

# UC Santa Barbara

## Newsletters

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# NCGIA UPDATE

National Center for Geographic Information and Analysis A National Science Foundation Center

APRIL 1994

## NEW OPPORTUNITIES FOR COLLABORATION WITH NCGIA

To facilitate cooperative research projects with individuals and institutions, NCGIA has recently adopted several new policies and procedures. US scientists not associated with an NCGIA site will find it easier to propose and co-lead research initiatives, to spend extended periods at NCGIA sites as visiting fellows, and to participate in specific collaborative projects funded through NCGIA. Further information on each of these programs is available through any NCGIA site.

### Visiting Fellowships

Beginning in January 1994, NCGIA will make available grants of up to \$20,000 per year to support US scientists not normally associated with NCGIA who wish to participate in NCGIA research activi-

ties for extended periods of two weeks to a year at any NCGIA site. Funds may be used to support travel, living costs, and salary; other costs associated with research will be covered by the host site. Proposals will normally be considered twice each year, although exceptions will be made. Proposals for fellowships should be submitted by September 30 to be considered at the December meeting of NCGIA's Science Policy Committee, and by March 31 for the June meeting.

### Collaborative Research Projects

NCGIA invites proposals for research projects involving collaboration between one or more NCGIA sites and other groups or institutions. Funding for such projects is shared between NCGIA and the collaborator. Researchers interested

in developing collaborative projects should discuss them with appropriate researchers within NCGIA before beginning joint proposal development. Proposals are considered at the June and December meetings of the NCGIA Science Policy Committee.

### Proposals for New Initiatives

Research initiatives are the primary vehicle for NCGIA research. To date, suggestions of topics for new initiatives have come primarily from within the Center, but researchers at other institutions have participated in specialist meetings, helped to plan initiatives, worked on initiative-related research topics, and co-led initiatives. NCGIA encourages participation by the broader research community in the formulation of new initiatives.

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(as of December 1993)

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### Conference on Law and Information Policy for Spatial Databases

October 28 and 29, 1994  
Arizona State University College of Law  
Tempe, Arizona

Organized by the Center for the Study of Law, Science, and  
Technology Arizona State University College of Law and  
NCGIA

The conference will be held during the first day and a half of the three-day NCGIA Initiative 16 specialist meeting on Law, Information Policy, and Spatial Databases. Early registration is advised, as seating is limited. There will be no on-site registration.

More information and registration materials are available from: Rosalind Pearlman, ASU College of Law (602/965-2124) or Kathleen Hornsby, NCGIA, 5711 Boardman Hall, University of Maine, Orono, ME 04469 (phone 207/581-2143 hornsby@mecan1.maine.edu)

# FROM THE DIRECTOR

## Renewal

Six years ago, when the National Center for Geographic Information and Analysis was established, NSF announced that it would initially fund the Center for five years, with the possibility of extending support for an additional three years. We submitted our renewal proposal in November 1991. In June 1992, we were visited by an NSF review team. We are delighted that NSF found the quality and influence of NCGIA's work sufficient to renew its support through November 1996.

We learned much from the review process, and we are using it to improve the Center. We have two new programs, described in this issue, to help the Center function better as a truly national resource and to help maintain intellectual vitality. The Visiting Fellowships Program opens the three NCGIA sites—in California, Maine, and New York—to visitors from elsewhere in the national research community for extended periods. The Collaborative Research Program encourages collaborative projects between NCGIA and other research groups within the United States. Working in a research center "without walls" can be exhilarating. New points of view give rise to new questions and new techniques. I extend a personal invitation to anyone interested in research in geographic information and analysis to find out more about these programs and to think about participating.

Funding is, of course, just one aspect of renewal in any organization that maintains a high level of energy and enthusiasm. Another important sign of renewal in organizational and scientific life is addressing new issues and framing novel approaches to solving problems. The federal government has recently taken significant steps in geographic information science, beginning with the publication of the National Research Council's Mapping Science Committee report, *Towards a Coordinated Spatial Data Infrastructure for the Nation*. The report defines a National Spatial Data Infrastructure and calls for partnerships

between all levels of government and the private sector to build it. The Gore Commission's *Reinventing Government* plan commits the Administration to building the NSDI. The Office of Management and Budget strengthened the mandate of the Federal Geographic Data Committee as the coordinating agency for NSDI in the federal government; Secretary of the Interior Bruce Babbitt is the new Chair.

The academic community is also contributing to the Center's renewal. The NCGIA Board of Directors authorized the Center to explore establishing a university consortium, both to help build the research and education infrastructure for NSDI and to develop collaboration within the academic community across all disciplines involved in geographic information science. We held open meetings at several conferences, most recently at GIS/LIS in Minneapolis in November, and we are planning to hold a founding meeting later this year.

Often, renewal is not an event, but a thoughtful and continuous process. Before NSDI can exist in anything close to the form envisioned in the National Research Council report, several key issues must be addressed. Unfortunately, many consider maps to be straightforward and think of geographic information systems as simply containers of maps. We will have to work hard to convince people that this view is wrong. To make NSDI function, we must find much better ways of describing spatial data, through metadata standards based on sound theory. Users will need much better ways of learning about data quality and its implications for their analyses, models, and decisions. It will have to be much easier to transfer data between systems, and for users to understand the data they have received. And we will have to surmount the whole complex of institutional barriers to data sharing: pricing of data, protection of intellectual property and personal privacy, legal liability, and equity of access.

Substantial investment in educa-

tion will also be needed for the National Spatial Data Infrastructure to be successful. Particularly in K-12 and the community colleges, new geographic technologies have so far had very limited exposure, although there are some notable exceptions. In late January, NSF sponsored the first of a continuing series of Education-GIS conferences in Washington, D.C. Educators, GIS specialists, and teachers came together to discuss ways of bringing GIS into the K-12 curriculum. Everyone was impressed by the displays of software and data—and by what individual teachers have managed to achieve in their classrooms, often with very limited resources. Several lessons emerged: the importance of exposing students to spatial reasoning, the value of GIS for learning environmental and social science in addition to geography, and the usefulness of GIS in developing problem-solving and other life skills.

To celebrate the many aspects of the Center's renewal, this issue of the *UPDATE* has a new look and some new features. Please let us know your thoughts on how to improve it further.

—Michael F. Goodchild

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# EDUCATION

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by Steve Palladino

*To increase the number of people who are familiar with GIS technology, members of NCGIA develop a variety of educational materials and programs for both college and pre-college students.*

## Bringing GIS to local classrooms

Institutions that would like to share their GIS software and expertise with local primary and secondary schools, as well as teachers who are interested in incorporating GIS into their teaching, have a new resource. The Workshop Resource Packet (Technical Report 93-2), based on NCGIA GIS workshops for teachers, includes a section on GIS in the schools, outlines of teacher-designed GIS projects, a model format of a GIS workshop for teachers, notes for the GIS short course, a list of GIS and related resources for teachers, and a glossary of basic GIS terminology. You may obtain a copy from the NCGIA Publications Office (phone: 805/893-8224, fax: 805/893-8617, [ncgia@ncgia.ucsb.edu](mailto:ncgia@ncgia.ucsb.edu)).

## The first national conference on GIS in education

Funded by NSF and organized by TERC, the conference was held in Washington in January 1994. Barbara Buttenfield (Buffalo) and Michael Goodchild (Santa Barbara) made keynote presentations. Discussions over the three days suggested that GIS technology not only introduces children to the technological aspect of our society, but that it can also foster curiosity, self-confidence, communication, and social skills.

## Teacher workshops

Santa Barbara and Maine each offered a one-week teacher workshop last summer that included GIS lectures and hands-on work with GIS software. Teachers representing six of the Geographic Alliances sponsored by the National Geographic Society attended the Santa Barbara workshop; science and computer science

teachers from Maine participated in the session in Orono.

Schools who sent teachers to either workshop could participate in ESRI's Adopt-a-School program and received free copies of ArcView software and (ArcUSA, ArcWorld, and ArcScene) data sets on CD-ROM.

## Advanced topics: GIS data issues

NCGIA Summer Institute Advanced Topics program provides college-level researchers and instructors from a broad range of disciplines with a chance to immerse themselves in GIS. The intensive week-long course, which assumes some experience with GIS, includes seminars, computer-based demonstrations, and discussion sessions led by NCGIA-affiliated researchers. Participants return to their own institutions with a fuller understanding of how to put GIS to work in their own research and teaching.

This year's program focuses on GIS data issues, including data accuracy, quality, visualisation, and sources. Lecturers will include Barbara Buttenfield, Max Egenhofer, and Michael Goodchild. It runs August 10-16 at the NCGIA's University of California, Santa Barbara site. The application deadline is June 15. Further information and application materials may be obtained from:

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## New material for GIS instructors

Rusty Dodson has updated the 1991 guide to materials for developing a hands-on computer laboratory curriculum. It includes exercises for GIS activities employing a variety of GIS software

commonly used in the teaching laboratory, as well as a list of data sets available for teaching and additional resources. The *NCGIA Guide to Laboratory Materials* (Technical Report 93-10) is also available from the NCGIA Publications Office.

## Core Curriculum

NCGIA has distributed more than a thousand sets of its teaching materials known as the Core Curriculum, which focuses on the theoretical underpinnings and concepts of GIS, the relationship between real phenomena and a database representing them, and the value of GIS as a scientific tool for advancing spatial research and analysis. (More information is available from NCGIA Publications, Department of Geography, University of California, Santa Barbara, CA 93106-4060.)

Worldwide interest in the Core Curriculum has led to foreign language editions. In Hungary, for example, the Technical University of Budapest began to distribute the Core Curriculum in English in 1991. Although the Curriculum was well received, differences in Hungarian educational environments, computer infrastructure, and society—as well as the language barrier—led to an effort to adapt the Core Curriculum to better meet the needs of the Hungarian educational and technical communities. The first volume of the Core Curriculum has been translated into Hungarian and examples have been modified to reflect Central European perspectives. More information on the Hungarian version is available from Dr. Bela Markus  
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Technical University of Budapest  
Muegyetem rkp. 3. Kmf. 16  
H-1521 Budapest  
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# FEATURES

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## UNITAR/NCGIA International Networking

To facilitate and increase collaboration of professionals and institutions in environmental management and GIS, NCGIA and the United Nations Institute for Training and Research (UNITAR) Environmental Training Programs in Geneva, Switzerland, are considering establishing a UNITAR/NCGIA International Networking Program.

The goal is to assist environmental decision-making for sustainable development (such as the UNEP/GRID Training Programs, the UNSO and OSS AfricaGIS Program, the UNEP Caribbean Environment Program, and the European Commission Mediterranean Desertification and Land Use Program).

The program will (1) facilitate international cooperation in research and training for environmental management using environmental information systems; (2) develop a database of EIS professionals, institutions, and research projects; (3) develop training for resource persons in electronic communication systems and in writing research and training grant proposals; and (4) facilitate the exchange and development of EIS training materials and information.

Carmelle J. Cote, a graduate student at Buffalo, was a research associate on this project in summer 1993. Stephen Gold and Walter DeVries, program officers of the UNEP/GRID Training Program, were the direct supervisors of the research in Geneva.

## ESF GISDATA

by Max Craglia

The European Science Foundation's GISDATA scientific program was launched in January 1993. This four-year program focuses on three research areas: data integration, database design, and socio-economic and environmental applications.

The goals are (1) to enhance existing national research efforts and promote collaborative ventures that will overcome European-wide limitations in spatial data integration, database design, and social and environmental applications; (2) to increase awareness of the political, cultural, organizational, and technical barriers to increased use of GIS in Europe; (3) to promote the ethical use of integrated information systems that handle socio-economic data by respecting legal requirements for data privacy; (4) to facilitate development of appropriate methodologies for GIS research at the European level; and (5) to build up a European network of researchers, particularly young researchers in the GIS field.

To implement the program, GISDATA is organizing a series of specialist meetings, two joint-task-force meetings, and two summer institutes.

**Specialist meetings:** Given the very large number of researchers in Europe interested in GIS and the variety of their backgrounds, the most effective way to implement the GISDATA program seemed to be to convene a series of specialist meetings on pre-defined topics. With this approach, a large number of researchers throughout Europe can be involved without sacrificing flexibility in a rapidly changing field. Three specialist meetings have been held on GIS diffusion, generalization, and spatial analysis.

**GIS Diffusion in Local Government in Europe, Knutsford, 27-31 October 1993:** This meeting focused on local government—

one of the largest GIS end-users. Local government also usefully illustrates the extent to which national and even local issues affect the diffusion of technology. A book is expected to be published in the next year or so.

**GIS and Spatial Analysis:** Amsterdam, 1-5 December 1993: Participants were chosen from four groups: Exploratory Spatial Data Analysis, Modeling, Socio-Economic Applications, and Environmental Applications. As a result of the wide-ranging discussions held, it was agreed to publish the contributions received for this meeting and to plan another meeting for next year more focused on the exchange of software and data sets so that more information can be exchanged among the participants. This meeting is being organized by a small panel of young researchers; they are also developing a network of interested individuals and institutions.

**Generalization:** Compiègne, 15-19 December 1993: This meeting, closely integrated with NCGIA's 1-8, considered both cartographic and model generalization. In addition to a definitive book on the subject, an on-line report on state-of-the-art generalization is being developed. (See also "Obstacles to Generalization" in this issue.)

**Joint Task Force Meetings:** The first of two joint task force meetings will take place in Aalborg, Denmark, in September and will provide the opportunity to review the three research strands of the program and define future research agendas.

**Transatlantic Summer Institutes:** Two joint ESF-NSF Summer Institutes are planned; one next year, in the United States, and the second in Europe, in 1996. These institutes are particularly targeted to young researchers in the United States and Europe, and fellowships to attend will be awarded by open competition.

**For more information:** See Arnaud, A., et al., "The research agenda of the European Science Foundation's GISDATA Scientific Program." *Int. J. GIS*, 7(5), 463-70, 1993. Michael Goodchild (Santa Barbara) is the key person in the United States for GISDATA information.

## COMPUTER THIEVES

Everyone at a university should re-examine computer security. Recent burglaries at NCGIA were part of a widespread epidemic in the country's collegiate computing centers.

Computer thieves ravaged our Santa Barbara offices in 1993: 408 megabytes of RAM from 12 IBM RS/6000 workstations were stolen. The SIMM memory modules and boards were worth over \$95,000. While insurance covered the costs, over six weeks passed before all workstations were restored to operation. Fortunately, our colleagues at UCSB helped us to maintain access to email.

Curiously, the latest workstation technology is only slightly more expensive than replacement memory from IBM. Therefore, we decided to upgrade the 4-year-old computers to the latest offerings. By May, NCGIA will have taken final delivery of IBM's new PowerPC RS/6000 250s. (The delay is undoubtedly due to the computer's overwhelming popularity.)

On February 5, 1994, the Santa Barbara office was again burglarized. However, due to new theft-prevention measures, only a single memory board was stolen. Further precautions have been taken, but to maintain security they will not be described.



# INITIATIVES

NCGIA's research is carried out by collaborative interdisciplinary teams. Each team addresses a different issue of GIS. The research agenda for a particular issue is established at a meeting of specialists from the GIS community. Results are presented at major conferences, usually within one or two years of the inception of a specific research initiative.

The NCGIA Science Policy Committee welcomes suggestions about future research. Please give them to Harlan Onsrud, SPC Chair.

Note: Barbara Buttenfield is currently on sabbatical at USGS National Mapping Division in Reston, Virginia.

## INITIATIVE 4: USE AND VALUE OF GEOGRAPHIC INFORMATION

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Hugh Calkins (Buffalo)  
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**This initiative focused on improving models for tracking the use of geographic information and expanding methods for assessing the value and benefits of geographic information. It was completed in summer 1993; the closing report is available from NCGIA.**

Advancing methods for modeling the diffusion of innovations in graphic information technology was one goal. A case study was developed that set forth a method for testing technology transfer theories in GIS environments. Investigators at other universities were invited to use the process to carry out a single case study to test a sample series of provided falsifiable hypotheses. Information on the studies is included in NCGIA Technical Report 93-8.

## INITIATIVE 6: SPATIAL DECISION SUPPORT SYSTEMS

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**This initiative examined the possible role of GIS and associated techniques in decision-making. Other threads will be picked up by I-17.**

"Strategies for Parallel Spatial Modeling on MIMD Computers," the thesis of graduate student Yuemin Ding (Buffalo), describes strategies developed for decomposing spatial problems into parallel processes to run on multiple instruction multiple data (MIMD) architecture parallel computers. The approach has been used by Ding and Densham to develop and implement a number of parallel algorithms on a Transputer array for generating shortest paths through a network, Delaunay triangulations and Thiessen polygons, and hill-shading on digital elevation models. Paul Densham and Catherine Dibble supplemented this work by investigating the use of Genetic Algorithms to generate interesting alternatives—those which are maximally different in attribute space but perform similarly in objective space. Both developments have been incorporated in Densham's LADSS (Locational Analysis Decision Support System) software, available from NCGIA.

The modifiable areal unit problem and its effects in linked spatial models is the subject of an article by Stewart Fotheringham, Paul Densham, and Andrew Curtis: "The Zone Definition Problem in Location-Allocation Modeling." (Research on this topic will continue as part of I-14.) I-6 research was presented at the AAG in Atlanta (no proceedings).

Research presented at Auto Carto and GIS/LIS in Minneapolis is published in the conference proceedings.

## INITIATIVE 7: VISUALIZATION OF SPATIAL DATA QUALITY

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**Faced with a rapidly swelling flood of data, scientists have turned increasingly to new, computer-intensive methods of visualizing data to search for interesting information. But the quality of the original data may not be apparent in the final visualization: viewers may not be aware of the uncertainty in a data set, for example. This initiative focuses on how to make viewers aware of data quality.**

To generate external interest on the problem of visualizing spatial data quality, the Data Quality Visualization Challenge was co-sponsored by the United States Environmental Protection Agency and the USDA Soil Conservation Service (each contributed a data set; participants had to use one) and by the American Statistical Association. Eight final papers were judged by Rick Becker, AT&T; Dennis Lytle, SCS; Phil Ross, EPA, Environmental Statistics Division; Charles Spooner, EPA Chesapeake Bay Program; Waldo Tobler, UCSB; and Leland Wilkinson, Systat. The winners were Alan MacEachren, et. al., from Pennsylvania State University. Their project looked at both spatial and temporal quality/uncertainty issues arising in exploratory analysis (categorization, interpolation, spatial filtering, and so forth). The student winner was Bouchra Miri, a master's student at the University of Maine.

Using radon data for the state of Maine, Kate Beard and Carl Amrhein have been examining the aggregation or modifiable areal unit problem. Although radon is a suspected cause of lung cancer, radon occurrence has shown no positive correlations with lung cancer rates when aggregated to demographic units for this comparison.

"Reference Grids: a Technique for Visualizing Process Error" is the subject of a paper by Khaled Hassen and Kate Beard. Reference grids were used as a visual audit trail to document changes in spatial data introduced by GIS operations. An interesting development has been the visualization of functions, or visualizing the outcome of GIS operations.

"Data Quality Filter: A User's Tool for Data Quality Assessment," by Jeff Paradis and Kate Beard, reports on a technique in which users set parameters for an error budget. Data are filtered based on these parameters, and only data that pass the filter are displayed. (The paper has been submitted to *URISA Journal*.)

William Mackaness and Kate Beard presented a paper on "Visualization of Interpolation Uncertainty" at Auto Carto 11. Interpolated values are typically represented as isolines, or perhaps Thiessen polygons in the case of areal interpolations. In few—if any—presentations is the variation in the uncertainty of the predicted values communicated. Reliability of interpolated values depends on such factors as sampling scheme, number of sample points, interpolation method, and measurement error in the observed  $x$ ,  $y$ ,  $z$  values, as well as the nature and complexity of the observed phenomena. Visual expressions for each of these components thus provide insight on their contribution to the uncertainty.

"Spatial Data Quality and Its Evaluation," by Victor Wu and Barbara Buttenfield extends the conceptual framework first proposed by Kate Beard and Barbara Buttenfield. The paper, which will appear in *Computers, Environment and Urban*

*Systems*, incorporates Searle's speech acts into the data quality framework with suggestions from Winograd and Flores.

A special issue of *Cartographica*, on mapping data quality (vol. 30, no. 2) includes articles by several of the I-7 specialist meeting participants: "Visual Access to Data Quality in GIS" (Kate Beard and William Mackaness), "Representing Data Quality" (Barbara Buttenfield), "Visualizing Uncertainty in Soil Maps by Animation" (Pete Fisher), "A Cartographic View of Spatial Data Quality" (Matt McGranaghan), and "Exploring the Quality of Enumeration-Area Data with Graphic Scripts" (Mark Monmonier).

#### INITIATIVE 8: FORMALIZING CARTOGRAPHIC KNOWLEDGE

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

In October 1993, specialists from a dozen different countries—representing academia, the private sector, and the national mapping agencies—met in Buffalo and identified four high-priority items for the research agenda: formalizing cartographic language, evaluating cartographic design, implementing data models to support cartographic knowledge representation, and identifying new methods for eliciting cartographic knowledge.

A GIS/LIS panel session was held in November to disseminate a preliminary research agenda and to initiate discussion in the community on research related to cartographic knowledge representation. Panelists included some I-8 Steering Committee Members: Barbara

Buttenfield (Chair), Geoff Dutton (Harvard Design and Mapping), Peter Fisher (University of Leicester), Roberta Lenczowski (Defense Mapping Agency), and Robert Weibel (University of Zurich).

"The Cognitive Ergonomics of Computer-Assisted Visualization Design," by William Mackaness (Maine) and Andrew Turk (Murdoch University, Australia) and "On the Abstraction of Cartographic Objects from Remotely Sensed Imagery" by Michael Collins and William Mackaness have been submitted for publication.

At Buffalo, Michael Leitner completed his master's thesis project, "Multi-Scale Inventory of a Topographic Map Series," part of an ongoing project at Buffalo to inventory symbol changes on European topographic map series. Chris Weber's dissertation, "Sonic Enhancement of Map Information: Experiments Using Harmonic Intervals," is an example of empirical research to elicit formal measures of knowledge that may enhance thematic map data. Paul Schwartz completed his master's thesis, "Digital Typography in Cartographic Design," as part of the research funded by the World University Games project at Buffalo.

Barbara Buttenfield has begun a project to extend the DLG-E data model to integrate object representations for multiple scales. She has also completed a needs and requirements study at the Library of Congress Geography and Map Division in Washington, D.C., to advise them on automating bibliographic research and map cataloging.



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# PUBLICATIONS

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## RECENT NCGIA TECHNICAL PAPERS

- 93-1: *Three Presentations on Geographical Analysis and Modeling: Non-Isotropic Geographic Modeling; Speculations on the Geometry of Geography; and Global Spatial Analysis*, by Waldo Tobler (Santa Barbara) \$7.50
- 93-2: *NCGIA Secondary Education Project "GIS in the Schools" Workshop Resource Packet*, by Stephen D. Palladino (Santa Barbara) \$24.00
- 93-3: *Environmental Modeling with GIS: A Strategy for Dealing with Social Continuity*, by Karen K. Kemp (Santa Barbara) \$25.00
- 93-4: *Remote Sensing and GIS Integration: Towards a Prioritized Research Agenda*, by John E. Estes and Jeffrey L. Star (Santa Barbara) \$4.50
- 93-5: *Teaching Introductory Geographical Data Analysis with GIS: A Laboratory Guide for an Integrated Spacestat/Idrisi Environment*, edited by Rusty Dodson (Santa Barbara) \$13.50
- 93-6: *Environmental Equity in Los Angeles*, by Laretta Burke (Santa Barbara) \$18.50
- 93-7: *Spatial Analysis and GIS: Interfacing GIS and Econometric Software*, by Luc Anselin, Sheri Hudak, and Rustin Dodson (Santa Barbara), with disk \$19.00
- 93-8: *Testing Technology Transfer Hypotheses in GIS and Environments Using a Case Study Approach*, edited by Harlan J. Onsrud (Maine), Jeffrey Pinto (Maine), and Bijan Azad (MIT) \$12.00
- 93-9: *GIS and the Coastal Zone: An Annotated Bibliography*, compiled by Darius J. Bartlett (University College, Cork, Ireland) \$7.50
- 93-10: *The NCGIA Guide to Laboratory Materials* (rev. 1993), edited by Rustin Dodson (Santa Barbara) \$32.50
- 93-11: *African Data Viewer*, compiled by Stephen D. Palladino (Santa Barbara) \$4.50
- 93-12: *GIS, Cartography, and the Information Society: An Annotated Bibliography*, compiled by William Dowdy (Santa Barbara) \$4.00
- 94-2: *Selected Bibliography on Law, Information Policy, and Spatial Databases*, compiled by Harlan J. Onsrud, Jeffrey Johnson and Xavier Lopez (Maine) \$4.50
- 94-3: *Land Information Systems in Developing Countries: Bibliography*, compiled by Harlan Onsrud, Jeff Johnson, Patrick Kirby, Ricardo Moreno, and Bheshem Ramlal (Maine) \$3.50
- 94-4: *Gap Analysis of the Southwestern Region*, by Frank W. Davis (Santa Barbara) \$15.50

A complete list of NCGIA Technical Papers may be obtained from NCGIA/Geography, University of California, Santa Barbara, CA, 93106-4060, phone: 805/893-8224, fax: 805/893-8617, [ncgia@ncgia.ucsb.edu](mailto:ncgia@ncgia.ucsb.edu)

## NCGIA SOFTWARE

S-92-1: SPACESTAT, developed by Luc Anselin (Santa Barbara), covers a range of descriptive spatial statistics, measurements of spatial autocorrelation, and tools to implement spatial analysis in regression models. The program interfaces with a number of commercial GIS, including ARC/INFO, IDRISI, OSU-MAP, and generic raster files. Requires an IBM PC or compatible with an 80386 or 80486 CPU, math coprocessor, 4 MB of RAM SPACESTAT with GAUSS (Aptech Systems, Inc.).

- Run time module \$250
- Each additional copy SPACESTAT with run time module, for lab distribution (no manual) \$65
- SPACESTAT without run time module (user has GAUSS) \$200
- Tutorial manual only \$50

S-92-2: GEOLINEUS (updated 12/93), developed by David Lanter (Santa Barbara), assists ARC/INFO users on the SUN4 and SPARCstation workstations in lineage tracking, data management, and graphic interface for GIS (available through NCGIA to academics only). \$120

S-92-3: LADSS, developed by Paul Densham (Buffalo), a Locational Analysis Decision Support System. Requires an IBM PC or compatible with math coprocessor, color video adapter, hard disk and 640 Kb of RAM (an 80386 or better is recommended). \$40

S-92-4: SAM, developed by Yuemin Ding and Stewart Fotheringham (Buffalo), a Spatial Analysis Module in cartridge form running on the UNIX operating system. It consists of AML and C programs and is run entirely within ARC/INFO. \$50

S-92-5: DIRIGO, developed by Manfred Ehlers and students (Maine), a fourth-generation, multispectral, digital-image processing system designed specifically for remote sensing applications on the Macintosh II. Requires a Mac II, 2 MB RAM, 8-bit display monitor, 20 MB (or larger) hard disk; optional laser printer for hard copy output. \$50

**NCGIA Technical Papers and Software may be ordered from NCGIA/Geography, University of California, Santa Barbara CA 93106-4060. Prepayment is preferred. Make check/money order payable to : UC Regents/NCGIA. (Funds must be payable in US dollars and drawn on a US bank.) Postage and handling are included in the price.**



## ELECTRONIC ACCESS TO NCGIA PUBLICATIONS AND OTHER INFORMATION

We try to make most reports available in both text and postscript formats (see "text" and "ps" directories). The entire publications list is available as pub.list. The papers available are named according to their publication number, so retrieving a copy of the current publications list would be a good starting point.

*FTP access: FTP to NCGIA.UCSB.EDU (128.111.105.65). Login as the user "anonymous" and type your email address as the password.*

*Please note: due to a disk crash this ftp site is being rebuilt from scratch. To prevent this from happening again, all information is being mirrored by all NCGIA sites. If ncgia.ucsb.edu is unavailable, please try grouse.umesve.maine.edu/pub/NCGIA or ncgia.geog.buffalo.edu*

We regret that not all Technical Reports are currently available via FTP. More papers will be added as the computer readable source for the papers becomes available.

## BOOKS PUBLISHED BY NCGIA RESEARCHERS

*Accuracy of Spatial Databases.* Michael F. Goodchild and Sucharita Gopal, eds. London: Taylor & Francis, 1989. ISBN: 0-85066-847-6

*Cognitive and Linguistic Aspects of Geographic Space.* D. M. Mark and A. U. Frank, eds. Dordrecht: Kluwer, 1991. ISBN: 0-7923-1537-5

*Map Generalization: Making Rules for Knowledge Representation.* B. P. Buttenfield and R. B. McMaster, eds. London: Longman House, 1991. ISBN: 0-582-08062-2

*Design and Implementation of Large Spatial Databases (First Symposium SSD '89, Santa Barbara, California, July '89, Proceedings).* A. Buchmann, O. Gunther, T. R. Smith, and Y. F. Wang, eds. New York: Springer-Verlag, 1989. ISBN: 3-540-52208-5

*The Integration of Remote Sensing and Geographic Information Systems.* Jeffrey Star, ed. Bethesda: ASPRS, 1991. ISBN: 0-944426-49-2

*Geographic Information Systems: An Introduction.* Jeffrey Star and John Estes. Englewood Cliffs: Prentice Hall, 1990. ISBN: 0-13-351123-5

*Geographical Information Systems: Principles and Applications.* D. J. Maguire, M. F. Goodchild, and D. W. Rhind, eds. London: Longman House, 1991. ISBN: 0-582-05661-6

*Cities of the 21st Century: New Technologies and Spatial Systems.* J. Brotchie, M. Batty, P. Hall, and P. Newton, eds. New York: Halsted Press and London: Longman Cheshire, 1991. ISBN: 0-470-21742-1

*Theories and Methods of Spatio-Temporal Reasoning in Geographic Space (International Conference GIS—From Space to Territory: Theories and Methods of Spatio Temporal Reasoning, Pisa, Italy, September 1992, Proceedings).* A. U. Frank, I. Campari, U. Formentini, eds. Berlin, New York: Springer-Verlag, 1992. ISBN: 0-387-55966-3

*Spatial Information Theory: A Theoretical Basis for GIS [European Conference, COSIT '93, Marcialina Marina, Elba Island, Italy, September 1993, Proceedings].* Andrew U. Frank and Irene Campari, eds. New York: Springer-Verlag, 1993. ISBN: 0-387-57207-4

*Environmental Modeling with GIS.* Michael F. Goodchild, Bradley O. Parks, and Louis T. Steyaert, eds. New York: Oxford University Press, 1993. ISBN: 0-19-508007-6

*Spatial Analysis and GIS.* Stewart Fotheringham and Peter Rogerson, eds. London: Taylor & Francis, 1994. ISBN: 0-7484-0103-2

*The Geographical Analysis of Population: With Applications to Planning and Business.* David A. Plane and Peter A. Rogerson. New York: John Wiley & Sons, 1994. ISBN: 0-471-5104-9

*Fractal Cities: The Geometry of Form and Function.* Paul Longley and Michael Batty. London: Academic Press, 1994.

*Diffusion and Use of Geographic Information Technologies.* Ian Masser and Harlan J. Onsrud, eds. Dordrecht, Boston, London: Kluwer Academic Publishers, 1994. ISBN: 0-7923-2190-1

*Cities in Competition.* J. Brotchie, M. Batty, E. Blakely, P. Hall, and P. Newton, eds. London and Melbourne: Longman-Cheshire, 1994.

**INITIATIVE 9:  
INSTITUTIONS SHARING  
GEOGRAPHIC INFORMATION**

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**This initiative focuses on developing models and strategies for sharing spatial data at every level, from local to global.**

NCGIA has begun a one-year program with USGS to identify datasets to form the backbone of the National Spatial Data Infrastructure. Specifically, the project is establishing criteria for identifying high-priority framework data sets for NSDI; defining minimum technical specifications that must be met by these data sets, including content and positional accuracy; and initiating further discussion of these requirements. A focus group of experts in a wide range of areas of application of spatial data will identify and refine questions, and a broad sample of spatial data users will be surveyed. Results will be compiled in a major report on framework data specifications. Harlan Onsrud and Michael Goodchild (Santa Barbara) are the principal investigators.

*Sharing Geographic Information*, twenty-nine chapters prepared by authors who participated in the I-9 specialist meeting, will be published by the Rutgers Center for Urban Policy Research.

Hugh Calkins (Buffalo) and Rick Weatherbe visited four sites in 1993 to analyze spatial data sharing patterns, cost management practices, interagency agreements, public/private sector partnerships, leadership issues, and organizational concerns. Weatherbe presented their paper, "Case Studies of Spatial Data Sharing," at GIS/LIS '93.

**INITIATIVE 10:  
SPATIO-TEMPORAL  
REASONING IN GIS**

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**Research for this initiative falls broadly into three categories: studies of how humans think about geographic space and time, and the formalization of these processes; investigations of how to interact with and display space-time information; and design of efficient methods to store space-time information.**

Thirty-nine people attended the specialist meeting of this initiative in Lake Arrowhead, California, in May 1993. On the basis of extended abstracts covering a wide range of different perspectives (including philosophy, geography, computer science, environmental psychology, planning, linguistics, history, and archaeology), twenty-two authors were selected for the specialist meeting. (Approximately twenty of the I-10 authors agreed to revise their papers for publication.) Invited discussants, center members, and industrial and governmental representatives completed the group.

Working groups identified over 80 researchable questions at the level of a master's or Ph.D. thesis topic. (The ranked research agenda will be published as an NCGIA technical report.)

Egenhofer visited the University of L'Aquila, Italy, last summer to work with Eliseo Clementini and Paolino di Felice on problems of hierarchical spatial reasoning in multiple topological representations. A first paper has been accepted for the *International Journal of Geographical Information Systems*, and a second one is being prepared for *Spatial Data Handling '94*.

Different computational models for reasoning about approximate distances and cardinal directions are compared in Jung-Hong Hong's Ph.D. dissertation (Maine). His initial results indicate symbolic distance/direction reasoning is stable and independent of an exact numeric representation for approximate distances if the ratio between two successive distance symbols is at least 1:3.

A bibliography of spatio-temporal databases has been compiled by Khaled Al-Taha (LSU), Richard Snodgrass (University of Arizona), and Michael Soo (University of Arizona). This resource will be published in the *International Journal of Geographical Information Systems*.

**INITIATIVE 12:  
INTEGRATION OF REMOTE  
SENSING AND GIS**

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**This research sought to remove impediments to the integration of remote sensing and GIS. Specific objectives included improving data acquisition and integration of remotely sensed data in GIS and extending GIS applications in scene classification, contextual classifiers, and expert systems. Closure is proceeding.**

The monograph for this initiative, under contract with Cambridge University Press, includes papers on accuracy issues (M. Goodchild and K. McGwire), large spatial databases (T. Smith), registration (M. Ehlers), visualization (N. Faust and J. Star), mapping (G. Asrar, J. Hensen, and D. Cowen), and management (T. Foresman).



### INITIATIVE 13: USER INTERFACES FOR GIS

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**This initiative addressed the practical design of user interfaces. In essence, it attempted to reconcile the view that user interfaces should be simple to use with the sharply contrasting view that ease of use is fundamentally at odds with the complexity of spatial concepts and reasoning. Research was closed in the summer of 1993.**

"A Graphical User Interface for Map Production within the Environmental Restoration Program at Los Alamos National Laboratory" was the subject of Todd Crane's (Buffalo) master's dissertation.

"Map Use, Spatial Decisions, and Spatial Language in English and Spanish" was the focus of Michael Gould's (Buffalo) Ph.D. thesis.

### INITIATIVE 14: GIS AND SPATIAL ANALYSIS

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**This initiative explores the ability of GIS to support a wide range of forms of spatial analysis, from simple intuitive exploration to complex confirmatory tests of statistical hypotheses.**

Initiative 14 research has been summarized in two publications edited by Fotheringham and Rogerson: *Spatial*

*Analysis and GIS* (London: Taylor and Francis) and a special issue of *Geographical Systems*.

Some of Rogerson's recent research will appear in *The Geographical Analysis of Population: With Applications to Planning and Business*, Plane and Rogerson (New York: Wiley).

### INITIATIVE 15: MULTIPLE ROLES FOR GIS IN U.S. GLOBAL CHANGE RESEARCH

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**Initiative 15 concerns the ways in which GIS could better support regional and global change research. GIS could play an important role in (1) enhancing models of Earth system phenomena operating at a variety of spatial and temporal scales across local, regional, and global landscapes, as well as in (2) improving assessments of the effects of global change on ecological systems over a range of spatial and temporal scales.**

The leaders propose a research agenda with five principal objectives: (1) to support increased integration of GIS and environmental modeling using techniques for managing, manipulating, analyzing, and displaying spatial data; (2) to critically assess the quality of existing global data in terms of spatially varying accuracy, sampling methodologies, and

completeness of coverage, and to develop means of managing and visually communicating the quality of environmental data; (3) to develop spatial database techniques to manage hierarchical structures across multiple scales of spatial patterning; (4) to develop methods both for dynamically linking human and physical databases within GIS and for exploring the regional impacts of global change; (5) to explore using GIS for detecting, characterizing, and modeling changes in ecotones. The specialist meeting will be held this fall.

Several potential members of the steering committee met in Breckenridge, Colorado, at the Second International Conference/Workshop on Integrating Geographic Information Systems and Environmental Modeling (September 1993), including Michael Goodchild (Santa Barbara), Jack Estes (Santa Barbara), Dennis Jelinski (University of Nebraska-Lincoln), David Clark (National Geophysical Data Center, NOAA), Louis Steyaert (USGS), Tim Foresman (University of Maryland-Baltimore County).

The Breckenridge meeting, although more broadly based than I-15, provided an opportunity to bring together presentations on several key I-15 topics. Programs of particular relevance included a session on hierarchical databases and the keynote presentation by Francis Bretherton. (Proceedings will be published in *GIS World* in 1994.)

Many papers relevant to I-15 are printed in the proceedings volume from the 1991 Boulder meeting, *Environmental Modeling with GIS*, Oxford University Press.

Also relevant is the Global Demography Project, supported in part by CIESIN, ESRI, the Rockefeller Foundation, and the World Resources Institute. The project has two goals: to assemble a world population database according to the second level of administrative boundaries within each nation-state, and to produce an inventory of world demographics by latitude/longitude quadrilaterals, a for-

mat that should be particularly useful for analytical modeling. Waldo Tobler (tobler@geog.ucsb.edu) directs the project. A version for Africa has been completed by Uwe Deichmann (uwe@ncgia.ucsb.edu). Anyone interested in learning more or contributing is welcome to get in touch with either Tobler or Deichmann.

#### INITIATIVE 16: LAW, INFORMATION POLICY, AND SPATIAL DATABASES

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**The goal of this new research initiative is to explore four interrelated aspects of information law that affect the handling of geographic information: access rights of citizens to publicly held information, intellectual property rights in spatial databases, privacy rights and principles, and potential liability of using, sharing, and distributing GIS data and analysis results. This knowledge will benefit institutions that must cope with the legal and public policy ramifications of GIS.**

The specialist meeting is scheduled for October 28–30, 1994, at the Center for the Study of Law, Science, and Technology in Tempe, Arizona.

An extensive bibliography divided into the major topics to be addressed by the initiative has been prepared by Harlan Onsrud, Xavier Lopez, and Jeffrey Johnson. It is available both on the Maine FTP and as an NCGIA publication in the Technical Report series.

#### INITIATIVE 17: COLLABORATIVE SPATIAL DECISION-MAKING

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**The objectives of this proposed initiative are (1) to examine the theory of the design, implementation, and use of computer-supported cooperative work (CSCW) environments and to evaluate their usefulness for GIS/GIA; (2) to identify impediments to the develop-**

#### Environmental Modeling with GIS

*Environmental Modeling with GIS, edited by Michael Goodchild, Bradley Parks, and Louis Steyaert. Oxford University Press: 1993. 512 pp; 247 illus. 8-pp color insert. ISBN: 0-19-508007-6*

*This book is for anyone who would like to know more about environmental modeling or more about the problems and advantages of GIS. Planners in federal agencies, academic researchers, environmental consultants, and teachers of advanced GIS courses will all find that it contains valuable information and insights.*

*The first part of the book describes the current state of GIS, environmental modeling, spatial statistics, and spatial databases. The second part reviews the state of integration in each of the major process areas, ranging from subsurface to atmospheric. Each section contains a comprehensive overview by a leading expert and a series of major case studies. The chapters of the book are derived from the papers presented at the First International Conference/Workshop on Integrating Geographic Information Systems and Environmental Modeling held in Boulder in 1991.*

**ment of highly interactive, group-based spatial modeling and decision-making environments; (3) to develop methods for eliciting, capturing, and manipulating knowledge bases that support both individual and collaborative development of solutions to spatial problems; (4) to develop methods for supporting collaborative spatial decision-making (CSDM), including methods for managing spatial models; and (5) to extend capabilities for supporting multicriteria decision-making in interactive, CSDM environments.**

A specialist meeting is tentatively set for late 1994, in conjunction with the GIS/LIS '94 meeting in Phoenix.

Research at Buffalo on water quality of the Great Lakes has provided an opportunity relevant to I-17. Hugh Calkins and Frank Xia have been developing a coupled GIS-watershed contamination modeling framework, known as GEOWAMS.

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# CONFERENCES

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## INTEGRATING GIS AND ENVIRONMENTAL MODELING

The second international conference/workshop on integrating GIS and environmental modeling was held September 26–30, 1993, in Breckenridge, Colorado. It built systematically on the first meeting held in 1991 in Boulder, but its program allowed intensive examination of progress over the past two years, and gave greater emphasis to the potential for GIS to be an integrating mechanism for environmental modeling. Three major issues were addressed: environmental databases and mapping, environmental modeling linked to GIS, and building environmental models with GIS.

David Stoms of UCSB reflected on the conference for *UPDATE*: "Presentations were heavily weighted towards physical process models in hydrology and meteorology, based on differential equations. One of the highlights was a plenary presentation by Craig McRae of MIT, whose videotape of air pollution movements through time beautifully integrated the multiple objectives of the conference: modeling, visualization, and linking science with policy. The presentation made the outputs from a complex three-dimensional model readily understandable by nonexperts in a way that a series of two-dimensional maps never could."

GIS World, Inc. will be distributing the proceedings volume in late 1994.

The Third International Conference/Workshop on Integrating GIS and Environmental Modeling will be held January 21–25, 1996, in Santa Fe, New Mexico. A call for papers, posters, and demonstrations will be issued later in 1994. Sandi Glendinning (Santa Barbara) will be happy to provide more information. phone: 805/893-8224, fax: 805/893-8617, sandi@ncgia.ucsb.edu.

## OBSTACLES TO GENERALIZATION

by Barbara Buttenfield

Research and development in the field of generalization, as well as theoretical and operational issues for automating generalization tools, were reviewed at a meeting hosted by the European Science Foundation GISDATA Scientific Programme December 18–21, 1993, in Compiègne, France.

Participants were invited from fourteen countries; they came from national mapping agencies, academia, and the private sector. Barbara Buttenfield (Buffalo) and Bob McMaster (University of Minnesota) represented the U.S. research community and the collaboration between NCGIA and the European Science Foundation.

Fundamental impediments to automated mapping appear to be due primarily to the lack of formalized knowledge about the cartographic process, and discussion centered on ways to acquire, represent, and implement such knowledge. (Similar topics were emphasized at the October 1993 NCGIA I-8 Specialist Meeting, and some participant overlap helped to inform the GISDATA discussions.)

The lack of data models and data structures to support comprehensive generalization techniques is another obstacle. Issues of data quality and human-computer interaction must also be kept in mind, since users need to be aware of the effects of generalization in interpreting and analyzing data.

Papers presented and discussed at Compiègne will be revised and published as a book. Opportunities for research collaboration and the results of research inspired by the meeting will be published electronically.

## FRIDAY HARBOR WORKSHOP

by Tom Poiker

Developing an understanding between the different groups that are involved in both the development and social critique of GIS drew researchers to Friday Harbor, Washington, in November 1993.

The intersections between geographic information and society are complex. One way of thinking about them is to consider four possibilities: two concerning the influence of society on GIS, and two concerning the influence of GIS on society.

Pressures of society can limit the scope of GIS (military funding or commercialization can affect the direction taken by GIS and its applicability in other contexts). On the other hand, societal influences can also extend the scope of GIS (grass-roots groups can expose and then transcend limitations in GIS).

Now, consider the effect of GIS on society. This, too, can be limiting (GIS can restrict what information is collected and available) or enlarging (by, for instance, including information about marginalized groups that have previously been excluded).

Papers that grew out of the workshop will be published in a special issue of *Cartography and Geographical Information Systems* and in a special issue of the *International Journal of Geographical Information Systems*. In addition, two sessions—and many private conversations—were dedicated to developing a research agenda for this area.



*The Buffalo NCGIA group includes (first row, l to r): Ronald Rozensky (GIS and workstation support specialist), Debbie Buffamanti (director, Geographic Information and Analysis Laboratory), Patricia Shyhalla (administrator), Michael Batty (associate director, NCGIA); (second row, l to r): research scientists Sam Cole, Peter Rogerson, Stewart Fotheringham, Hugh Calkins, and David Mark.*

*The world is a beautiful book, but of little use to one who cannot read it.*

— Carlo Goldoni

The National Center for Geographic Information and Analysis was established in 1988 by the National Science Foundation for the advancement of geographic information science.

NCGIA focuses on issues that lie beyond the reach of a single scientific discipline. Maps, one of the most ancient means of transmitting information, present select qualitative and quantitative data on a plane surface; each point on a map corresponds to a position in space. Recently, computers and graphics software have become sufficiently powerful to rapidly process an enormous volume of information and transform digital data into a cartographic image of a spatial domain with distinct regions, contours, and patterns. The visual display of quantitative information enables scientists to have insights and make predictions that would otherwise be extremely difficult, if not impossible. Our research concentrates on the theory, methods, models, and techniques required to collect, ma-

nipulate, and interpret spatially referenced data. These are of growing interest not only in geography, but also in such fields as civil engineering, anthropology, ecology, geology, sociology, political science, and economics.

In addition to promoting interdisciplinary collaborative research, NCGIA's goals are to increase the number of people in the country who are proficient in geographic information science and spatial thinking, to support the infrastructure needed to communicate effectively about geographic information science, and to shape the development of related software.

Led by the University of California, Santa Barbara, the Center also comprises the State University of New York at Buffalo and the University of Maine, visiting researchers at these institutions, and researchers at other institutions within the United States. Members of the Center retain their primary institutional appointments; their membership in the Center is an additional affiliation.

The collaboration is dedicated to enlarging understanding of the spatially referenced sciences, accelerating their achievement, and increasing their contributions to science and to humanity.



**NCGIA UPDATE**  
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