joel Michaelsen
 Physical Geography of the World's Oceans, Fall 1997, Libe Washburn
 Urban Geography, Fall 1997, Helen Couclelis
 Environmental Hydrology, Fall 1997, Vladimir Aizen
 Introduction to Soil Science, Fall 1997, Oliver Chadwick
 Geographic Photo Interpretation, Fall 1997, Paul Sutton
 California, Fall 1997, Michael Costanzo
 Introduction to Geographic Information Systems, Fall 1997, Keith Clarke
 Urban and Environmental Systems Analysis, Fall 1997, Richard Church
 Human-Induced Environmental Change, Fall 1997, James Proctor
 Introduction to Geographic Research, Fall 1997, Daniel Montello
 Seminar in Geography, Fall 1997, Reginald Golledge
 Analytical Methods for Geographers, Fall 1997, Joel Michaelsen
 Advanced Remote Sensing, Fall 1997, Dar Roberts
 Behavioral Geography, Fall 1997, Reginald Golledge
 Introduction to Physical Oceanography, Fall 1997, David Siegel
 Seminar in Oceanography, Fall 1997, Thomas Dickey
 Human-Induced Environmental Change, Fall 1997, James Proctor
 Urban and Environmental Systems Analysis, Fall 1997, James Proctor
 Advanced Topics in Pedology, Fall 1997, Oliver Chadwick

Buffalo

(Note this list does not include numerous courses taught in other departments, including Planning and Design, Industrial Engineering, Political Science and others)

Physical Environmental Geography	Larsen
Industrial Geography	Bagchi-Sen
Cartography and GIS	Krygier
Census Data and Their Use	Calkins
Decision Support Systems	Cole
Environmental Change	Larsen
Geographic Information Systems	Bian
Geographic Information Systems	Mark
Geographic Perspectives and World Issues	Calkins
Geography of Development	Lentnek
Geography/Social Theory	Cope
Geostatistics	Bian
GIS Algorithms and Data Structure	Mark
GIS and Environmental Modeling	Bian
GIS Design	Calkins
International Environment & Com	Bagchi-Sen
Introduction to Graduate Geography	Woldenberg
Introduction to Human Geography	Cope
Introduction to Cartography	Krygier
Introduction to Soils	Larsen
Landscape Ecology	Larsen
Maps and Mapping	Krygier
Mathematical Models in Social Sciences	Cole
Multimedia/Hypermedia/World Wide Web	Krygier
Multivariate Statistics	Rogerson
Physical/Environmental Geography	Woldenberg
Population Geography	Rogerson
Remote Sensing	Bian
Spatial Problems of Multinational Operations	Bagchi-Sen
Spatial Statistics	Thill
Transportation (Graduate)	Thill
Transportation (Undergraduate)	Thill
Transportation Systems	Thill
Univariate Statistics	Rogerson
Urban Geography	Cope
Urban Geography	Lentnek
Urban Models and Policy	Cope
World Regions/Commercial Problems	Bagchi-Sen

Maine

Spring 1997

Principles of Information Systems, Max Egenhofer
 Geographic Information Systems, Doug Flewelling
 Legal Aspects of Land Surveying, Harlan Onsrud
 Digital Image Processing, Peggy Agouris

Research Methods, Max Egenhofer
Cadastral and Land Information Systems, Harlan Onsrud
Analytical Y Digital Photogrammetry, Peggy Agouris
Selected Studies - Remote Sensing Detection/Underground, Peggy Agouris
Selected Studies - Digital Spatial Library II, Kate Beard
Selected Studies - GIS Applications, Doug Flewelling
Selected Studies - Digital Image Analysis, Max Egenhofer
Selected Studies - GIS Application Development, Kate Beard
Selected Studies - Marine Information Systems, Kate Beard
Selected Studies - Spatial Information Engineering Practical Training, Kate Beard
Graduate Seminar, Harlan Onsrud
Spatial Reasoning, Max Egenhofer
Graduate Thesis, Harlan Onsrud

Fall 1997

Adjustment Computations, Anthony Stefanidis
Engineering Databases, Doug Flewelling
Remote Sensing, Peggy Agouris
Selected Studies - Elements For Linear Algebra For Spatial Information, Peggy Agouris
GIS Applications, Kate Beard
Information Systems Law, Harlan Onsrud
Selected Studies - Digital Photogrammetric Applications, Peggy Agouris
Selected Studies - Basin Digital Library, Kate Beard
Selected Studies - GIS Applications, Kate Beard
Selected Studies - Spatial Data Systems, Max Egenhofer
Graduate Thesis, Kate Beard

APPENDIX 9: GRADUATE DEGREES GRANTED AT NCGIA SITES

Santa Barbara

- GARDNER, Margaret, M.A., Spring 1997, Mapping Chaparral with AVIRIS Using Advanced Remote Sensing Techniques (Roberts, Church, Gautier, Michaelsen).
- GARVER, Sara, Ph.D., Summer 1997, Variability in Ocean Color Observations and Their Use in the Study of Upper Ocean Ecosystem Dynamics (Siegel, Washburn, Michaelsen, Tony Michaels).
- JOHNSON, Andrea, M.A., Summer 1997, 20th Century Growth Trends in *Pseudotsuga macrocarpa* in Relation to Climate and Atmospheric CO₂ - Pine Mountain, CA (Michaelsen, Davis, Loaiciga).
- LOVELACE, Kristin, M.A., Spring 1997, Comparing Spatial Knowledge from Two Sources and in Two Orders of Recall using Verbal Navigational Instructions (Montello, Golledge, Couclelis).
- MCGHIE, R. Gavin, M.A., Spring 1997, Creation and Accuracy Assessment of a Comprehensive Managed Areas Spatial Database for the Conterminous United States (Estes, Goodchild, J. Michael Scott).
- NUNEZ, Alfonso, M.A., Spring 1997, Mapping of Vertical Leakage in the Hueco Bolson Aquifer in El Paso County, Texas, using a Geographic Information System (Loaiciga, Chadwick, Arturo Keller).
- O'HIROK, William, Ph.D., Winter 1997, Three-Dimensional Cloud Effects and Enhanced Atmospheric Absorption (Gautier, Dozier, Michaelsen, Richard Somerville).
- PHINN, Stuart, Ph.D., Spring 1997, Remote Sensing and Spatial Analytic Techniques for Monitoring Landscape Structure in Disturbed and Restored Coastal Environments (Stow, Franklin, Mertes, Michaelsen).
- RENEHAN, Stephen, M.A., Spring 1997, Analysis of Water Demand, Supply, and Pricing: 1987-1992 Drought in Santa Barbara, California (Loaiciga, Church, Chadwick).
- RICHARDSON, Anthony, M.A., Spring 1997, Spatial Knowledge Acquisition from Maps and from Navigation in Real and Virtual Environments (Montello, Golledge, Mary Hegarty).
- SHORTRIDGE, Ashton, M.A., Summer 1997, Characterizing the Relationship between 7.5 and 1 Degree Digital Elevation Models (Goodchild, Clarke, Michaelsen).
- THORNE, James, M.A., Spring 1997, GAP Analysis: The Vegetation of Northwestern California (Davis, Goodchild, Roberts).
- VENEGAS, Juan, M.A., Winter 1997, Place and Space Factors Affecting Employment Opportunities for Latinos within California Enterprise Zone (Couclelis, Golledge, Montello).

Buffalo

Masters Degrees

Scott Steigerwald
Geoffrey Adams
Donald Cole
Stuart Graham
Keng-pin Chang
Kelly Pew
Paul Rooney
Chris Olney
Mark Trice
Manqing Chu

PhD Degrees

Valerie Hartung
Brandon Plewe
Michael Leitner
David Koeppsel (Philosophy)
Daniel Barwick (Philosophy)

Maine

Bertrand, Matthew, M.S., August 1997, Spatial Information Science and Engineering
Blyler, Nancy, M.S., December 1997, Spatial Information Science and Engineering
Flewelling, Douglas, Ph.D., May 1997, Comparing Subsets from Digital Spatial Archives: Point Set Similarity
Florence III, John, M.S., August 1997, Predicting Frequencies of Topological Relations in Geographic Datasets
Gartrell, Bryce, M.S., December 1997, Spatial Information Science and Engineering
Hayes, Laura, M.S., December 1997, Spatial Information Science and Engineering
Hodson, Timothy, M.S., December 1997, Spatial Information Science and Engineering
Kim, Young Su, M.S., August 1997, Spatial Information Science and Engineering
Kornuta, Dale, M.S., August 1997, Spatial Information Science and Engineering
Paluzzi, Michael, M.S., August 1997, Spatial Information Science and Engineering
Raubal, Martin, M.S., December 1997, Structuring Wayfinding Tasks with Image Schemata
Rodriguez, Andrea, M.S., August 1997, Image Schemata-Based Inferences: The Container-Surface Algebra for Solid Objects
Sharma, Vyjayanti, M.S., December 1997, Synthesis and Visualization of Metadata in a Digital Spatial Library
Timmons, Jeanne, M.S., December 1997, Spatial Information Science and Engineering

