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Spatial Technologies, Geographic Information, and the City: Research Conference Report (96-10)

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Research Conference Report

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Technical Report 96-10

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A lot of people worked hard to make this conference possible. The contributions of the members of the steering committee - Ron Abler, Mike Batty, Ken Dueker, Susan Hanson, and Kingsley Haynes - were substantial at all stages and are gratefully acknowledged. Mike Batty, Ron Abler and Susan Hanson had been involved with this project since its inception as a potential NCGIA Research Initiative. Ron Abler also provided the first draft for the research agenda in this report that was put together by the three discussion groups.

I wish to thank LaNell Lucius, Sandi Glendinning, and Elan Sutton of the Santa Barbara NCGIA office for their hard work dealing with the logistics of the meeting. Chris Stebbins built a particularly attractive Web site for us. Despite a few minor glitches, the staff at the Lord Baltimore hotel helped make our stay enjoyable. Thanks also to Tim Foresman and Dana Hinzman of the University of Maryland, Baltimore County, for suggesting the Rusty Scupper for the conference dinner, and for other on-site help.

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THE BALTIMORE CONFERENCE

Background

The idea for this meeting originated in 1994 when Mike Batty and Helen Couclelis (both geographers with a background in planning and urban and regional modeling) decided to propose an NCGIA Research Initiative on the role of GIS in the cities of the information society. The Research Initiative,

a structured set of meetings and other research-related activities focusing on a specific theme over a two-year period, is the main mechanism through which the NCGIA carries out its research agenda. In the past each Initiative has been directed by two or more co-leaders from NCGIA sites, supported by a steering committee also primarily drawn from NCGIA personnel. Batty and Couclelis put together a proposal for what was tentatively designated as Initiative 18 and submitted it to the NCGIA Board of Directors for review. While enthusiastic about the theme of the proposal, the Board (which at the time included Ron Abler and Susan Hanson as members) questioned the appropriateness of the Initiative formula for an enterprise of such breadth in scope. Indeed, all NCGIA Initiatives thus far had focused on well-defined, mostly technical topics; the only broadly formulated Initiative to this day (Initiative 19: "GIS and Society") was subsequently approved using a new, more open formula, i.e. with co-leaders and a steering committee largely external to the NCGIA. Initiative 18 thus became the research conference entitled "Spatial Technologies, Geographic Information, and the City".

The term "spatial technologies" was defined by Couclelis (1994) as the complex of transportation, communication, and information technologies that together modify spatial relations:

"We need a collective name for all these technologies that modify spatial relations, because we need a new concept that will allow us to explore the new geography they generate together as an interdependent whole" (p. 143).

Thus spatial **information** technologies, of which GIS is arguably the most important example, is a subset of spatial technologies: geographic information systems both provide information about spatial relations, and contribute to the modification of these relations by affecting people's spatial behavior in multiple ways. It is this peculiar role of GIS as both active cause and passive observation platform for the changes taking place in the city of the informational age that encouraged the NCGIA to include this broad topic of spatial technologies in its research agenda.

The Call for Papers (see APPENDIX A) circulated in December of 1995 solicited contributions in the following three areas:

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

Thus the intended focus of the conference was primarily on the changing conditions of urban accessibility under rapidly evolving spatial technologies, the impact of these changes on specific populations, and the contribution of geographic information science and technology in helping us deal with these changes and impacts. However, neither the research notes submitted, nor the discussions at the meeting, nor the research agenda that was proposed were limited to these questions. A number of participants were primarily interested in the question of access (especially by disadvantaged groups) to information technology in general, or to geographic information in particular. Others saw the societal threats of information technology, such as the issue of surveillance, as the most pressing question (the improper or unethical access to information, in a sense), along with the more general ones of spatial and social justice and power. Obviously this is a topic area of very

broad import where people from substantially different research perspectives can fruitfully work together.

Figure 1 shows the thematic distribution of the papers (research notes) submitted by the conference participants relative to the three original questions of the Call: (A) Changes in

urban accessibility; (B) Impacts on populations; and (C) Role for GIS. Some of the submissions focused on only one of the three questions, some connected two, and some all three. The research notes themselves are reproduced in this report as APPENDIX B.

Figure 1 Distribution of the research notes across the three main conference themes

The meeting

The Baltimore meeting was planned as a small "research conference" or workshop along the lines of an NCGIA Initiative specialist meeting. The immediate goal was to formulate a tentative national research agenda in the areas of concern to the conference. The research notes submitted by the participants had been circulated earlier and with the exception of keynote lectures by the members of the steering committee and T R Lakshmanan, no papers were presented at the meeting. The working sessions alternated between breakout group discussions and plenaries where the results of the group discussions were reported, examined and synthesized.. The conference program is included in this report as APPENDIX C.

The initial breakout groups were assigned to the three "bullet" questions of the conference call roughly as shown in Figure 1. While group reshuffling from session to session was encouraged, most participants chose to remain with their original groups and continue discussing the same issues in more depth. As a result the discussions grew very intense and focused and by the last morning the participants were ready to present their views on what should constitute a national research agenda in the general area of spatial technologies, geographic information, and the city. The three group reports are reproduced below.

The future

Unlike an NCGIA Initiative specialist meeting, the Baltimore conference is not part of a sustained package of research activities of the NCGIA. However, interest in the general area covered by the conference is booming nationally and internationally. Several conferences and workshops on related themes were announced within the past couple of years. At the same time, several related major government initiatives were taken, and some landmark publications on the subject appeared. Prominent among these, but by no means unique, were the U.S. Congress's report entitled "The Technological Reshaping of Metropolitan America" (OTA-ETI-643); the book "Telecommunications and the City" coauthored by one of our conference participants (Stephen Graham); and the joint NSF/ESF Transportation Workshop held 10/7/96 in Strasbourg, France. That growing interest in the urban impacts of spatial technologies bodes well for those seeking a new intellectually exciting area to do research in, along with funding possibilities to help carry out such research.

The NCGIA also plans to be part of these developments. At the time of writing NSF funding is expected for the next three-year phase of the Center, which will continue its activities around a new three-part research agenda, the third area of which is entitled "Geographies of the Information Society". The Baltimore conference and the tentative research agenda it produced will likely find a

natural continuation within that environment.

References

Couclelis H, 1994, "Spatial technologies", Editorial, *Environment and Planning B: Planning and Design*, 21(2), 142-143.

Graham S, and Marvin S, 1996, *Telecommunications and the City: Electronic Spaces, Urban Places*, Routledge: London and New York.

TOWARDS A NATIONAL RESEARCH AGENDA: THE GROUP REPORTS

This section presents the edited versions of the three group reports presented on the last two plenary sessions of the Baltimore meeting, as these evolved following the general discussion and subsequent feedback to the editor. The groups were asked to define their special area of interest and provide a list of researchable questions within it, along with one or more suggestions for specific research projects addressing each question. The three-part report reflects a fairly strong consensus among those present.. Additional views on the research questions proposed and the themes of the meeting in general are reported in the next section.

Group A

The Measurement and Significance of Accessibility Changes in Urban Space-Time Structures

New research perspectives are required to study the effects of modern spatial technologies on urban areas, in particular the ongoing changes in accessibility conditions and their direct and indirect impacts, both short-term and long-term. New approaches to measuring and representing urban phenomena should facilitate shifts of focus from macro- to micro-scales of analysis, from static to dynamic views, from structures to processes, from material to electronic flows, and from space to space-time. Theoretical as well as empirical work is needed in these areas. Along with new definitions of distance, interaction, and accessibility we also urgently need studies on the questions outlined below. These should be undertaken for a number of different metropolitan areas, using comparable data and methods, cross-referencing existing data bases and generating new data from surveys and other sources. The creation of longitudinal data sets is particularly critical. These data bases should seek to include disaggregate data and should incorporate space-time diary studies on in-home as well as out-of-home activities. In some areas ethnographic research methods and data may be the most appropriate. Data collection should also include temporal coding for businesses and services (what goods and services are available when?). A literature review of work in cognate disciplines is also a high priority, to establish what is known and not known in each domain.

Priority Research Questions

A1 Explore/propose a typology appropriate for distinguishing different levels of accessibility among individuals, households, employment categories, and social and economic groups in time and space.

Relevant questions include:

- What are the parameters of accessibility in urban areas under expanding communication and information technologies?
- What geographic scales are appropriate for assessing accessibility conditions for different groups under changing spatial technologies?
- What qualitative accessibility differentials are produced by the new technologies among different urban population groups?
- Is there a useful operational distinction between **accessibility** (potential reach) and **access** (actual use)?

Categories could be derived from the literature. Existing surveys in Los Angeles, Portland, Seattle, and elsewhere could provide data for exploratory data analysis. However, in the interest of generalization, it is necessary to locally validate and appropriately cross-reference the results of similar surveys. Qualitative studies involving ethnographic methods may be needed to determine appropriate measures, especially those that incorporate access to goods, services, and places via information technologies (see also A7) .

Specific Project: Study of disparities in electronic accessibility: geocode origin/destination flows of electronic transaction data to examine patterns and distances; analyze these patterns in relation to area demographics/ area type.

A2 We assume that the new technologies are encouraging a spreading of activity over time as well as space. What is the evolving relationship between work in space and work in time? How does this affect spatial structure?

Time-budget research should be undertaken to unpack the temporal dimension from data; it should attend specifically to the 'colonization of time' , i.e., the spreading of activity into the late evening and early morning hours. The research should also focus on different age and gender groups and their activity patterns. Data collection should be sensitive to multitasking, i.e., the reality that people often are doing more than one thing at a time. European work (e.g., by K.Achshausen and D. Elterna) assembling historical data sets on activity patterns might be useful to US researchers.

Relevant questions include:

- Which traditional and new kinds of activities tend to spread over time and space with the help of spatial technologies?
- Which social and occupational groups are most affected by such spreading?
- In which parts of metropolitan areas (central cities, suburbs, exurbs...) is such spreading most manifest?
- Which urban patterns tend to facilitate/inhibit discontinuous activity patterns over time and space?

Specific Project: (1) Study the colonization of time in the capital markets industry: A number of people have to work at night, leading to more (support service) people having to also work at night. (2) Study systems using support from different time (and space) zones.

A3 What has been the effect of the telephone on urban growth and spatial patterns?

The telephone has been around a long time and in many respects its effects on human interaction have been comparable to those of the more recent communication and information technologies. Telephone infrastructure and use studies would help answer many of the questions about future patterns that have arisen at the meeting. We need microstudies of telephone penetration, in the developing as well as the developed world. (Good source: Claude Fisher's 'Calling America').

Relevant questions include:

- In what respects are the spatial impacts of the telephone similar to/different than those of more recent communication and information technologies (fax, Internet...)
- What has been the relationship between telephone calls and trips in different settings (social, by socio-economic group; business and government, service provision)
- How has telephone infrastructure affected urban growth patterns in both the developed and the developing world?
- What is the evolving role of the telephone in the context of the other spreading spatial technologies?

Specific Project: Within specific metropolitan area(s), study place-to-place variations in telephone infrastructure at the micro level and personal access to the telephone: Find areas with little telephone penetration and compare with 'similar' areas with well-developed telephone infrastructure. Distinguish between availability and use.

A4 What is the effect of mobile communications on urban growth, travel, and spatial patterns? Does greater penetration contribute to greater dispersion activity and/or more efficient trip patterns?

Research should focus as much on the social market as on economic/business uses of mobile telephones and pagers, and on time series analyses. Disaggregate data on mobile communications have existed for over a decade and may be used to track locational changes for places of employment and households.

Relevant questions include:

- How are the spatio-temporal patterns of mobile communications different from those of fixed communications?
- In what percentage of such interactions are both ends of a communication mobile?

- How does use break down by occupational, socioeconomic, etc., class?
- In which parts of a metropolitan area, and which times of day, are such communications most heavily concentrated?
- What is the effect of pricing on the different categories of use and users?
- What are the patterns of penetration of non-telephone mobile communications (pagers, portable e-mail...)?
- How are such technologies impacting the activity spaces of people with disabilities?

Specific Projects: (1) Individual activity space analysis: map and explain relationship between mobile telephone use and extent of activity spaces for different age groups (e.g., children and teenagers); compare activity spaces for adopters and non-adopters; for city/suburban/exurban areas. (2) Map and explain relationship between mobile telephone use and driving/commuting behavior, especially in congested urban settings..

A5 To what extent is there substitution between travel and communications, and to what extent are they complementary or synergistic (and increase each other's efficiency)?

Attend specifically to telecommuting within metropolitan regions over time. This is a specific aspect of the broader questions of technology and adaptation. A considerable literature on both telework and telecommuting exists (e.g., Nillis, Salomon (?), Mokhtarian), going back to the 1970s. We need to determine what is known and not known about the topic. Research on this topic is amenable to investigation using participant-observer methods as well as aggregate analysis and simulation (e.g., the Stough/Paelinck simulation model).

Specific questions include:

- Why are people not making more use of telecommuting?
- How is people's choice of a new home influenced by the possibility to telecommute?
- What differences in activity spaces are there between partial and total telecommuters/teleworkers?
- How are the effects of telework on urban and business organization different from (and more important than) those of telecommuting?
- What literature is there on neighborhood work centers? What have we learned?
- What measures matter for assessing urban impacts of telecommuting (and telework)?
- What are the effects of different levels of service (cost, bandwidth, reliability...) on the relation between travel and telecommunications?

Specific Projects: (1) Set up a multi-university virtual seminar on this topic: a case of telework - the seminar can study itself!

(2) Correlate travel and information flows: compare work trip flows within urban areas at tract level with telecommunications traffic; compare business travel with Internet flows at intercity level.

(3) Develop a ZIP-level data base, to include: distance matrix, travel time matrix by mode, traffic flows by vehicle type and trip type, telecommunication flows by medium (phone, fax, Internet...).

A6 How do changing conditions of employment alter patterns of individual behavior and affect urban spatial structure?

Research addressing this questions should attend to changes in temporal work ordering including flextime, shared jobs, shift work, and uncertainty of employment location; also to temporary workers and those with changing work locations (itinerant workers). Data on the proportion of the labor force and of various industries and occupations engaging in such work would be helpful. We also need micro-level studies of these workers to assess the impacts of the new work patterns on households and on the city. Some data bases already exist (e.g., a Phoenix, AZ data set) that provide information on individual employee work start and stop times and weekly schedule choices, and can contribute greatly to this effort.

Relevant questions include:

- How are information technologies used to create flexibility in work patterns?
- Do urban areas with a strong informational base differ in their spatiotemporal work patterns from other areas?

Specific Projects: (1) Compare rush hour traffic in areas with and without a high percentage of information-based industries. (2) Compare spatiotemporal activity patterns for IT itinerants and blue-collar itinerants (e. g., roofers, plumbers) ; compare IT itinerants and more conventional white-collar itinerants such as visiting nurses and piano tuners. Study changes in the work patterns of traditional itinerants following the adoption of IT.

A7 We need new measures of accessibility that capture both the distance-transcending effects of information technologies and the new dimensions of spatio-temporal diversity in human activities and roles.

Traditional distance-based measures of accessibility are inadequate in their current forms for addressing the effects of technologies that transcend distance. Also, traditional measures have assumed that both the accessor and the accessed are fixed in space (and time). This is no longer true at a time when society appears to be moving more and more from place-based towards person-based activity patterns. The notion of role-group diversity may be relevant in this context. Space-time activity options across role groups display a range from low diversity (specialization or little variation in activities in time and space) to high diversity. To study and plan for the high-diversity role groups in particular, new definitions and measures of accessibility are needed.

Relevant questions include:

- How can traditional measures of accessibility be adapted to the new realities?

- What fundamentally new conceptualizations of accessibility would be practically useful?
- How could concepts of entropy and utility, or a Shannon-Weaver measure of diversity be applied to time-space activity data to help reveal the diversity spectrum in group roles?

Specific projects: (1) Expand traditional accessibility measures to include time and the effects of IT: Assume accessibility is a **relation** between person or group x and resource (person, group, good or service) y at time z . Then the XYZ matrix represents accessibility for a set of social groups X to a set of resources Y over a period of Z hours/days/weeks. (A difference with traditional measures is that neither X nor Y need to be fixed in space) . The cells of the matrix can be vectors representing how accessible resource y is to group x at time z by each of a number of appropriate media (car, bus, telephone, pager, Internet...) Do pilot study with small number of groups and concrete set of resources.

(2) In specific urban areas where a significant amount of IT-based access takes place, compare the performance of a series of traditional place-based and individual -based measures of accessibility: are any of them satisfactory with or without modification?

Group B

Unpacking Urban Social, Political, and Behavioral Impacts of Information and New Media

Research in this realm should focus on relationships between information technologies and the restructuring of cities, with specific attention to in-home and out-of-home activities, highly portable information technologies, and space-creating technologies. Issues of social justice, ideology and power underlie many of these evolving relationships, and need to be closely examined next to the more visible structural and behavioral impacts.

B1 What spatial, temporal, behavioral, social, economic, and political dimensions of these technological developments exist, and what are their implications for cities? Who benefits from these changes?

Information technologies have the potential to restructure in-home and out-of-home activities (including work, shopping, recreation, and socializing) and in turn they may be changed themselves. Similarly, the electronic delivery of services has the potential to restructure public and private enterprises and household activities and to co-evolve with physical changes. (On the other hand, some media have been around for decades with few discernible effects on cities). Research on this topic should be merged with question B5 on the economic geographies of the information economy. Banks and health services should offer fertile ground for this kind of research. The iconography of such services should not be ignored; it reveals what traditional functions are being altered.

Specific Projects: (1) Study the impact of electronic banking (including ATM use and on-line services) on banking behavior of consumers (time, length, frequency, duration of trips to the bank; shifts in banking service use within households; choice of bank; effect on single-purpose and multi-purpose trips).

(2) Compare enterprises that do/do not use IT heavily. Examine how they make locational decisions; how has IT affected their real estate holdings. Need to examine multisite organizations for insights. (e.g., Bank of America).

B2 What are the implications of highly portable information technologies for individuals and specific groups, for the separation of public and private realms, and for changes in the use of time and activity patterns?

Wearable (highly portable) technologies are becoming more prevalent and could either liberate or constrain individuals. Investigating activity spaces in relation to highly portable technologies would be one way to begin. Relationships between portability and surveillance should not be neglected. (This topic should be subsumed under a general Mobile Communications heading: see also question A4).

Specific Project: How do people use the mobile telephone? How dependent do people become on these phones? How does mobile telephone use affect spatial decisions and behavior? Study especially people with physical disabilities or other groups with constrained mobility.

B3 What are the geographies of surveillance technologies in the city and how is this changing over time? What are the implications and consequences of these technologies?

Emerging surveillance technologies offer promise for improved data acquisition and increased security, but they also raise questions about privacy, exclusion, and social control. This research could examine surveillance technologies in connection with highway networks and traffic flows, shopping malls, or gated communities.

Specific Project: Map closed-circuit television surveillance areas in cities and measure

their effects on the behavior and well-being of both insiders and outsiders.

B4 What consequences result from the commodification of information?

Differential access to the information market place could exacerbate social (and eventually also locational) differences. Customizing information may provide efficient matches between consumer needs and wants and supply, but may also leave out those who cannot pay and lead to more social and political fragmentation. Marketing uses of information technology - especially consumer profiles and targeted advertising, may affect peoples lives, actions, identities, and perceptions of others. Social and spatial isolation can be measured and compared with increasing or decreasing commodification of information. Geodemographics research offers an entry point into these questions: one could begin by determining who is using 'pay-per' services, and whether lack of access to such commercially provided services means lack of access to similar services altogether.

Specific Project: Document the roles of intermediaries that provide geographic

information to community groups, and their effectiveness: what are the effects of the beliefs and ideologies of these intermediaries on outcomes?

B5 What are the economic geographies of information technology industries? What is the

spatial structure of cities whose primary economic base is information? What are the implications in terms of location, scale, and spatial distribution in such places?

How do places emerge as information nodes? Where are they located? How do we measure 'information intensity' in an urban area? At what geographic scales is the phenomenon of an informational node most salient in its effects on people's lives? How does spatial structure reflect these new functions, and how does the tradition-bound construction industry adapt to new needs? How are socioeconomic and demographic profiles different in these areas? How do unskilled, lower-income people fare in these areas?

Specific Project: For any of the questions above, determine critical measures and methods of study, and compare a range of information-based cities with others.

B6 Who creates and controls information technology, and for whose benefit?

What kinds of political and regulatory systems for the control of information technology exist, and what issues do they raise? What ideologies, discourses, biases, geographic representations, and metaphors are embedded in information technologies and in the institutions that implement them? How do these institutions vary with culture and country? How might institutions be restructured to create a more robust, just, and equitable means of accessing and controlling information technologies within cities?

Specific Project: Measure the diversity and extent of information concerning services exchanged within specific social groups. Inventory some of the on-line services available to these groups and contrast publicly provided services with those offered by commercial networks such as CompuServe. What is the role of trust, personal contact, and word-of-mouth information in the adoption of on-line services by communities?

B7 What methodological issues need to be addressed in designing research on spatial technologies and cities?

What mix of quantitative and qualitative methods are appropriate for investigating spatial technologies and cities? What kinds of data are needed? How can they be collected or obtained, and by whom? What scales of analysis are appropriate for various research questions? What are the time frames of causes and effects? How can sequences of causes and effects (including nth-order effects) be exposed? How can comparative research be used? The absence of information on information flows hampers research: much is known about the flows of commodities, but virtually nothing about information flows: how can information flows be mapped? Can the World Wide Web be used to study its own functions and effects? What new research methods should be invented to help deal with the impacts of the new media?

Next to these methodological issues, there are deeper theoretical questions regarding the changing nature of spatiality and temporality in the informational city. There is a need to re-conceptualize urban space, time and process so as to deal with the phenomenon of 'community without propinquity' and the 'death of distance' already widely proclaimed by the media.

Specific Project: No specific project is proposed here as these are cross-cutting questions underlying many of the other projects mentioned.

Group C

Operational Issues and Infrastructure Design Strategies

for Understanding Spatial Technology's Roles

in Building Improved Urban Communities

Discussion within Group C, which focused on the operational aspects of the issues raised at the conference, evolved in two parallel directions. The first was guided by the premise that a very decentralized information infrastructure was both desirable and possible; the group went on to propose some ideas about how a community-level spatial data infrastructure might be put together. The second focus of the group's discussion was the broader question of how to develop tools to support the substantive research proposed by Groups A and B.

C1 What is the appropriate level for a spatial data infrastructure from the public's point of view, what needs should such an infrastructure meet, and what should be its characteristics?

There is an urgent need to attend to spatial data infrastructure, but not at the level of the NSDI (National Spatial Data Infrastructure). Focus should be on the community level and in particular on community-based organizations (CBO's) but not limited to them, nor limited to user-friendly access as the problem. The perspective of the users should be emphasized in a two-way framework in which communities contribute as well as receive relevant data using new kinds of flexible tools..

Relevant questions include:

- What kinds of data do communities need most, in what format, and for what purposes?
- What kinds of data can communities usefully contribute to a spatial data infrastructure primarily geared to community-level use?
- What are the most fruitful scales and perspectives for studies in this area: should urban systems, community-based organizations, government program evaluation, or human geography issues be emphasized?
- Do the Internet outreach schemes of libraries, schools, churches, social services, etc. have different requirements in terms of spatial data infrastructure? How can privacy, security, and credibility be addressed in each of these contexts?
- Uses of the information infrastructure involve problem formulation and interpretation and design as well as answers to specific queries: what are relevant research questions regarding language, visualization, tools, and networking suitable for different contexts and audiences?
- What neighborhood indicators would be most useful to communities for different purposes - how can we avoid such indicators being seen as too distilled an 'us- versus-them' view?

Specific Project: Within particular communities, examine how the three main kinds of functions of GIS as viewed from a non-technical user group's perspective (information provision, problem analysis, and group communication) are used . (May be combined with project outlined under B6).

C2 What novel system design principles need to be developed in order to provide the appropriate technical support to the requirements established under C1?

It appears that current information systems are neither flexible nor decentralized enough to serve many local user needs. The market is unlikely to build and maintain the needed infrastructure. The notion of a simple, coherent, multipurpose, cadastre-type spatial data infrastructure is too narrow, inflexible, and hierarchical to be helpful. In the technical realm, new tools for data access and synthesis can play major roles in shortening the pipeline from raw data to analyses, answers, and cross-referencing. The notions of 'user self-service' and 'just-in-time data access' are proposed to address the need for timely, flexible data access using existing widely distributed databases.

Relevant questions include:

- What interoperability characteristics and metadata would facilitate user 'self-service' in that process?
- Can administrative and operational data and tools be applied to existing data to avoid costly, separate analytic data bases?
- What data models (e.g., dynamic segmentation) allow just-in-time cross-referencing? Can scales be chosen or tools be built to facilitate data aggregation and synthesis as needed?
- How can geographic information systems be better linked with recent developments in information technology, and in particular the Internet?

Specific Project: Within a particular community-level application, explore the idea of 'user self-service' or 'just-in-time data access', where users can synthesize the information needed on *ad hoc* basis out of existing data bases. What are the patterns of behavior likely among users of such systems? What are the technical, administrative, and conceptual obstacles to implementing these ideas? What levels of data quality are required for community uses, and what levels are technically possible under such highly decentralized conditions?

C3 A Framework to Support Research

Most research projects suggested by Groups A and B will require at some point GIS-based tools for analyzing spatial and temporal information. The group discussed a framework suggesting how different aspects of these research projects could be linked with GIS data models, functions and operations. Some of these already are available in current systems, but others will need to be substantially modified or designed from scratch. The framework proposed is a matrix with different aspects of GIS use (e.g., information provision, data modeling and analysis, graphic communication...) as the rows, and questions A1-B7 as the columns. Each cell of the matrix represents the GIS-related research issues that may need to be addressed in order to help implement the kind of research proposed in the substantive question. The matrix may thus be seen as a systematic tabulation of research topics in GIS relevant to the general question of spatial technologies and the city.

OVERARCHING THEMES

The general discussion that followed the presentation of the three group reports identified the

following issues as being of very high priority for research.

- The need for new general measures of accessibility. These should take into account the fact that urban activities are becoming increasingly person-based as opposed to place-based, and increasingly distributed over both space and time.
- The need for data on information flows that are comparable in scope and quality to the data available on the movement of persons and goods in urban areas. Pricing effects on such flows should also be studied as for transport flows.
- The need to assess the role of spatial technologies in restructuring the geography and economy of cities: how is the economic geography of cities being rewritten under the combined effects of these technologies?
- The need to distinguish the effects of spatial technologies on the corporate and government sector from those on individuals and households
- The need to empirically investigate the social and spatial disparities induced by new spatial technologies and information technologies.
- The need to fully integrate time as a fundamental dimension in research involving spatial technologies in urban settings.
- The desirability to reconceptualize cities as dynamic processes of flows, interactions and transactions, rather than as static mapped patterns
- The need to carry out research on cross-cultural and cross-regional comparisons of the effects of spatial technologies on cities.
- The need to recognize that in the presence of exceedingly complex relationships, as are those involving spatial technologies and the city, second- and third-order effects may be as or more important than primary effects
- The need for theoretical work advancing current conceptions of urban space and time in the light of the redefinition of spatial interaction through technologies that transcend distance.
- The need to clarify the hidden philosophical and ideological assumptions and biases underlying the increasingly widespread production and adoption of electronic spatial technologies in particular, and their consequences for socio-spatial justice.

There was further general agreement that a comprehensive bibliography should be put together, perhaps as part of an ongoing virtual seminar to grow out of this meeting.

PARTICIPANTS' COMMENTS ON THE GROUP REPORTS

The edited draft of the research agenda was circulated to the participants after the meeting and several responded with extensive comments. Most were suggestions of an editorial nature and were incorporated in the final draft reproduced here. Others were elaboration's on issues briefly raised in the group reports, personal reflections on what was (or was not) accomplished, or opinions on what

could have been done or said more effectively or differently. A couple make some fundamental points about cities, communication, access, and social justice. Because of their interest these comments are reported here verbatim, in alphabetical order by their authors' name.

Stuart Aitken, on the social implications of information technologies (IT):

I have two points I'd like to add to the soup:

First, one theme that may be missing in your conclusion relates to surveillance and power structures around the control and abuse of IT. We kept coming back to this in Group B and although it is subsumed within a couple of the other themes, perhaps it warrant a place of its own. Here's how I might word if it were to become an overarching theme:

"The need to critically analyze the ways that information technology is used to undermine spatial justice in the city."

Second, there was some discussion in Group B and in our general discussions (I know Mel Webber raised this several times) of the use of ethnographic methods to study the uses and abuses of IT. In the introductory paragraph of the report, you mention disaggregate data and space-time diaries should be included in "common data bases" but I'd like to see that taken a little further to include in-depth interviews and ethnographic data. The wealth of information garnered from these methods are not amenable to "measures of accessibility" (first overarching theme) but they have been found to be

incredibly useful in unpacking social, cultural and power structures in urban settings. I notice in your report of A1 that discussion revolves around using qualitative methods to determine appropriate measures, but I think several of us at the conference believe that they have significant worth in and of themselves.

Elizabeth Burns, on data sets:

My few comments are offered in the spirit of clarification on discussion in Group A.

First, you note in the introductory paragraph the need for comparative studies using common databases that result from cross-referencing existing ones. Our discussions emphasized the value of longitudinal datasets. Existing data may include only recent information rather than studies done ten, twenty or more years ago when communications conditions were truly different. Existing datasets may be based on surveys conducted for specific purposes that did not require the complete in-home and out-of-home information we would like to examine. As an example, the Phoenix data covers individual employees, but has a relatively short time span beginning in 1990 with survey questions focused on the journey to work. Under question A6 you note how research should attend to changes in temporal work. The Phoenix dataset can contribute some activity information on individual employee work start and stop times and weekly schedule choices. Perhaps our virtual seminar could include discussion that articulates the desirable common qualities of these existing databases and surveys and addresses ways to extract the maximum information from databases not designed for our purposes.

Amy Helling, on accessibility measures:

I am concerned with reinforcing the (obvious, but not emphasized in the current draft) point that

measures of accessibility, to be valuable, must have (empirically demonstrable) relevance. The interest we express in more sophisticated measures is conditional upon being able to demonstrate that they are useful in prediction or explanation. In my work

so far I have tried to use accessibility measures to predict residential density and, more recently, travel (number of trips and minutes spent in travel). The gravity measures I have experimented with are clearly able to do this, though they leave a lot of variation unexplained. Presumably any new variant would be worth pursuing if it did a better job, or perhaps did a better job for a subset of the population. Our narrative sometimes made it sound like constructing new measures was a worthwhile end in itself. I wouldn't agree with that.

Incidentally, since our meeting, a colleague and I have decided to seek funds to expand our last summer's telecommuting survey (over 300 responses in Atlanta) over time, questioning the same people who participated in the first survey one or more times in the future (depending on funding). This is the first step toward the conference's expressed

interest in a longitudinal look at telecommuting in a single metro area.

Kingsley Haynes, on the scope of the conference theme:

Particularly important is an assessment of how access to these technologies affect access to other economic and social opportunities - education, employment, retailing, information, cultural opportunities, and how this in turn affects class and social consciousness.

(On transport uses)

With information technologies real time control of urban/metro traffic flows is increasingly possible. However, the comparative statics point-to-point urban traffic flow forecasting models are no longer adequate for guidance on systems intervention in real time. Traffic flows are nonlinear, dynamic, self organizing feedback systems. What new models and data is needed to support such management activity even at the theoretical level is very unclear. Basic research is needed in this area. further it is unclear - in a behavioral sense - how people will react to such information if it is supplied to them.

Don Janelle, on the discussions at the meeting

(On the "accessibility" discussions:)

Positive Outcomes:

Active accessibility researchers (e.g., Amy and Michael) and GIS scholars (Betsy) departed with new ideas on how to incorporate representations of information technologies in their measures and information systems. I had a distinct sense that the younger scholars (David, Lauren, Laxmi, Matt, and Yongmei) were excited by the proceedings and appreciated an opportunity to interact with senior researchers.

I was pleased that people took seriously the notions that accessibility measures and assessments of the effects of information technologies should incorporate the temporal

conditions of employment and the timing of spaces. We never did discuss the formal map

representation of accessibility, but we had enough other things to focus on.

Controversy:

Ken Hillis mentioned a tension between those focused on empirical analysis and positivist science and those concerned with critical analysis. Specific issues were empowerment and the commodification of information, and the ideologies embedded in IT. Personally, I see this as an opportunity for a new synthesis of ideas and approaches. Groups B and C could explore this to link theoretical and applied aspects. The tension is a healthy one and is inevitable with such a broad topic of discourse.

Neglected Areas:

Susan's presentation on "trust" and personal contact through social networks needed more discussion -- this is both an accessibility issue and IT implementation issue.

While Groups A and B were able to establish some common linkages, Group C's focus was more internal to the issues of introducing information technologies into communities (the empowerment issue). Maybe this can be tied more clearly to questions of accessibility and access. Linkage to Susan's and Ron's presentations and to Reg's and Steve's papers need emphasis.

Questions raised by Aharon Kellerman on spatiality and temporality did not receive much attention, though they did share common ground with some of the ideas of Ken, Matt, Stuart, and Steve.

While the matter was discussed, the idea of instituting a broad general space-time survey (diaries) in metropolitan areas was apparently deemed impractical -- too bad.

(On measuring space-time diversity:)

The question of measuring the space-time diversity of urban environments needs clarification. It relates to the dynamic nature of accessibility and to the fact that every situational change in person/group, time, place, or activity alters the set of possible options. Diversity measures (e.g., the Shannon-Weaver Information Statistic) might provide a partial answer. It is hypothesized that role group diversity is increasing and that

space-time activity options across role groups display a range from low diversity (specialization or little variation in activities in time and space) to high diversity. Role groups could be defined a-priori based on the existing literature or be derived from empirical analysis to incorporate indicators responsibility (family, job), constraint (income, education, mobility), social network, etc. Activity options could be derived

from the time-budget literature and be based on space-time diaries.

(On transportation:)

A general observation: Transportation, per se, is not given specific recognition in this report, reflecting the focus of discussion in Baltimore on information technologies and GIS. The discussion in Baltimore did touch on behavioral aspects of transportation and A5 (3) does mention data requirements. Yet, as a major facilitator of interaction and as a principal force in structuring space-

time patterns, it is not given sufficient attention. Some of the papers did have a transportation focus (Burns, Helling, Janelle). But, excited as we were to embrace consideration of the newer forms of accessibility, we neglected the persistent importance of transportation.

(On the tension between materiality and immateriality:)

The continuing material basis of human life (regardless of trends towards dematerialization) assures that human interactance will always be constrained by transportation resources. The mediation of communication and information technologies in reducing this constraint needs research, but so does the constraint of transport on the possible applications of IT and on its role in contributing to differential patterns of accessibility.

Seymour Mandelbaum, on the structure of the research agenda:

There is a breathless quality to the report that might be alleviated if you divided the two major themes that engaged us and were more expansive in introducing them.

Theme One: Representing Cities

The ways in which we variously represent cities are shaped by our sense of salient issues and the technologies at hand. The premise in this first theme is that we are still largely bound into a representational mode that describes the clustering of populations within spatial zones and the travel time or distance between zones. The central metaphor of that mode is that of "mass" and "gravity."

Even when it is applied to nineteenth century cities, that representational mode loses information and serves some purposes better than others. (Cities characteristically appear, for example, as settings and instruments rather than as moral objects or agents.) The urgency expressed in the proposal is grounded in a sense that the development of communications has increased the information loss (e.g. we know less than we use to about interaction patterns when we simply observe trips and travel times) and reduced the usefulness of our representational tools and metaphors.

The first theme at the conference was the importance of using the new information technologies to create and cultivate an amended set of representational modes and tropes.

Theme Two: Access

The second theme isn't addressed with the same clarity and authority as the first. There are two competing versions of this theme. One is devoted to the attempt to understand the impact of communication and information systems -- a-spatial technologies -- upon urban form; the second to shaping access to those systems.

The first version has a long and (as Ron Abler suggested at the Tuesday afternoon plenary session) rather dismal history: for almost every contention about the impact of telecommunications on concentration or centralization there is an equally compelling case

for its obverse. We cannot entirely avoid all of the conceptual difficulties of this theme but we need not bang our head deliberately against a stone wall. (The title of the conference

butts against that wall by trying to distinguish a set of "spatial technologies" that are independent of

the concept of "city.")

Listening to the Tuesday talk and reading the research notes, I think we would come closer to the essential interests of the group if we focused on the second version of this theme. Here are all these new communication and information systems. We are

interested in understanding who has access to these systems, who uses them, and how and in what ways they are useful to individuals and collectivities. ("Access" and "accessibility" seem to me both to point to a possibility: the relevant contrasts are between access, use and utility. So, for example, I know how to use the machine on which I am writing this memorandum to send messages across the Internet -- that is, I have access to the Internet -- but that fact doesn't tell you how I use that access or its utility.)

There are two sorts of issues presented by this theme. The first engages the measurement of access, use and utility over time. (Consider the sense of urgency that pervades accounts of the superhighway and the implicit insistence that we cannot afford to replicate the diffusion rate of the telephone.) The second deals with the relations between the three dimensions, the appearance of bottlenecks, and the design of diffusion campaigns. (You will recognize that second set of issues in "The Intelligence of Citizens.")

Laxmi Ramasubramanian, on the discussions in Group C:

As a member of Group C, my personal interpretation was that there was a certain creative tension between the folks who were advocating the spatial data infrastructure and interoperability solutions (the data perspective) and those who were more concerned about operationalizing the issues from the users' perspective. Related to this was the discussion about the expected abilities of the "user" and the need to clarify the kind of user we were thinking of.

While I am happy that there is mention of community-based organizations (CBO's) as the focus of research, it is not clear why community-based organizations were chosen and if or whether other aggregations or units of analysis were even considered. I remember Seymour making a case for religious groups and some discussion about what we meant by CBO's in the first place.

I must reiterate that as a junior scholar, it was incredibly useful to me to read the ideas of the senior scholars and to hear them and to have the opportunity to talk with them in an informal setting. Thanks to you and the other organizers for giving me and the other young scholars this opportunity.

Mel Webber, on the normative aspects of accessibility measures.

[Re: A1 and A7] A major rationale for an accessibility index is its normative utility. We need such a measure for evaluating alternative metropolitan spatial structures and other spatial arrangements. We've always appraised urban forms against preconceptions of density and building types. Far more important are the functional consequences of spatial patterns, not their static morphologies. If we could compare NY and LA in the language of accessibility, rather than that of density, I suspect we'd find them to be very similar. City planners and others have typically judged the merits of one urban form over another on quite different criteria than their comparative levels of accessibility, but it's accessibility that's important, not shape.

Further, accessibility levels vary widely among demographic groups. It would be extremely helpful in

seeking to improve welfare to know how much variance there is. An accessibility index could become something like a surrogate index of well-being for different population groups. This is to say, we need such indices for more than their scientific interest, for more than their values as descriptors. We need them for normative policy purposes, as bases for evaluation.

[Re: A8] The most egregious externality of the auto highway system is not air pollution, fuel consumption, congestion, and perhaps not even accidents. It's the loss of transit service among carless persons -- folks too young, too old, too handicapped, or too poor to drive. They've lost access to all sorts of opportunities, directly because the automobile has been such a successful and effective transport mode. So we need to find a new way of supplying transportation services to transit dependents. It can no longer be trains, or buses. They're too big and so can't match the small numbers of persons with the same origins, destinations, and schedules. We need to exploit the new telecommunications and new computing technologies to create a new kind of transit service that uses automobiles as transit vehicles.

APPENDIX A:

CALL FOR PARTICIPATION

National Center for Geographic Information and Analysis

Spatial Technologies, Geographic Information, and the City

A Research Conference

Baltimore, September 9-11, 1996

Spatial technologies, that is, the complex of new transportation, communication, and information technologies, are rapidly changing spatial relations in today's cities. The appearance of "Edge Cities" on the periphery of metropolitan areas, and the experiments with Intelligent Transportation Systems, have already captured a lot of public attention. But spatial technologies also affect accessibility conditions for different activities and population groups, as well as the urban structure itself, in ways that are not as visible and often very difficult to gauge. The conference will explore the ways in which these technologies are both transforming our cities and, in the case of information technologies in particular, also expanding our ability to plan for these changes. A specific focus will be on the role of geographic information technologies in enabling us to deal with changing conditions of accessibility, distance, and spatial interaction in urban environments. This is a critical but as yet little researched area. We will review the current state of knowledge on these issues, chart potential research directions, and focus on the ways in which planners and policy-makers might respond to these new developments. We see geographic information science and technology playing a significant role in bringing together those working in this complex area, in particular, experts in urban geography

and planning, urban transportation and telecommunications, urban sociology and service provision, and GIS. To this end, the conference will address the following broad questions:

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

Within these broad themes, the following more specific questions may be addressed :

Relating to changing conditions of urban accessibility and their impacts:

- What empirical evidence is available to support the widely conjectured changes in urban accessibility brought about by the increasingly widespread use of communication and information technologies?
- How are urban land use and structure, at different geographic scales, responding to the changes in access brought about by modern spatial technologies?
- How can land use and transportation models be adapted to reflect the substitutive, complementary, or synergistic effects of new spatial technologies?
- What empirical work is available documenting how access (and lack of access) to information and opportunities is practically experienced by traditionally disadvantaged urban populations (inner city residents, the aged, working mothers, etc.)?
- How will advanced spatial technologies, especially electronic information networks, change conditions of access to employment opportunities for geographically localized, disadvantaged urban populations?
- In the context of urban service delivery, to what extent will the new spatial technologies be substitutive, complementary, or synergistic relative to one another and to the more traditional ways of bringing information and services to urban populations?
- What are the trends in the electronic delivery and use of retail, library, and other services, and what are the positive (e.g., improved access) and negative (e.g., further competitive disadvantages, job losses) impacts on urban populations?

Relating to the role of geographic information science and technology:

- What new conceptual or formal models need to be developed to capture changing notions of distance and access, and how can these be most usefully implemented in GIS?
- What kinds of data will be needed to implement the necessary concepts and models, how will these

be collected, and how will they be accessed and synthesized?

- How can GIS-based systems handling aspects of the urban access issue be fruitfully interfaced with other relevant technologies (especially the National Information Infrastructure), as well as with the informal, socially-based information networks?
- What current uses of GIS in urban planning and transportation, policy making, and management are relevant to the access issue? Which are the institutional structures, agencies and stages within the urban policy process where GIS can make the most positive contribution to the problem of access?
- Who will be the main users and managers of GIS-based systems intended to contribute to the improvement of urban access conditions for disadvantaged populations? What are the user needs, professional and managerial as well as among the public at large, with respect to such technologies?

The Conference will be sponsored by the National Center for Geographic Information and Analysis (NCGIA). We are planning for a meeting of 25-30 scholars who will contribute research notes to be circulated to all participants prior to the meeting. The conference itself will include both plenary and small-group discussion sessions, and hands-on workshops. Its goal is two-fold: (a) to prepare for the formulation of a research agenda identifying major themes and funding opportunities for concerted research efforts, and (b), to plan for an edited book summarizing the state of knowledge and outlining the major issues in the general subject area of the conference.

Research notes of about 2,000 words, presenting empirical or theoretical work or reviewing the state of knowledge in the areas of interest to the conference, should be sent to the following address by March 31, 1996, in both hard-copy and electronic (e-mail) formats. Notification of acceptance will be issued on May 15. An important selection criterion will be the degree to which submissions integrate the three thematic dimensions of urban accessibility, impact on populations, and geographic information. Research notes should be accompanied by a brief resume and statement of the applicant's research interests beyond those directly reflected in the note.

A number of fellowships of up to \$500 (\$750 for West Coast and overseas applicants) will be available from the National Center for Geographic Information and Analysis towards accommodation and reasonable travel costs. Applications for funding must be included with the research note submissions, along with a mention of any other sources from which additional funding may be obtained. Please quote lowest available economy fare. Overseas fellowship recipients must use US air carriers.

For further information please contact

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Conference steering committee:

Ron Abler (AAG), Mike Batty (University College, London), Helen Couclelis (NCGIA/University of California, Santa Barbara), Ken Dueker (Portland State University), Susan Hanson (Clark University), Kingsley Haynes (George Mason University).

APPENDIX B:

[THE RESEARCH NOTES](#)

APPENDIX C:

[CONFERENCE PROGRAM](#)