

# UC Santa Barbara

## Newsletters

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### I-1 Accuracy of Spatial Databases

GIS are high precision systems which process data as if they were perfectly accurate; in reality, spatial data are often subject to surprisingly high levels of uncertainty and inaccuracy, which current GIS designs largely ignore.

#### UPDATE:

Over 50 people attended the specialist meeting for the first research initiative (December, 1988), and a book is being published from the proceedings (*Accuracy of Spatial Databases*, published by Taylor and Francis, publication expected in December 1989). For a report on the specialist meeting, see NCGIA Technical Paper 89-1. Research has been under way for almost a year, and results are starting to appear in different forms. Specific research activities include a bibliography/taxonomy of spatial data errors, to raise user awareness of the problem (Technical Papers 89-9 and 89-12).

Santa Barbara researchers are simulating stochastic process models of error for large arrays of pixels using a grant of time on the supercomputer at the IBM Palo Alto Research Center; the simulations will be used to estimate the uncertainty of various GIS products, given known levels of uncertainty in the underlying database. Maine researchers are simulating uncertainty in connection with studies of the sliver problem in polygon overlay. Other Santa Barbara researchers (including visitors from the University of Sheffield and the University of Rome) have been studying the uncertainties in social and economic data resulting from aggregations by reporting zones; error propagation through GIS processes (with USGS support); and finite resolution data structures, particularly for global datasets (Technical Paper 89-5).

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### I-2 Languages of Spatial Relations

GIS can be seen as a technology for helping people work with spatial data, and more specifically as a tool for learning and reasoning about space and spatial relationships. Initiative 2 research will help to improve digital representation of spatial data, the design of GIS user interfaces, and the emulation of user learning and reasoning processes.

#### UPDATE:

The specialist meeting was held in January 1989 (see NCGIA Technical Papers 89-2 and 2A).

Seventy-one persons are currently on the I-2 mailing list. As of September 1989, twenty-one I-2 papers had been accepted or published in proceedings volumes, as book chapters, or in refereed journals; three NCGIA reports had been published (88-6, 89-2, 89-2A), and two I-2-related Ph.D. theses had been accepted (University of Maine; Swiss Federal Institute of Technology [ETH Zurich]). Sessions are being organized for the AAG Annual Meeting (Toronto, April 1990), and the 4th International Symposium on Spatial Data Handling (Zurich, July 1990).

Current work involves wayfinding, driving directions, and spatial knowledge acquisition; cross-linguistic spatial terms and landscape generics; vehicle navigation aid systems; user interfaces; computer generation programs and other cognitive aspects of GIS interfaces; the visualization of spatial relations; formal definitions of topological relationships, metrical relationships, algebras of spaces and morphisms between spaces; and non-quantitative query languages and reasoning about space.

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### **I-3 Multiple Representations**

Research topics include hierarchical data structures for solving problems of scale-dependent multiple representations of features within a spatial database; definition of the rules for automating the generalization process; systems for describing the ways features change with scale; and data structures which formalize the logical relationships of multiple representations. The Specialist Meeting was held in February 1989.

#### **UPDATE:**

One major product is a multi-agency, multi-scale database intended to serve as a standardized data domain for benchmarking algorithms and establishing comparable results for generalization research. The U.S. Bureau of the Census (TIGER), National Ocean Survey (Shoreline), USGS (DLG) and DMA (DTM) have cooperated in this project. A graduate intern (J. DeLotto, Buffalo) was funded by Census and NCGIA to implement the database and write unpacking software and documentation. Five sets of data are planned, each containing data from several agencies. NCGIA will disseminate the data sets in the public domain on a cost recovery basis, in both DOS and Macintosh formats (5 1/4" and 3 1/2" for 800K, 1.2 MB, and 1.44MB diskettes). Sessions at a national conference will report on actual use by agencies and researchers.

A report of the Specialist Meeting has been published by NCGIA (Technical Paper 89-3), and a bibliography is forthcoming (Technical Paper 89-11).

An NCGIA-Syracuse University symposium, "Towards a Rule Base for Map Generalization," will be held in April, 1990, at Syracuse University, to address substantive and conceptual issues prerequisite to the development of a knowledge base for cartographic generalization. Participants have been invited from universities in the US and elsewhere and from the private sector; each will present a specific problem.

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### **I-4 Use and Value of Geographic Information**

Three research themes on social, economic and institutional issues emerged at the specialist meeting (May, 1989): the need for a taxonomy of geographic information and its uses (what types of geographic information exist, and how do they relate to the variety of data models of spatial databases; are certain types of geographic information more or less suitable for handling in spatial databases; what role does geographic information play in human activity, who uses it, and for what purposes?); development of objective methods for measuring the value of geographic information; and empirical studies of the diffusion of GIS technology.

#### **UPDATE:**

Some I-4 researchers are focusing on the development of techniques for modeling the use of geographic information in decision making, and case studies to test such geographic information use models have been funded (Department of Natural Resources, Washington State; Town of Amherst).

Several proposals are pending to investigate factors influencing the adoption of GIS by engineers and facilities managers; factors influencing the extent to which GIS adopters actually utilize its potential; GIS in conflict management; and bureaucratic factors in the adoption of GIS by public organizations.

A bibliography of I-4 issues is nearing completion, and will be issued as an NCGIA Technical Report (89-8). Two I-4-related Ph.D. theses (Maine, Buffalo) are being written. The report and proceedings of the Specialist Meeting (Technical Paper 89-7) and an accompanying research deliberables list are also available from the NCGIA.

Responsibility for work on the value of geographic information is centered in Buffalo; responsibility for the other elements is centered in Maine.

#### **For more information, contact:**

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### **I-5 Very Large Spatial Databases**

The following section of I-5 is treated at greater length than for the other initiatives, since this is the first time I-5 has appeared in the UPDATE. Initiative 5 is of central significance to the research mandate of the NCGIA, as well as being closely related to I-1, I-2, I-3, and I-12. Spatial databases are growing in size at a rate that may, at least temporarily, outstrip our abilities to handle them successfully. VLSDB datasets are often heterogeneous and multilayered, and comprised of a large variety of data types. Nevertheless, such databases are necessary for studying a wide array of key scientific problems, such as environmental change on a global scale, and for a key number of applications, such as a comprehensive GIS for a large urban area or for major resource management.

I-5 was set in motion in July, 1989, with an open symposium (with both invited and contributed papers) and a 3 1/2 day workshop (to produce a long-term research agenda) immediately following. Both were held in Santa Barbara. Over 170 persons from academic, commercial and government sectors attended the symposium. Eighteen papers were presented, and two panel discussions were held (problems of large spatial databases and possible solutions to these problems). The papers will be published by Springer-Verlag in their "Lecture Notes in Computer Science" series (ed. Buchmann, Gunther, Smith and Wang).

The workshop was jointly led by Terence R. Smith (Santa Barbara) and Andrew Frank (Maine). Other participants from the NCGIA included Barrera, Egenhofer, and Ehlers (Maine), and Estes, Simonett, and Star (Santa Barbara). About 35 persons were present during most of the meeting, comprising an experienced group of individuals from Europe and North America and representing academic, commercial and government sectors. The workshop dispensed with formal presentations, and instead alternated between full group sessions and working group sessions. Groups were led by A. Frank (Interfaces), P. Mantey (Hardware), D. McKeown (Acquisition), S. Morehouse

(Architecture), H. Schek (Object-Oriented), A. Buchmann (Metadata), R. Lorie (Extensibility), and H. P. Kriegel (DS/FS). The goal of the working groups was to identify and document key research issues in areas that were selected by the group as a whole:

**Architecture of GIS databases.** Map algebra, extensible query optimization, transaction models for GIS, integrity and validation issues for GIS, DBMS issues, GIS requirements and sample data.

**Concurrency control.** Analysis and validation of long transaction models, physical concurrency on spatial indices, lock-types and consistency among multiple representations of the same data, recovery and audit trail issues.

**User interfaces.** Use of icons in overview menu or entry window, other user interface tools; issues relating to queries (including zoom and pan), granularity criteria, search and browse criteria, layering criteria, launching and macro execution and transcript log and system status; the development of user interface development environments.

**Hardware.** User scenarios, working set characterization, exploitation of parallelism and GIS specific hardware.

**Object modeling.** Object models, extensible systems, operational facilities; analysis of existing systems (with identification of candidates for validation), validating a set of chosen systems, comparison of results.

**Acquisition, capture, integration and maintenance.** Integration of data from a variety of sources, the construction of large databases, database maintenance techniques, source data analysis, high resolution databases, data availability.

**Extensibility.** Identification of requirements, analysis of extensible approaches, mapping of requirements onto particular systems with evaluation and comparison of evaluations to determine best approaches.

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## I-6 Spatial Decision Support Systems

Definitions of geographic information systems often focus on the capture, storage, manipulation, analysis and display of spatial data—implying that geographic information systems implicitly are designed to support spatial decision-making. For many spatial problems, however, this is not true: GIS analytical modeling capabilities are lacking and system designs are not flexible enough to accommodate variations in either the context or the process of spatial decision-making. One response to these needs is the development of spatial decision support systems (SDSS).

Promising areas of research in SDSS include database management (cartographic display, spatial query, and analytical modeling through an integration of locational, topological and thematic data; the ability to construct and exploit complex spatial relations among all three types of data at a variety of scales and levels of aggregation; possible benefits of object-oriented programming); analytical modeling (model-based management systems; algorithms in GIS and their taxonomy); graphical display and report generation (general and specialized forms for representing output from statistical analyses and analytical models; graphical interactive user interface; human factors and cognition); and user interfaces (more interactive modelling and intuitive interfaces; expert knowledge; environmental, procedural and structural knowledge).

*The Specialist Meeting for Initiative 6 will be held March 14-18, 1990, in Santa Barbara.*

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## I-7 to I-12

**Initiative 7 (Visualization of the Quality of Spatial Data):** Beginning 1990-91. Leaders: *Kate Beard (Maine)* and *Barbara Buttenfield (Buffalo)*. Objectives: (1) Develop and implement a large number of distinct methods for displaying the quality (reliability, accuracy, certainty, etc.) of spatial information; (2) Evaluate the efficacy of these methods using experimental subjects; and (3) Test the most promising methods in real-world situations. (Visualization; spatial statistics; applications.)

**Initiative 8 (Expert Systems for Cartographic Design):** Beginning 1990-91. Leaders: *Andrew Frank (Maine)* and *David Mark (Buffalo)*. Objective: To develop an expert system to design cartographic displays of various types. (Visualization; expert systems.)

**Initiative 9 (Institutions Sharing Spatial Information):** Summer 1991. Leaders: *Tom Ducheneau (Maine)* and *Hugh Calkins (Buffalo)*. Objectives: (1) Identify the social science aspects of people and agencies dealing with geographic information; (2) Document policies regarding inter-agency and agency-citizen information exchange; (3) Investigate the sharing of information in the public-sector agencies (i.e., the non-technical aspects of building common databases); (4) Explore the liability aspects of sharing data, and the impacts of electronic data processing on responsibilities; (5) Develop models for political support for shared databases, including aspects of privacy and public access; (6) Analyze the impacts of GIS on the standards of professional practice by surveyors, planners, and lawyers. (Social, economic, and institutional issues.)

**Initiative 10 (Temporal Relations in GIS):** Beginning 1990-91. Leader: *Andrew Frank (Maine)*. Objectives: (1) Understand the modeling of time (continuous time, discrete time, and events); (2) Assess inference methods in temporal logic and deduction strategies in non-monotonic systems; (3) Compare modeling of states to methods of modeling incremental changes with respect to different GIS applications; (4) Study the problems of building temporal GIS data-

bases and implications for queries ("What was known as of [date 1] about the state of X as of [date 2]"); (5) Extend the methods for dealing with multiple and alternative representations to include temporal aspects. (Spatial and spatio-temporal analysis.)

**Initiative 11** (*Space-Time Statistical Models in GIS*): Beginning 1990-91. Leaders: *David S. Simonett* (Santa Barbara) and *Joel Michaelsen* (Santa Barbara). Objectives: (1) Systematic documentation of characteristic scales of spatial and temporal variation for basic processes in the social, natural and applied sciences; (2) Development of a taxonomy of space-time statistical models to help select appropriate database structures for representing the temporal variability of specific social and natural processes in GIS; (3) Development of algorithms for efficient data refreshing in systems with different characteristic frequencies and scales of temporal variation; and (4) Development and application of methods of multiple representation in the time domain for computing efficiency. (Spatial and spatio-temporal analysis.)

**Initiative 12** (*Remote Sensing and GIS*): Duration: October 1990-April 1992. Leaders: *Jack Estes* (Santa Barbara) and *Frank Davis* (Santa Barbara). Objectives: (1) Improve methods for data acquisition and processing; (2) Develop principles for identifying appropriate data structures for storage and integration of remotely sensed data in GIS systems; (3) Extend GIS applications in scene classification, contextual classifiers, and expert systems. (Spatial analysis; spatial statistics.)

Tentative plans are now being made for the Initiative 12 Specialist Meeting to be held in Fall of 1990.

For more information on any of these Initiatives, please contact the Initiative leader(s) at the appropriate NCGIA site:

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## EDUCATIONAL INITIATIVES Core Curriculum Project

The "Core Curriculum Project" is currently the major educational initiative of the NCGIA. Since GIS is a new area of study for most universities and colleges, there exists a demand for comprehensive teaching materials covering the basic theory and concepts, as well as the technical and application issues.

During the 1988-89 academic year, the Center at Santa Barbara, with the help of academic and private sector experts from around the world, developed a comprehensive set of course materials for a year-long introductory sequence in GIS. Designed for instruction at the upper division undergraduate level, these materials consist of 75 sets of lecture notes with overhead and hand-out masters, slides, lists of suggested readings and videos, and twelve laboratory exercises complete with datasets on disk.

The materials in a draft form are now being tested by over 70 educational institutions in the US, Canada, Britain, Australia, New Zealand, Hong Kong and Taiwan. Academic departments represented by test sites include Geography, Environmental Studies, Engineering, Geology, Urban Studies, Surveying, Anthropology, Regional Planning, Forestry, Marine Affairs and Landscape Architecture.

The evaluation phase has two main objectives. First, is the material comprehensive and does it provide students with useful knowledge and marketable skills? Second, how useful are the materials to instructors actually preparing and teaching these introductory GIS courses? The results of the evaluation will be of interest not only to the NCGIA, but also to the funding agencies, the users of the curriculum and the education community in general.

Although the evaluation phase relies primarily on written surveys filled out by both students and instructors using the materials, an emphasis is being placed on direct contact with individual evaluators. Users Group meetings are taking place at GIS/LIS '89 in November at Orlando and at the Annual Conference of the Association of American Geographers in April, 1990, at Toronto. By

bringing these evaluators together in one place, we hope that some consensus will be reached on issues related to the teaching of introductory GIS in general and the role of the NCGIA Core Curriculum in particular.

The final result of the evaluation phase will be a thorough revision of the draft materials. Although the details of the production of this final version are not yet complete, the materials will be available for wide distribution by the end of July 1990, probably at a cost of approximately \$200. Publication information will be widely disseminated prior to release.

In addition to the final version of the curriculum materials, several other products are under consideration: (1) a volume of laboratory exercises for GIS courses, covering a range of software and hardware implementations and comprised of exercises contributed by instructors at the test sites and others; with diskettes containing the necessary datasets; (2) short volumes of background notes for instructors, a comprehensive slide set, and possible case study scenarios and materials which can form the core of a term project; (3) information on various laboratory configurations, including suggestions for obtaining the institutional and financial support necessary for setting up GIS labs in educational institutions; (4) several short workshops on "Materials for Teaching GIS." A workshop will be offered at the International Symposium for Spatial Data Handling at Zurich in July, 1990; (5) a longer workshop course for GIS educators (under consideration).

Additional funding is being sought for these further, possible projects.

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## SITE NEWS

### BUFFALO

*Professor Jean-Claude Muller, Director of the Institute of Technical Cartography (ITC) in Enschede, Netherlands, has tentatively accepted an invitation to spend fall 1990 in residence at NCGIA Buffalo, to pursue research on map generalization (I-3; planning of I-7 & I-8), lead a graduate seminar and collaborate on research on visualization. He has published on cartographic symbolization, expert systems, map transformations, and generalization.*

*Additions to the faculty: Munroe Eagles (Political Science and NCGIA Research Scientist: political geography, spatial analysis of electoral politics), Peter Morgan (Economics: economics of information), Michael Palecki (Geography: climatology).*

*Grants awarded to NCGIA researchers include Initiative 3 research topics (USGS); "Route Planning for Overnight Parcel Deliveries" (Federal Express); "Locational Analysis of Bank Retail Functions" (M&T Bank [Manufacturers and Traders Trust Company]); "GIS Requirements Study for the Town of Amherst" (Town of Amherst).*

*Equipment or software grants have been received from PRIME Computers and SUN Microsystems.*

*The Buffalo NCGIA and the UB Department of Geography will be relocated over the next two years. The office and lab space available to Geography, the NCGIA, and the Canada-US Trade Center will increase to at least 18,000 square feet.*

*NCGIA/Buffalo hosted the Fifth Annual New York State Geographic Information Systems Meeting on October 16 and 17, 1989.*

*The UCSB site of the NCGIA is negotiating an agreement with IBM Corporation for a Joint Study in GIS. The goal is to work together on issues such as conceptual design of Next-Generation GIS, global workstations, and topics in the design and implementation of spatial data bases. IBM and NCGIA will also collaborate in developing curricular materials in digital cartography.*

*It is expected that IBM will supply state-of-the-art computer equipment, peripherals, and software worth \$2.3 million, retaining title and maintaining and replacing the equipment as necessary. The NCGIA will use these in teaching and research in computerizing spatial information. This partnership offers the NCGIA a chance to work with IBM on removing impediments to the increased use of GIS. The participation of IBM is especially appreciated in light of the difficulties of providing a state-of-the-art computer environment in a time of tightened university budgets and fast-moving technology.*

### MAINE

*To foster international cooperation in land information research, the Universities of Maine, New Brunswick, and Laval (Québec) founded the Atlantic Institute in July 1989. The first Atlantic Institute Research Seminar, on "Land Information Management, Land Tenure, and Cadastral Systems," was held at Maine on July 27-29; participants included visitors from the Polytechnic of East London, the Center for Latin American Studies at the University of Pittsburgh, Ohio State University, the University of Wisconsin, the University of Melbourne, the World Bank (Urban Development Division), and the US Bureau of Land Management.*

*Topics of research grants awarded to NCGIA researchers at Maine include "Geographic Information Systems for Groundwater Management" (USGS Water Resource Division); a joint project on Marine GIS with the Sea Grant Office (Sea Grant College Program); "Object-Oriented Integrated Information System Design" (Digital Equipment Corporation); "Lattices for GIS II" (US Bureau of the Census); GIS applications for the Cancer Registry and Division of Disease Control (Maine State Bureau of Health); "Automated Control Point Extraction from Digital Image Data" (Ohio State University Center for Mapping); "Study of Glacier Movement from Digital Landsat MSS Data" (Quaternary Institute).*

*Equipment and software grants were awarded by the following companies or agencies: Apple Computer, Inc.; ESRI; Intergraph Corporation; and NASA.*

*Additional space for the NCGIA office, postdoctoral offices, one lab and two large graduate student offices has been obtained. The 16,000 square foot building which will be the permanent home of the NCGIA and the Department of Surveying Engineering will be completed by early 1991.*

### SANTA BARBARA

*A multidisciplinary conference on "States and Economic Transformations in the Pacific Rim" will be held at Santa Barbara on March 22-25, 1990. It will explore the possibilities for geographic and social science analysis of the spatial aspects of regional development in the emerging global economy using GIS-aided techniques.*

*Several minority undergraduate students worked with a graduate student and a faculty mentor (L. Anselin) on "Regional Publication Projections for California Counties" as part of the Summer Academic Research Institute (funded by the US Department of Education and the University of California).*

*Grants have been received from: California Department of Forestry ("Use of Vegetation Maps and GIS for Assessing Conifer Lands in California"); Lawrence Livermore National Laboratory ("Design and Implementation of an Object-Oriented Data Model for Very Large Spatial Databases"); USGS ("Accuracy of Spatial Data Bases," "Symposium on the Design and Implementation of Large Spatial Databases," "Image Processing and GIS Development," "Optical Worm Technology for Spatial Data Archiving"); Oak Ridge National Laboratory/Martin Marietta ("Symposium on the Design and Implementation of Large Spatial Databases"); California Department of Water Resources ("Estimating Drought Probabilities in California Using Tree Rings"); EPA ("Remote Sensing & Geographic Information Systems Technology Demonstration & Basic Research Cooperative Agreement").*

*The second annual Geographic Data Workshop was held on August 25. Dr. Robert Marx, Chief of the Geography Division of the Bureau of the Census and a major architect of the Topologically Integrated Geographic Encoding and Referencing (TIGER) file system, was a keynote speaker.*

## UPCOMING NCGIA EVENTS

- |                   |   |
|-------------------|---|
| March 14-18, 1990 | <p><i>I-6 Specialist Meeting: "Spatial Decision Support Systems (SDSS)"</i><br/>                 Santa Barbara, CA<br/>                 Michael Goodchild, (805) 961-8049</p>   |
| March 21-22, 1990 | <p><i>Conference: "GIS Design Models and Functionality"</i><br/>                 (Co-sponsored by RICS, NCGIA, RRLs)<br/>                 Leicester, England<br/>                 Anna Alexander-Williams<br/>                 Midlands Regional Research Laboratory (MRRL)<br/>                 Bennett Building<br/>                 University of Leicester<br/>                 University Road<br/>                 Leicester LE1 7RH<br/>                 U.K.<br/>                 Telephone: 0533-523849.<br/>                 E-mail: JANet RRL@UK.AC.LE<br/>                 (GIS performance &amp; functionality; assessing suitability of systems for different applications; determining magnitude &amp; significance of errors; developing new methods of analysis)<br/>                 (Preceded March 20-21 by "GIS Education and Training" conference, also organized by MRRL.)</p> |
| March 22-25, 1990 | <p><i>Multidisciplinary Conference: "States and Economic Transformations in the Pacific Rim"</i><br/>                 Santa Barbara, CA<br/>                 Helen Couclelis, (805) 961-2196, Luc Anselin, (805) 961-2599, or Richard Appelbaum (805) 961-2043 (Santa Barbara)<br/>                 (Focus: analysis of spatial aspects of regional development in the emerging global economy, using GIS-aided techniques)</p>   |
| April 12-15, 1990 | <p><i>I-3 Symposium: "Towards A Rule Base for Map Generalization"</i><br/>                 Syracuse University<br/>                 Barbara Battenfield (Buffalo), (716) 636-2283<br/>                 (For more information, see I-3 Update)</p>   |
| April 19-22, 1990 | <p><i>Initiatives Sessions and Core Curriculum Users Group Meeting</i><br/>                 AAG Annual Meeting<br/>                 Toronto</p>   |
| July 23-27, 1990  | <p><i>Initiative Sessions and Workshops</i><br/> <i>Fourth International Symposium on Spatial Data Handling</i><br/>                 Zurich</p>   |
| Summer 1990       | <p><i>Planned distribution of final version, NCGIA GIS Core Curriculum.</i></p>   |
| Fall 1990         | <p><i>Conference: GIS Applications in the Social Sciences</i><br/>                 (Dates to be determined.)<br/> <i>Expressions of interest in this conference are welcomed.</i> Please contact Michael F. Goodchild, NCGIA, 3510 Phelps, University of California, Santa Barbara CA 93106 or telephone (805) 961-8049.</p>  |

The NCGIA welcomes ideas for appropriate future research interests within the framework of the Research Initiatives: Accuracy of Spatial Databases (I-1), Languages of Spatial Relations (I-2), Multiple Representations (I-3), Use and Value of Geographic Information (I-4), Architecture of Very Large Spatial Databases (I-5), Spatial Decision Support Systems (I-6), Visualization of the Quality of Spatial Data (I-7), Expert Systems for Cartographic Design (I-8), Institutions Sharing Spatial Information (I-9), Temporal Relations in GIS (I-10), Space-Time Statistical Models in GIS (I-11), and Remote Sensing and GIS (I-12).

For each of the above Initiatives, outside participation on all levels is sought in the categories of Specialist Meeting Participant, and Scholar in Residence. Outside participation as a Scholar in Residence is welcomed for the already ongoing Initiatives 1-6. Please contact the appropriate Initiative Leader for more information.

### NCGIA ANNOUNCES

- The Scientific Policy Committee (David Mark, Chair) invites *suggestions for future additional NCGIA Research Activities and Initiatives*. Research Initiatives are normally multi-investigator, interdisciplinary projects lasting 18-24 months. Please contact David Mark at SUNY/Buffalo (Buffalo, NY 14260) or any NCGIA member.
- A *University Affiliates Program* has been established whereby U.S. universities may affiliate with NCGIA to engage in joint research on existing or future research initiatives. Please contact David Simonett or Michael Goodchild at NCGIA, Santa Barbara (University of California, Santa Barbara CA 93106) or phone (805) 961-8224.

*Already, many visitors have come to one of NCGIA's three sites. More than 30 have come from other US universities, more than 45 from foreign universities, about 10 from research institutes in the US and abroad, over 20 from US and foreign government agencies, and about 40 from industry.*

*Many of the visitors presented papers, led colloquia or seminars, or discussed possible future research.*

*In addition, NCGIA personnel have made many visits to universities, research centers, and government agencies, both in the US and abroad.*

*To arrange a visit, please contact one of the Site Directors or any member of the NCGIA.*

**1. TECHNICAL PAPERS.**

- 88-1. *Full Proposal.* 300+p. Includes appendices of Center personnel & bibliography. **\$20.00.**
- 88-2. *Edited Proposal.* Abridged version of above. No appendices. **\$8.00.**
- 89-1. *Accuracy of Spatial Databases: Initiative 1 Specialist Meeting Report.* M. F. Goodchild, comp., 22 p. **\$4.50.**
- 89-2. *Languages of Spatial Relations: Initiative 2 Specialist Meeting Report.* D. M. Mark et al., comps., 50 p. **\$6.50.**
- 89-2A. *Languages of Spatial Relations: Researchable Questions & NCGIA Research Agenda.* D. Mark, comp., 14 p. **\$3.50.**
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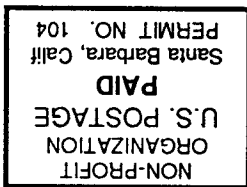
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