Title

NCGIA Research Initiative 9- Institutions Sharing Geographic Information: Scientific Report for the Specialist Meeting, 26-29 February 1992 (92-5)

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Publication Date

1992-06-01

NCGIA

National Center for
Geographic Information
and Analysis

NCGIA Research Initiative 9
Institutions Sharing Geographic Information

Scientific Report for the Specialist Meeting
26-29 February 1992
San Diego, California

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National Center for Geographic Information & Analysis/NCGIA
Technical Paper 92-5
June 1992

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Acknowledgments

The initiative leaders wish to thank all the Specialist Meeting participants for their energy and enthusiasm in helping to focus and generate research priorities for this initiative. Particular thanks must be extended to the core planning group who aided the co-directors in creating a pre-specialist meeting paper defining the issues to be addressed and established the procedures for selecting participants.

We also extend a hearty thanks to Bijan Azad, Steven Frank, Richard Baron and Timo Luostarinen for their hard work and patience in recording discussions and otherwise helping to make the meeting run smoothly. For careful and cheerful preparations behind the scenes, we thank Kathleen Hornsby and Blane Shaw. We also thank Humphrey's Half Moon Inn in San Diego, California for their hospitality and for supporting a constructive and enjoyable working environment.

The Specialist Meeting and this report are contributions to Research Initiative #9 - "Institutions Sharing Geographic Information" of the National Center for Geographic Information and Analysis. We acknowledge support from a grant by the National Science Foundation (SES-88-10917).

Chapter One
Introduction

Geographic information is used to address a broad range of critical problems. The value and social utility of geographic information comes from its use. Sharing of geographic information is important because the more it is shared, the more it is used, and the greater becomes society's ability to evaluate and address the wide range of pressing problems to which such information may be applied.

Sharing of geographic information involves more than simple data exchange. To facilitate sharing, the GIS research and user communities must deal with both the technical and institutional aspects of collecting, structuring, analyzing, presenting, disseminating, integrating, and maintaining spatial data. Significant efforts are already underway in addressing the technical difficulties inherent in sharing spatial data. Those efforts need to be bolstered with increased activities and research in addressing institutional, organizational, and behavioral problems.

In order to spur research on these topics, a group of specialists was brought together to explore behavioral, organizational, and institutional issues acting as impediments or incentives to the sharing of geographic information among and within organizations. Participants were drawn from three major groups:

Group 1: This group consisted of participants from five different user segments who regularly share geographic data with other institutions. The five user segments included: 1. federal government; 2. state/regional government; 3. local government; 4. geographic information system (GIS) consultants familiar with the needs of users; and 5. private sector value-added spatial data suppliers.

Group 2: A second group of participants consisted of individuals from the academic community who specialize in the methodological questions that arise in research related to the sharing of spatial data. These included researchers in the fields of organizational theory, management information systems (MIS), and behavioral theory.

Group 3: The final group of participants was drawn from those members of the GIS research and academic communities having interests in behavioral and organizational issues relating to the sharing of geographic information.

At professional meetings and in specialized newsletters, the scope and purpose of this specialist meeting was made known to practitioners in each of these communities. We solicited short concept papers and biographies from individuals who expressed an interest in participating. After refereeing these submissions, the specialist group was selected and invited to the meeting. In selecting participants, consideration was given to the relevance of the material they submitted to the goals and scope of the meeting, the experience of the participants in their activities related to the topics of the meeting and, finally, to selecting participants to ensure that both breadth and depth of the specialist meeting topics would be addressed. After selection and prior to the meeting, all participants prepared longer papers addressing their experiences and concerns that they believed were most relevant to extending future knowledge about

the problems of institutions sharing spatial data. The first group wrote about their experiences of sharing spatial data. The participants from the organizational theory academic community wrote papers discussing the current state of knowledge in their field that they believe could form a foundation for further research on significant topics in spatial data sharing among institutions. Members of the GIS community wrote about their efforts and ideas regarding the state of current knowledge about the problems of institutions sharing spatial data.

The specialists met for three days of presentations and discussions in San Diego from February 27 through February 29, 1992. During the meeting, participants took on the task of suggesting areas of research likely to be fruitful in addressing both near and long-term problems in the sharing of geographic information. For the research topics suggested, theoretical frameworks and methodological approaches for their accomplishment were proposed. This document reports the discussions and research recommendations arising from the specialist meeting process.

Chapter Two
Purpose and Scope of the Initiative

2.1 Background

Geographic information is used to satisfy many needs. These include the needs of those who make location-related decisions in government, industry and the private sector. Likewise, many scientists and educators have a frequent need to access geographic information. Thus, any piece of land and its resources are of interest to many individuals and institutions. The expertise and time it takes to collect and maintain information about land creates a need to share that information.

The flow of data and information is subject to impediments and incentives. Some of these are technical. Numerous efforts have been undertaken to address the technical impediments to geographic information sharing. Among these continuing efforts are standardizing hardware interfaces, developing spatial data transfer standards, and compiling general purpose spatial databases.

Other incentives and impediments are cultural, reflecting people's behavior and the behavior of the organizations to which they belong. When attempts are made to share spatial data among organizations or among the divisions of a single organization, those involved often report that the most significant impediments to sharing are institutional, organizational, or behavioral in nature rather than technical (see for example, summary findings from the literature compiled by Croswell, 1989). For instance, many organizations have developed agency or corporate databases in support of their organization's primary missions but few have been willing to freely allow others outside their organization to access and copy their databases or to allow others to contribute data to them. Technical capabilities and safeguards which could readily allow transfer and sharing may already exist but typically are not provided or facilitated due to one or more organizational, institutional, or personal impediments.

As another example, several attempts have been made to develop and propagate spatial data standards or transfer standards for the general GIS community. Many of the experts suggest that a reasonable set of standards may be readily developed from a technical perspective. However, convincing other government agencies, vendors, software developers, and the private sector to "buy into" and adhere to the standards or convincing them to agree on a process for developing mutually acceptable standards appears to be much more difficult. Again, it is the institutional and organizational problems which if adequately accommodated could allow effective technical solutions to be used.

2.2 Research Framework

The results of research on behavioral and organizational issues that affect decision-making in other fields promise to be useful in studying the sharing of geographic information and in developing prescriptive strategies. A substantial body of literature addressing such issues already exists and must be consulted. However, our understanding of behaviors and activities needs to be considered in venues beyond the library, classroom, or study area. In particular, there is a need for observations in real settings of the process of accessing and using shared spatial data. Existing settings in which the sharing of spatial data can be observed might be categorized by

institutional setting (e.g. sharing throughout a municipal government, as fostered by a state council on geographic information, among federal agencies, between an agency and private industries, etc.), type of spatial data shared (e.g. sharing DLG, TIGER, EOS, local databases, etc.), or type of problem being addressed by the decision maker (e.g. sharing in order to select a suitable building site, to identify critical habitats needing preservation, to relocate district lines, etc.). Any studies of sharing within these or similar settings should be soundly grounded in theory and methods of observation should be selected based on their appropriateness in eliciting the forms of information desired. Solid theoretical frameworks provide a means of gauging the limits of generalizability of any principles which might be formulated from a study or series of studies.

Figure 1 highlights three primary components of a research framework: the theories of individual and organizational behavior (particularly their relevance in understanding impediments and incentives to the sharing of information); the arenas among which sharing of spatial data occurs, could occur, or could be enhanced; and observations of the process of spatial data sharing in existing settings. Ultimately, these three components must be brought together to produce models of behavior in regard to spatial data sharing. These results, in turn, should be useful in developing normative proposals for successful spatial data sharing in specific situations.

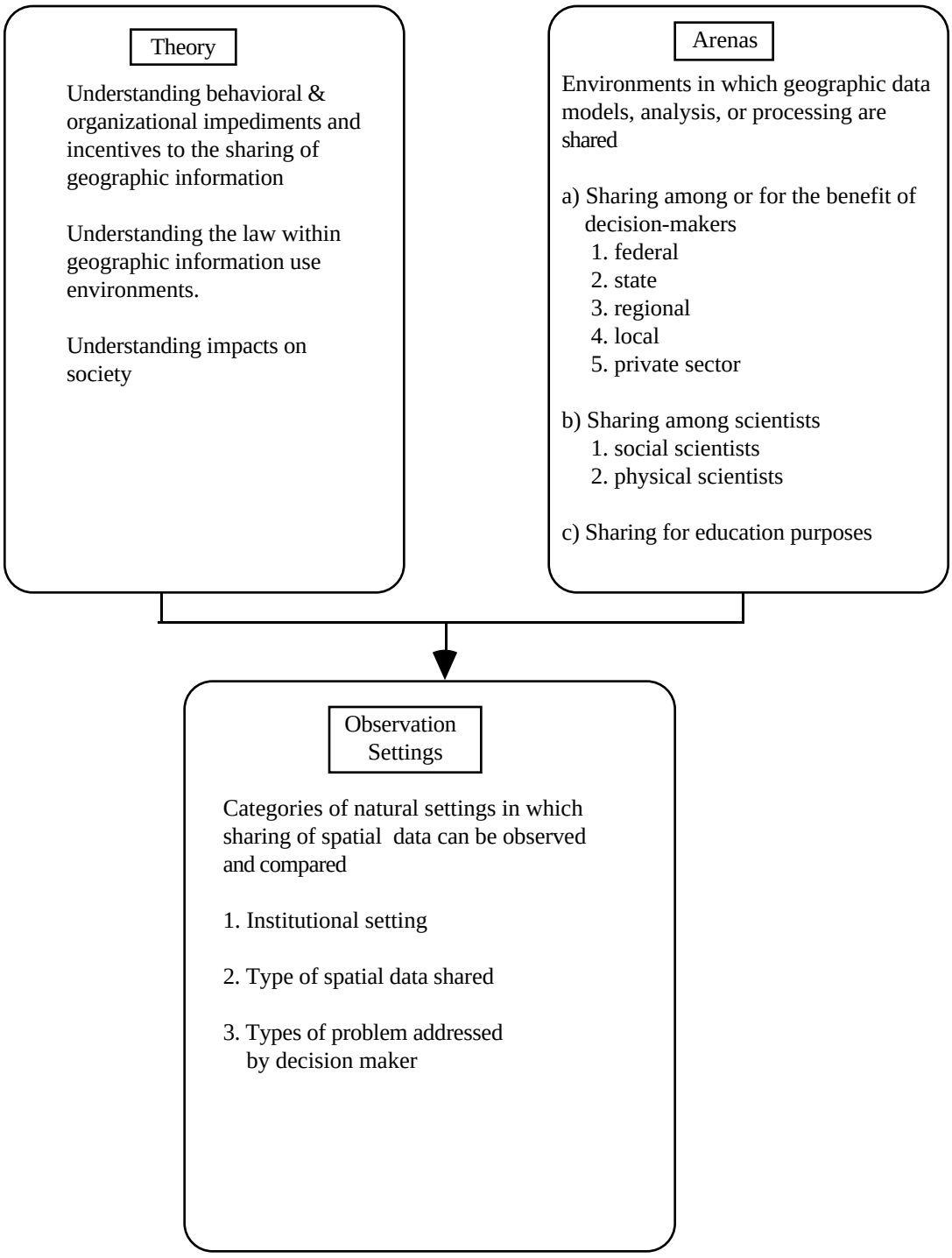
2.3 Organizational and Behavioral Theory

As stated, there is a large and growing body of research that suggests that factors influencing the institutional sharing of information are often more directly tied to behavioral and organizational concepts rather than technical. Certainly it is necessary that two organizations possess similar technical capacities and capabilities in order for information exchange to proceed efficiently. However, to an increasing degree, research has pointed to various aspects of organizational culture, bureaucratic practices and standard operating procedures, political realities, and behavioral norms as having a stronger impact on the likelihood of one organization's willingness to share information with others (Obermeyer, 1991; Kirby, 1986; Williams, 1987). Because of the strong potential for the significant impact of these "organizational" factors on institutional sharing of GIS data, it is important to examine, in some detail, a relevant set of these constructs.

2.3.1 Organizational Issues

Organizational issues may be thought of as referring to those "macro-level" constructs or issues that pervade an organization at all levels. For example, an organization's culture refers to the unspoken norms, or unwritten rules of the organization that bind the company together, solidify its purposes, and give it a sense of identity (Kilmann, Saxtan and Serpa, 1985; Deal and Kennedy, 1982). Because of the effect such organizational factors can have on the attitudes and practices of an organization, it is important to suggest a sample of some of the more relevant factors and their impact on institutional sharing of spatial data.

1) Bureaucratic Practices and Standard Operating Procedures: Organizations create both bureaucracies and operating procedures as a method for instituting control mechanisms through their various levels and functions (Galbraith and Nathanson, 1978; Obermeyer, 1990). One of the


Theory
Understanding behavioral & organizational impediments and incentives to the sharing of geographic information
Understanding the law within geographic information use environments.
Understanding impacts on society
Arenas
Environments in which geographic data models, analysis, or processing are shared
a) Sharing among or for the benefit of decision-makers
1. federal
2. state
3. regional
4. local
5. private sector
b) Sharing among scientists
1. social scientists
2. physical scientists
c) Sharing for education purposes
Observation Settings
Categories of natural settings in which sharing of spatial data can be observed and compared
1. Institutional setting
2. Type of spatial data shared
3. Types of problem addressed by decision maker

unfortunate, but recognized potential side effects of an over reliance on bureaucratic forms of control is rigidity, adherence to tried and true (but outdated) procedures, and a general inflexibility to accept or institute change (McCann and Galbraith, 1981). One potential research issue suggested is the impact of bureaucratic procedures on the willingness of organizations to engage in sharing of GIS data.

2) Degree of Cross-Functional Cooperation: The degree to which organizations require or even permit different departments to interact varies widely across institutions (Pinto, Pinto and Prescott, 1991). One potential problem with successfully sharing GIS data has to do with internal organizational expectations about cooperation. When organizations do not operate internally in ways that facilitate cooperation, it is likely that external relations with other organizations will not be effective.

3) Organizational Structure: The structure an organization employs can have a tremendous impact on information flows, degree of rigidity versus flexibility, and ability or willingness to react in a timely manner to external demands or requirements (Covin and Slevin, 1988; Bourgeois, McAllister and Mitchell, 1978). Therefore, an additional research question suggested is to investigate a variety of organizations, encompassing several types of structures, and determine the impact of structural type on institutional sharing of GIS.

4) Corporate Culture: As mentioned above, a corporate culture refers to the overarching attitude or set of beliefs about an organization, its identity and purpose, and what it takes to get ahead (e.g., adherence to unwritten but upheld rules of conduct and performance). In many instances, organizations refuse to share information with each other as the result of deeply held attitudes of antipathy that may contradict sound business sense or public policy. In these instances, there is no physical or technical impediment to sharing information; rather, the problem is attitudinal and (because of the organization's culture) institutionalized within the organization. Research needs to assess the impact of culture on the willingness to accept and use new technologies and share information across organizational or institutional boundaries.

5) Political Environment: "Organizational" politics differ from the more commonly viewed idea of politics as democratic activity. Organizational politics refers to the process by which various parts of organizations seek to gain and maintain power, through attempting to acquire scarce resources needed by other organizational units (Pfeffer, 1981). Using this definition, information (including GIS data) is seen as a scarce resource that can provide leverage to its holder. As a result, the organization having GIS data may be reluctant to share this information without exacting some sort of quid pro quo from another institution needing the data. Knowledge is perceived as power and power is never freely offered without exacting some price.

2.3.2 Behavioral Issues

From a socio-psychological perspective, many researchers have pointed to behavioral and individual issues as the principal drivers of action within organizations. Obviously, a large number of behavioral constructs could be hypothesized as helping or hindering the sharing of GIS data. Some possible examples of the types of behavioral issues are considered below.

1) Individual Differences: One possible reason why some individuals and organizations are unwilling to exchange information comes from the perceived differences between the institutions. In other words, the "other" organization is different. Because the other organization is not perceived as technologically sophisticated, our organization will refuse to share data with it. Because they are not "geographers" like us, the "engineers" in the other organization may misuse our data and we should refuse to share data with them. On a more basic level, key decision makers in one organization may simply not like those in another and as a way of wounding the other organization, will refuse to share information.

2) Turf Battles: Another powerfully felt and often expressed reason why one organization is often loath to share information is the perception of "turf battles" with others. In this scenario, if one organization perceives that its GIS data is proprietary, it will often delineate a clear boundary with other interested organizations and refuse to share the data. Information is hoarded as a critical resource and perceived as a source of power in inter-organizational rivalries. As a result, it is highly unlikely that such data will be willingly shared with other organizations.

3) Opinion Leaders or New Technology Champions: Some individuals within organizations can act as catalysts for change or form cooperation with other institutions due to their personal status or expertise. Such champions for change can have an important impact on the cooperation between organizations by acting as informal bridges between the institutions.

2.3.3 Additional Substantive Issues

The issues suggested above are but a small sample of organizational and behavioral issues potentially affecting the sharing of geographic information and for which further understanding is needed. Numerous additional theories and hypotheses are suggested by both the academic and experienced-based literature (e.g. See the references at the end of this chapter). The intent of NCGIA Initiative 9 on Institutions Sharing Geographic Information is to spur research on a broad range of such issues.

In addition to organizational and behavioral issues, legal and public policy issues also affect the sharing of geographic information. Such issues include legal system acceptance of data within GIS and the products generated from GIS, access rights of citizens to publicly held information, privacy, confidentiality, liability in the use, sharing, or distribution of data or analysis results, work product protection (i.e. copyright, licensing, contracts, patents, etc.) and security of systems. Because legal and public policy issues are slated to be addressed by a forthcoming NCGIA initiative, a pre-specialist meeting decision was made that such issues would be

covered to a lesser degree than organizational and behavioral issues in Initiative 9 on Institutions Sharing Geographic Information.

2.4 Methodological Issues

Issues in the sharing of geographic information should be addressed through theory-focused empirical research. While it is not within the purview of this document to encourage one research approach over any other, there currently exists a broad range of quantitative and qualitative empirical methods that can be employed (for example, mathematical modeling, controlled experimentation, field surveys, case studies, and archival and secondary research). Certainly, no one method can be deemed more appropriate than another for the study of issues in institutional sharing of GIS data. Each research method sheds additional, valuable information on the facilitation of institutional information sharing.

It is important to note, however, that while each research methodology has advantages, they also carry with them a concomitant set of limitations. In other words, each method or combination of methods has advantages and disadvantages as well as different assumptions, biases, and degrees of usefulness (Williams, Rice, and Rogers, 1988). For example, while case study methodologies have the potential ability to generalize beyond their specific example to the shaping and development of theory (Onsrud, Pinto and Azad, 1992), survey research offers considerably greater statistical checks, sampling reliability, and generalizability (Onsrud & Pinto, 1991). However, survey research methodologies typically suffer from lack of supportive information in the form of interviews and archival data (Dickinson, Benbasat and King, 1982). As a result, a recent approach has been to emphasize use of several research methods in combination in order to accommodate the weaknesses of each method with the strengths of others (Kaplan and Duchon, 1988). We believe such a multi-faceted approach is necessary in order to understand comprehensively the impediments and incentives to sharing of geographic information among and within organizations.

2.5 Summary

The goal of the NCGIA Initiative 9 Specialist Meeting was to discuss, debate, and formulate a research agenda which, if accomplished by the broad academic community, would be valuable to institutions sharing or attempting to share geographic information. Advancing understanding of institutional, organizational and behavioral issues and developing prospective models and prescriptive strategies from that increased understanding are critical in increasing the ability of organizations to use geographic information systems. Using the foundation and illustrative principles set forth in the above chapter, the initial bounds of the subject material to be addressed at the Initiative 9 Specialist Meeting were established.

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Chapter Three
Specialist Meeting Process

The Specialist Meeting for this initiative was held February 27-29, 1992, in San Diego, California. The specialist meeting process was initiated several months prior to the actual meeting through the formation of a core planning group with representation from six universities (see Appendix 1). This group prepared a background paper laying out the issues to be addressed at the specialist meeting (see Chapter 2) and developed a process for selecting meeting participants.

A public call for papers on institutional sharing of spatial data was issued and participants were selected through the refereeing of submitted paper proposals by the core planning group. Thirty papers were accepted for presentation at the meeting (see Appendix 2 - Meeting Agenda, and Appendix 3 - Paper Abstracts).

The first day and a half of the meeting consisted of ten-minute presentations of paper "highlights" by each author. Two or three presentations were made in each session followed by a short discussion period. Upon completion of these presentations and discussions, specialists were assigned to small focus groups, asked to review the material from the discussions, and requested to prepare a list of major incentives and impediments to the sharing of geographic information. The lists were reported back in a plenary session.

Through consideration of these lists and reflection, participants were then each asked to suggest a subset of important researchable issues which could be addressed in greater depth through a working group. The topics suggested in the plenary session are listed in Appendix 4. From this larger body of topics, the following five topics were selected for detailed consideration by focus groups:

1. Metadata
2. Infrastructure
3. Legal, Economic and Cultural
4. Organizational Aspects of Sharing Geographic Data
5. Methodology and Substantive Case Studies

Participants formed themselves into focus groups and each group was charged to:

a. Identify the research issues and define researchable questions
b. Construct a research agenda, and
c. Suggest for the broad research community a list of potential actions.

After working on the first of these tasks, a plenary session was called to report tentative results and receive comments from the larger group. A third round of small group and plenary sessions allowed the focus groups to complete their charges. The chapter which follows contains the final reports of the working groups.

Chapter Four
Recommendations for Research in Sharing Geographic Information

4.1 Metadata

Participants: Roemer Alfelor, John Evans, Steven Frank, Michael Goodchild, Patrick McGlamery, Bill Miller, Stephen Ventura, Ric Vrana.

4.1.1 Basic Definitions

This focus group felt it was important to begin with accepted definitions of key terms, since this would help to focus discussion later. It began with the notion of 'fitness for use', which the group felt was a useful umbrella term for the process of determining the feasibility of data sharing. Fitness for use includes aspects of data quality, and encapsulates the issues considered by the user in determining whether a dataset meets specific needs.

The group agreed to focus on digital spatial data, and not to attempt a more general definition of metadata that would include such analog forms as maps and atlases. 'Spatial data' was defined as a collection of digital records that together represent the distribution of some geographical phenomenon over the surface of the earth.

This allows us to propose the following definition of spatial metadata:

> Digital information that allows the potential user of spatial data to understand that data's fitness for use.
>
> Components of such spatial metadata (SMD) might include information on database contents, database schema, its source and history, and its quality.

The group then asked itself whether this definition of SMD implied that metadata is associated only with the dataset itself, or whether it also depends on the system used to process the data, or within which the dataset is housed. For example, some encrypted datasets are meaningless unless accessed through particular database software. The group decided that in principle, SMD defined in this way is associated with a **view** of the data, rather than with the dataset itself, and that SMD might have to change to reflect the capabilities of the system used to access the data. However, in practice, SMD will usually be associated with a dataset, even though different systems might be capable of generating quite different information from the same dataset. For example, the presence of polygon topology would likely be reported in a dataset's SMD, even though many systems would be capable of generating polygon topology on the fly from unstructured data.

4.1.2 Scope of Spatial Metadata

SMD must be viewed as a hierarchical concept, since we can apply its ideas at many levels in a spatial dataset. At the lowest level, SMD might describe each individual element in the database, including its history of processing, lineage and sources. At a higher level, SMD might describe the processing history and lineage of entire

datasets, including scale, geographical coverage and quality. At the highest level, SMD might describe the attributes of entire databases and systems.

SMD supports data sharing by providing information on many aspects of spatial data, each having meaning in particular application contexts. SMD that describes database contents includes data dictionaries and definitions, attribute ranges and data types. Support for these types of SMD exists in all standard database products, and tools are often provided to facilitate creation of such SMD, and its management by the user. At a more technical level, SMD can describe details of physical data models and structures, and these will be important to users needing to convert data between systems, or to access data in unfamiliar formats. SMD can also be used to track and report the operations and processes that have affected the data. These are often used as indicators of data quality, and are generally subsumed under the heading of 'lineage'. Finally, SMD can be used to describe databases as entities, in data catalogs and directories, in order to facilitate access. The group did not try to distinguish between catalogs and metadata, choosing to regard them as different views of the same general issue.

4.1.3 Fundamental Questions

Given this definition and scope, the group then focused on the fundamental research questions of significance to SMD. In doing so it chose to see SMD as a process rather than a fixed set of information. Users possess vastly different levels of knowledge about data. In the case of soils data, it is possible to compare the soil scientist who may be able to make use of data without any additional information, to a user who knows almost nothing about soils and requires a comprehensive education in soil science to make effective use of a soil dataset. The group saw SMD as a process that was continually aiming to make data meaningful to a broader set of users.

In this sense, the following questions seemed fundamental:

> How to strike a balance between exhaustive completeness (SMD for the user who knew nothing about soils) and cryptic efficiency (SMD for the soil scientist).
>
> What methods can be used to measure the knowledge of users, and the comprehensiveness of SMD?
>
> Where should metadata reside - with the dataset, or loosely associated with it, or in some other repository - and who should maintain it - the creator of the data?
>
> What kinds of standards can be formulated to guide the use of SMD?
>
> What is the role of current and proposed SMD standards, such as SDTS (the Spatial Data Transfer Standard being evaluated by the National Institute of Standards and Technology) and efforts under ASTM (the American Society for Testing and Materials)?

Given the obvious need, why is there currently so little metadata in the GIS field - how have we been able to survive without it, and what impediments are preventing its development?

What GIS software tools are needed to support compilation, manipulation and management of SMD by the user?

4.1.4 Research Topics

The group then moved to the discussion and formulation of research projects to address these questions. The priorities given with each topic are indications both of the topic's importance and also of its feasibility.

1) *Particular case studies (no priority assigned)*
Research could focus on particular SMD efforts, to examine their successes and failures, and the degree to which they met overall goals and objectives. An important issue would be the process of iteration through evaluation and feedback, and the degree to which it had been able to engage an adequate cross-section of the user community. Also of importance would be the degree of integration with comparable efforts.

2) *Cross-analysis of case studies (no priority assigned)*
Comparative studies of more than one SMD standard or formulation effort might allow us to gain insight into the inherent variability in SMD requirements; the process by which SMD standards can be adjusted to technical developments in the field; and the dynamics of the relationship between user community and SMD. Comparison might allow us to identify commonalities and perhaps move toward a consensus.

3) *Research on existing SMD efforts (high priority)*
SDTS will have a substantial impact on the spatial data community in the next few years, and this will provide a unique opportunity for researchers to track its impact, and to determine its limitations. The process of implementing SDTS might be studied in particular agencies as a way of gaining better understanding of the role of metadata and format standards in facilitating sharing. Other spatial data efforts such as that sponsored by ASTM could also be studied, and it would be useful to examine the significance for spatial data of non-spatial standards such as the MARC cataloging system, and ISO standards.

4) *Types of data that are difficult to describe with SMD (high priority)*
Datasets containing raw measurements may be much easier to describe than datasets containing highly interpreted, and possibly subjective information. Access and security issues may create special problems for SMD, as may such uniquely spatial issues as generalization. There is a need to rank different types of spatial data by their suitability for description in SMD, and thus their suitability for sharing.

5) *What can be learned from experience in remote sensing? (very high priority)*
As a spatial data technology, remote sensing presents many of the same problems as GIS, and there may be much to learn about SMD from the remote sensing community, which has been dealing with these problems much longer. We need to review the remote sensing literature on SMD, and to adopt those parts that are applicable to spatial data in general. NASA's Goddard Space Flight Center is sponsoring a master data directory through its catalog interoperability working group. At the Eros Data Center, the GLISS project is an important effort to develop access tools to spatial data.

6) *Investigate existing information networks (high priority)*
Besides conventional catalogs, a number of novel structures have developed in the past few years to facilitate sharing of data. These include virtual stores available over electronic networks, such as WAIS (Wide Area Information Service); ESIC (Earth Science Information Center); and such tools as Geobrowser. It would be useful to survey these, to examine the degree to which they support or could support SMD, and their impact on the sharing of spatial data. This topic overlaps strongly with the issues discussed by the Infrastructure group, since metadata is only one of its aspects.

7) *Investigate current GIS software for SMD support (high priority)*
There is a need to examine the state of current GIS software, and the extent to which it provides SMD support tools. Does the GIS software industry lag or lead the need for SMD support, and what prospects are there for change in the short and medium terms?

8) *Experiments to examine SMD requirements (medium priority)*
Surveys and studies could be devised to determine SMD requirements directly from users, particularly with regard to contents, methods of distribution and usefulness. This approach would only be effective following work on topics 3, 4 and 6 above.

9) *Determine minimal surrogates for SMD items (low priority)*
Although the potential set of items in a SMD description is huge, in practice we use a few simple surrogates to communicate necessary information. Although scale has no real meaning for a spatial dataset, the scale of the map from which the dataset was digitized is often used as a surrogate for its accuracy and level of generalization, and even for its contents in the case of topographic maps. Research into such surrogates could provide us with a minimal but essential set of SMD items.

10) *The relationship between data updating and metadata updating (low priority)*
Given sufficient research on topics 2, 4 and 8 above, it would be possible to examine an important question for transaction- oriented databases: to what extent do changes in data contents require associated changes in metadata. Clearly, it is desirable for SMD descriptions to be stable, but changes will be inevitable as transactions accumulate.

4.2 Infrastructure

Participants: Robert Barr, Don Cooke, Ken Dueker, Jack Estes, Joe Ferreira, Gerry Rushton, Jon Sperling, Gene Thorley, Nancy Tosta

Spatial data infrastructure is defined as basic geographic data used for reference (e.g. digital base map data) and for linkage (e.g. geographic feature identifiers), the coordinating and control structures that develop and maintain the data, and the distribution system that enables access to the geographic data.

Currently, consensus fails to exist on the data which should be included in a national general-usage spatial data infrastructure. Often mentioned data themes are transportation centerlines, hydrography, land use/land cover, land ownership parcels, and topography. In addition, the roles of various institutions in developing a national spatial data infrastructure of practical use for a wide range of applications have yet to be defined. The federal government has responsibility for nationwide coverage of some data at relatively small map scales, low levels of detail, and with long update cycles. On the other hand, local governments deal with more detailed data.

A nationwide spatial data infrastructure might be viewed as a single integrated robust system. However, a national spatial data infrastructure might also be viewed as consisting of separate major database components suitable for different purposes with not all systems necessarily integrated with the others. For instance, there are great incompatibilities in data among local governments and with federal agencies that make it difficult to aggregate local data upward to the federal level.

4.2.1 Basic Definitions

A number of organizations are working towards a vision for a national spatial data infrastructure in the United States and some are actively developing components of such an infrastructure.

1) The Federal Geographic Data Committee (FGDC) "supports surveying and mapping activities, aids geographic information systems use, and assists land managers, technical support organizations, and other users in meeting their program objectives." The FGDC has established subcommittees to coordinate activities and develop standards for different, defined, spatial data categories. In addition, it has established working groups to deal with issues common to all spatial data categories: standards, technology, and liaison with state and local governments, academia, and the private sector.

2) The National Academy of Sciences, Mapping Science Committee, "serves as a focus for external advice to the federal agencies on scientific and technical matters related to spatial data handling and analysis. The purpose of the committee is to provide advice on the development of a robust national spatial data infrastructure for making informed decisions at all levels of government and throughout society in general."

3) The Earth Observing System Data and Information System (EOS-DIS) will provide computing and networking facilities for the NASA EOS observations, data interpretation and modeling; and processing, distribution and archiving of EOS data. A primary goal of EOS-DIS is to allow research scientists at widely dispersed locations ready electronic access to EOS data and information.

4) Approximately twelve states have agencies to coordinate spatial data activities in their states.

5) Many regionally defined organizations have developed agencies that either coordinate or actually develop and hold spatial data for their region.

6) The private sector includes a number of companies that develop and disseminate spatial data or add value in a variety of ways to existing spatial data.

7) Public and university libraries are primary agents for the distribution and dissemination of information in society. Through its formal network, the Federal Depository Library Program, federally-produced, public-domain information is made available to the public.

The group discussed the role of the NCGIA in this area and noted that its self-defined role at the current time is to *conduct research, disseminate the findings of such research and educate researchers in appropriate methods for conducting research* on the essential characteristics of a spatial data infrastructure and the impediments and incentives to the development of a robust spatial data infrastructure for the United States. In addition, in cooperation with appropriate international organizations, its role is to research the characteristics of and the impediments to and incentives for the development of such a spatial data infrastructure for research on critical global issues.

4.2.2 Key Questions About Infrastructure

1) Is establishment of a spatial data infrastructure conducive to improved sharing?

2) What is the taxonomy of the infrastructure? (cadastral, street centerline data system, land use/cover, remotely sensed?)

3) What will be the profile of uses and users of the spatial data infrastructure of ten years hence?

4) How can a spatial data infrastructure that is not centrally controlled be sustained?

5) What are the key fundamental elements at the global, national, state and local levels?

6) Can a staged implementation strategy be designed with key milestones and strategies for moving from any one to the next?

7) What is the current state of the spatial data infrastructure?

8) What articulated goal would be appropriate with regard to developing the nation's spatial data infrastructure (e.g. what is the equivalent statement to "Put a man on the moon by the end of the decade!")?

4.2.3 Recommendations For Research

Moving from these key questions, the group concluded that questions about the development of the spatial data infrastructure should be linked to fundamental reasons

for its existence and for facilitating access to it. They propose that the fundamental reason is the potential for realizing substantial benefits of both efficiency and effectiveness in the quality of decision-making to a very large group of public and private organizations and institutions if a coherent spatial data infrastructure existed. Research on the characteristics of the national spatial data infrastructure should proceed by examining current and future important spatial decision support activities that depend upon spatial data. This is a long list and one that contains a bewildering variety of application areas. Research should be conducted to determine a minimum list of spatial functional procedures, and their relationship to each other, that operate on the spatial data and that, when combined with the substantive information peculiar to the specific application area, are combined to provide the essential decision support information. In addition, research is required to determine the spatial data requirements of these spatial functional procedures. An example of such a critical path of reasoning was provided by Mike Goodchild in his discussion during the meeting of the requirements for the rail network spatial database in a specific decision support case.

1) *Spatial Decision Support and Spatial Data Infrastructure for the Next Decade: The Bottom-Up Strategy.*
   The group recommended that research proceed, first by examining current spatial decision support areas and tracing the critical path of connections to spatial functional procedures, spatial data requirements and strategies for developing and providing access to such data. Particularly important is the development of a typology of the spatial functional procedures on which the spatial decision support tasks are constructed. It is from these tasks and the procedures that use spatial data, that criteria can be developed for assessing spatial data requirements. Issues such as data quality and content can best be resolved in relation to the requirements that follow from decision support tasks. We label this research path, the bottom-up strategy. Research proposed here would take an area such as transportation planning and ask: what decision support questions, what models, what data requirements, what strategies for meeting these requirements, and what milestones are appropriate?

2) *Spatial Decision Support and Spatial Data Infrastructure for the Next Decade: The Top-Down Strategy.*
   A second research path should be oriented to possible spatial decision support areas that could be active in ten years time. A number of important decision support areas that do not now exist can be anticipated. Some of these, like intelligent highway vehicle navigation, will require new spatial functional procedures and these, in turn will require an expanded spatial data infrastructure. It is possible that new forms of data sharing will be necessary to accommodate these application areas. This research should pursue the same critical path examining, in particular, the validity of the spatial functional procedures identified in the first research theme to meet the newer areas of spatial decision support expected to emerge in the next ten years.

3) *Middling Through: Research that links the conclusions from the Bottom-Up and Top-Down Strategies*
The group thinks that it is important to experiment with alternative pathways for information infrastructure development and sharing. Alternative ways to implement federated spatial databases are possible and critical experiments should be designed to provide guidance to decision-makers who will make choices between different implementation methods. The group's attention was drawn to a recent National Academy report, Data Management and Computation. Research is needed on HOW one makes connections between different sources of spatial data. Possible roles of organizations need to be devised and discussed. We should examine how the current infrastructure works. What are the elements already there at the global, national, state and local levels? What could enhance the value of the current infrastructure? Given the existence of a nascent infrastructure, how can access to that infrastructure be improved? There should be experiments involving prototyping of possible answers to these questions. Can the evolving educational highway network play a role in these experiments?

4.3 Legal, Economic, and Cultural Aspects

Participants: Earl Epstein, Harlan Onsrud, and Richard Taupier

4.3.1 Basic Definitions

Legal, economic, and cultural aspects refer to real and perceived economic value, the general legal environment, and the ideology, theory, politics, and actual behavior in a community. These constitute the basis for relations between people in regard to objects such as data and information.

The details of the legal regime reflect these various aspects. They establish a specific framework for expectations and actual behavior among people in regard to control of data and information, including conditions for data and information exchange.

4.3.2 Scope

The legal regime that expresses societal expectations in regard to the control of data and information includes freedom of information and open records, privacy, work product protection (e.g. copyright and patent) and liability statutes, regulations and cases.

The economic domain includes theory and practice in regard to the use and value of public and private goods, especially publicly held data and information.

Politics, ideology, theory, tradition and behavior represent, collectively, a community's attitude about who shall develop, fund, and control data and information, and under what conditions exchange of that material shall occur.

4.3.3 Fundamental Questions

The overarching issue is the question of what mix of legal, economic, and cultural elements encourage or discourage cooperation among organizations in regard to the development, sustenance, and distribution of data and information. Cooperation among public agencies and between public and private organizations are the primary concerns.

There is a need to better understand the economic, legal, and political conditions that determine the nature and extent of cooperative efforts under specific conditions at a particular place. This understanding is the basis for clarification of and, if appropriate, changes to the legal regime.

Academics, politicians, systems managers, systems operators, users, and citizens represent the primary set of parties whose attitudes and behavior determine the legal, economic and cultural environment.

There is a set of specific issues which require attention. These are:

1. The state of economic theory and practice in regard to publicly held data and information as a public good.

2. The nature and extent of theory and practice in regard to organizational arrangements for the development, sustenance, and distribution of data and information.

3. The nature and details of records and other laws that influence control of data and information.

4. The legal, economic, and political viability over time of cooperative and other arrangements among organizations in regard to data and information.

4.3.4 Research Topics

1. The impact of economic theory and practice in regard to public and private goods on the control and exchange of data and information.

2. The impact of theory and practice in regard to organizational and institutional arrangements for the control and exchange of data and information.

3. The impact of the existing legal regime on the control and exchange of data and information.

4. The impact of law, economics, and culture on the long-term stability and viability of arrangements for the control and distribution of data and information.

4.4 Organizational Aspects of Sharing Geographic Data

Participants: Bijan Azad, William Bamberger, Ian Masser, Paul Meredith, Nancy Obermeyer, Jeff Pinto, Bruce Rocheleau, David Stage

4.4.1 Major Questions of Interest

Participants reflected on the data sharing impediments and incentives issues raised during previous discussions and formulated subsets of issues that they felt were fundamental to the understanding and promotion of data sharing. The following subset of research questions were raised as being related to the organizational aspects of geographic information sharing:

- identification of the sharing relationship variables in a distributed system structure that promote or inhibit data sharing

- identification of the processes and functions of the coordinating bodies in a data sharing environment

- development of process and content model(s) of interorganizational cooperation as related to data sharing as well as political factors

- identification of bureaucratic factors that affect GIS and data sharing

- examination of the application of organizational theory to GIS data sharing

- examination of the aspects of creating vs. sharing data

4.4.2 Group Deliberations

The group included diverse views on what constitutes organizational/behavioral aspects of geographic information sharing. There were several views expressed on what constitutes an organizational view and what is important or critical to geographic information sharing. One view expressed was that organizational survival is often very important in explaining organizational behavior and therefore research which tries to address geographic information sharing should do so by evaluating sharing behavior from an organizational survival perspective. Another view was that organizational survival is but one of many potentially important factors, and should be included with those other important factors as "content factors" in a model of facilitators/inhibitors of the geographic information sharing. Another complementary view was expressed that a process time-dependent stage model of geographic information sharing should be developed because any useful model should reflect the reality of major stages that "typical" geographic information sharing goes through. Still another view was expressed that any model of sharing derived from process and content factors should include acknowledgment of the "chaotic" and ad hoc nature of decision-making that typically is experienced in geographic information sharing.

Some members expressed the view that GIS as a product versus GIS as tool should figure prominently in the design/formulation of research because of the drastic impact of each on geographic information sharing.

A strong view was expressed by some that the dominant research question should be "What is (are) the most effective organizational form(s) for coordinating geographic

information sharing?" Still another strongly stated research interest was "What practical advice can be developed or investigated by the research community and provided to GIS practitioners on how to proceed on various aspects of geographic information sharing?"

Also, a number of frameworks were suggested for looking at the organizational aspects of geographic information sharing. There appeared to be minimal consensus on the appropriate framework. As a way to not get bogged down by this phenomenon, the group agreed to formulate a research question regarding development of various models/frameworks for looking at geographic information sharing.

As an adjunct to the framework(s) question, the issue of developing content factors and process stages, as well as any other factors that may be considered important in geographic information sharing activities was relegated to a general question of developing competing taxonomies.

A view was expressed that the sole research method should not be case study and others should be considered, particularly learning from Initiative 4 of NCGIA was deemed useful. There was some agreement on this point and emphasis was made on the cross-case comparative analysis as a complementary method of research to address some of the research questions for the topics of concern to this group.

4.4.3 Research Questions

1) *To identify organizational/behavioral variables that facilitate/inhibit geographic information sharing*
   The purpose of this question is to inventory the factors/variables from appropriate fields including but not limited to organizational behavior, organizational theory, information systems, and geographic information systems. These factors should be assessed and evaluated in terms of their appropriateness for geographic information sharing and serve as inputs to the question below (2). Some papers prepared for the I-9 specialist meeting attempt to get at this question. An important element of the inventory process can be "extraction" of appropriate factors from the knowledge-base that consultants have built over the years related to geographic information sharing, perhaps using a Delphi method. Taking into account the complexity of the sharing activities through the interaction of the above factors/variables is also considered important. That is, factors that may be positively correlated with more sharing in one setting may produce the opposite effect in other settings. Gauging complexity tries to get at some of the dynamic interactions at work in sharing activities.

2) *To develop models of organizational and interorganizational spatial information sharing*
   The purpose of this question is to develop models of spatial information sharing among organizations by looking at the organizational behavior and organizational theory literature and adapting them to the geographic information sharing concerns. These models can be content, process, as well as other models. They can also incorporate the interaction among these dynamic processes. There are examples of such attempts in a few of the specialist meeting papers.

3) *To assess which organizational structures will be most effective in different situations*
This question is fairly specific and is thought to produce a body of knowledge that will ideally have information that will indicate the effectiveness of various structuring alternatives to their respective effectiveness taking account of their context. In the table described in the next section, each of the cells in the rows across different columns is an example of the type of research that can shed light on this question. It is thought that the elements of each cell have to be worked out in tandem with questions 1 and 2 above.

4) *Development/Preliminary Testing/Validation of Factors and Models through Case Studies*
The emphasis on case studies for generating and validating factors and models using cross-case comparative analysis was deemed important by the group. For illustrative purposes, the table which follows (Table 1) is provided by the group. It is thought that typically one can expect a two-dimensional matrix of certain types of variables as they relate to organizations and sharing data can be chosen so that each individual cell in the table can be some "bite-size" piece of research. For example, the columns relate to a certain division of organizational factors (as well as those in the environment beyond the control of the organization). The rows on the other hand represent certain organizational structuring alternatives that move along the spectrum of lower to higher autonomy for participating organizations in the sharing process. This table is by no means exhaustive of the factors and models that are expected to be useful for research on the organizational aspects of geographic information sharing, but demonstrates what typically may be asked in framing research questions. The rows and columns for other similar research frameworks are thought to be generated from sections 1, 2 and 3.

	Class of Organizational Issues		
Organizational Forms	Cultural Norms	Leadership/ Management/ Vision	Organization
Formal Coordinating bodies			
Single GIS Organizations			
Ad-hoc data-sharing arrangements			

Table 1

5) *Measures*
A variety of measures need to be developed to assess the outcome in the research on geographic information sharing. These measures include but are not limited to: degree of information sharing, and the impact of sharing. Both of these have elements of achieving goals for the organization, the project, and the net impact on the organization, both tangible and intangible.

6) Unintended Consequences
The time-dependent events that take place as a result of sharing arrangements and activities are thought to induce varying degrees of change in the sharing organizations. Some of these changes may have been foreseen but others are not. However, what is crucial from the research point of view is that the latter may sometimes be even more important than the former. For example, certain sharing arrangements and activities among three departments in a city produce a certain level of sharing. As time passes, there is a growing recognition of the problems that are embedded in the existing division of labor for tasks as well as geographic information collection and maintenance tasks. Subsequently, the sharing organizations move to closer cooperation, reduce certain duplicated tasks, and thereby change their organizational structure, task environment and data collection/maintenance specialties (The group felt that scenario development and Delphi technique could be of immense help here).

7) *Practical Dissemination of Results*
The practical application of research results from investigation of these research questions can be enhanced by concentrating the dissemination efforts on media choices that will have the greatest impact. The existing professional association network of special interest groups as well as conferences are examples of this, as are the State and Province SIG of URISA (other organizations such as ICMA, ASPA, AM/FM are additional examples).

In addition, the tangible products distributed through such networks might be things such as "best practice" notes, perhaps similar to the American Planning Association's Planning Advisory Service pamphlets.

4.5 Methodology and Substantive Case Studies

Participants: Michael Batty, Hugh Calkins, Will Craig, Michael Kevany, Rebecca Somers, and Lyna Wiggins.

4.5.1 Introduction

There was consensus in the larger group that case studies should be an essential component of any research agenda recommended by Initiative 9 Specialist Meeting participants. Field work and careful observation of actual situations will provide a core knowledge base to help us understand the impediments to and incentives for geographic data sharing in and between organizations. The discussions of the larger group, and the papers presented at this meeting, frequently reminded us of the value of "war stories" and personal anecdotes to our current state of knowledge. However,

much of the material in the professional literature (e.g., papers in the proceedings of URISA and GIS/LIS) describe single-cases. There is an almost complete lack of cross comparisons of multiple cases in the academic literature. Most of the cases in the professional literature are also written by participant observers, rather than by more neutral researchers. For these reasons, a specialist meeting working group was formed to place special attention on case studies and associated research methodologies.

4.5.2 Fundamental Questions

Given this charge, the working group met to consider the fundamental question of what methodologies and series of studies might best be suggested for a research agenda on institutions sharing geographic information. The group agreed that most of the topics under discussion (e.g., organizational issues, metadata, legal/economic/political issues) could be studied within a case study research framework. We therefore defined our task to be recommendations of the types of case studies likely to be appropriate, specific focus areas for cases, and the appropriate sequencing of studies that might be undertaken.

The working group first broadly debated the issues of case study methodology, and agreed that a structured approach to cases will provide the most long-run benefit. The group discussed the case study approach proposed by Onsrud, Pinto and Azad (1992) and concurred that the recommendations in that paper could provide a starting point for this work. In their paper, Onsrud, Pinto and Azad adapt the case study approach of Lee (1989) to GIS research. This approach recommends preparing a structured set of propositions to test before beginning field work, and allows conclusions to be drawn even from single case studies. The working group also discussed the roles of case studies in both theory building and theory testing.

4.5.3 Research Topics

The working group concluded that the case study methodology should be applied to both theory building and theory testing. In the area of theory building, four research topics were proposed:

1) *Develop propositions to test in the field.*
   Literature from organizational behavior and management information systems should be reviewed. Theories from this literature that appear appropriate to geographic data sharing should be identified and clarified. Such theories from other disciplines will provide one source of propositions to be studied in the case work. The group noted that it will be important to coordinate the work of the researchers addressing institutional sharing of geographic information issues, so that as theoretical contributions are made they are communicated to those conducting field studies. Conversely, the results of case studies must be conveyed to those working on theory building.

2) *Descriptive surveys*
   The group agreed that it is too early to begin large scale survey research in evaluating institutional sharing of geographic information. Our questions are not yet well enough defined for classic survey research. Indeed, a major purpose of comparative case studies is to develop such clarity. On the other

hand, more general descriptive surveys are appropriate at the beginning of this work. Surveys of the extent of use and diffusion of GIS, organizational characterizations of adopters of the technology, and other descriptive information provide a useful base for selection of appropriate case studies. Such descriptive survey work should be encouraged early in the study of institutions sharing geographic information.

3) *Focus groups*
The working group recognized the important expertise and experience of both "old-timers" in the GIS field and of the consultants who have wide ranging knowledge of many cases. The suggestion was made that an early research phase should include either a focus group or Delphi study designed to capture the knowledge of this group. It will also be important to encourage the involvement of this group as cases are developed, since they will often be a source of both case information and of useful contacts for particular studies. In discussion with the larger group, it was mentioned that such a focus group had been convened at GIS/LIS in 1989, and that this experience should be reviewed.

4) In-depth cases
The group felt that there would be great benefit to theory building in conducting a few in-depth cases. Such cases, although time consuming, often provide valuable insights. Models of case studies using the ethnographic interviewing techniques of anthropology might be valuable here. The group also discussed the studies of Zubrov, as described in The Age of the Smart Machine, and concluded that this work provides an example of the value of such in-depth cases in the area of information technology. We note again that the working group concluded that the case study methodology should be applied to both theory building and theory testing.

From the discussions of the larger group, several likely clusters of focused case studies were identified. These clusters focused either around particular thematic areas of interest (e.g., street centerline files) or around particular characteristics of theoretical concern (e.g., role of coordinating councils in data sharing). Focusing a number of cases in the same area should better enable cross comparisons needed for theory testing. Such focusing might also allow different researchers, working independently on different cases, to contribute to a cooperative effort. For such cooperation to occur, it will be necessary for the research community to have "model" cases on which to base their own individual work. Mechanisms to enhance the "pulling together" and comparisons of multiple cases also need to be developed. It would be highly productive if NCGIA researchers were able to provide both the model cases and the coordinating mechanisms needed. The group discussed the following examples of potential clusters of cases at some length:

a) TIGER. A cluster of case studies around the sharing of this federal data source seems both timely and relevant. The use, enhancement and maintenance of TIGER data by a large number of state, regional and municipal governments as well as by private sector users provides a natural cluster of focused cases.

b) EOS/DIS. Another timely and important federal data source is the Earth Observing System Data and Information Systems (EOS/DIS) which will be made widely available to scientists researching environmental issues. With the growing importance of global climate change research, these data will find wide distribution and use. Again, this is recommended as a natural place to look for clusters of related cases.

c) State GIS efforts. In the general meeting it was noted that many state GIS offices are already both pricing and sharing data. There are already enough of these state efforts in operation to provide a cluster of case studies.

d) Municipal multi-participant GIS. On the municipal scale there are also sufficient examples of large data sharing organizations (e.g., RUIS, CAGIS) with enough experience and history to provide a focused cluster of cases.

e) Ad hoc requests. Another suggestion was to focus a cluster of case studies around issues of data sharing with the public, researchers and other organizations around ad hoc, one-time requests for information. One idea was to focus on planning departments, where ad hoc requests are common, to examine geographic data sharing in a variety of circumstances.

f) Organizational structures. In order to test the effects of particular organizational structures in impeding or enhancing data sharing, it will be necessary to focus clusters of case studies around certain organizational structures. For example, a cluster of cases might center around state-level data sharing organizations with coordinating councils as a core structural element.

Following the discussion of the various possibilities of clusters of focused case studies, the group considered the variety of selection criteria for case studies. Among the topics discussed were obtaining a geographic spread of cases, and including cases of both successes and failures in the clusters. Also discussed at some length was the value of continuing to examine some cases over a period of time. Such longitudinal studies, rather than snapshot cases, should strengthen the theory testing potential of case study research. There was general agreement in the larger group that changes in leadership and staff over time was one of the strongest determinants of organizational change of policy in data sharing. Longitudinal studies should clarify the role of such institutional shifts.

A goal of the entire case study research effort is to develop the depth of understanding necessary to eventually be able to survey a large number of cases. The development of questions and scales for a large mail survey must build on the results of in-depth and focused case studies. As theories are built and tested within the case study environment, the clarity needed for survey research will eventually be reached.

Chapter Five - Conclusion

Spatial information has a wider range of potential users and a longer life-span than most other kinds of information. Its exchange, however, is still too often confined to a single organization or to even smaller units. The demand for efficient, equitable, and timely access to spatial data by the user community will continue to grow.

As the need to share grows, there will be a greater need to understand the patterns of institutional, organizational, and individual behavior within the GIS user community. Prospective models and prescriptive strategies for sharing spatial data from the local level to global scales need to be developed.

In this report, participants in the Specialist Meeting have set forth and analyzed critical sharing issues. They have made recommendations on actions or activities (including but not limited to research activities) that would enhance data sharing among federal, state, regional, and local levels of government. They have also made recommendations directed at enhancing access by private businesses, scientists, educators, and the general public to the geographic databases maintained by various levels of government.

The research agenda for spatial data sharing prepared by the specialist meeting participants and contained in this report identifies numerous important questions about data sharing which need to be addressed. The initial bounds established by the core planning group on the substantive matter to be covered at the specialist meeting (i.e. Chapter 2) was greatly expanded through the dynamics of the specialist meeting process. As a result, a much broader research agenda than originally envisioned emerged (i.e. Chapter 4 and Appendix 4). Due to limited personnel, NCGIA itself will select and accomplish only a small proportion of the research agenda suggested. However, NCGIA investigators will also attempt to facilitate the research work of other investigators, provide opportunities for interaction, and communicate progress and findings to the broader GIS community. The purpose of the preceding agenda is to encourage research and concerted work efforts by the general research community on the full range of important topics identified.

The public, private, and academic sectors represented at the Specialist Meeting expressed a strong need and desire to move research forward on the various indicated facets of institutions sharing geographic information. Initial projects and products proposed for the initiative include a book addressing a range of sharing issues in greater depth, a working bibliography, a periodic newsletter, an E-mail discussion list, options for publishing refereed research articles as a group or in special editions of journals, and organized presentations of research by a range of investigators at national and international conferences.

Appendix 1

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** Unable to attend - paper prepared and presentation made by William Miller

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Appendix 2
Agenda
Initiative 9 - Institutions Sharing Geographic Information

Wednesday, February 26

Participants arrive at San Diego Airport in afternoon or evening.
Take hotel shuttle to **Humphrey's Half Moon Inn**

7:00-9:30pm **Meeting Registration/Refreshments** - Sunset Room

Thursday, February 27

7:00am **Breakfast**

8:15am **Specialist Meeting begins** (Marina Ballroom)
Welcome and Introduction - Gerard Rushton
Overview of NCGIA Research and Education Missions - Michael Goodchild
Objectives of Initiative 9 and Review of Agenda - Harlan Onsrud

I. Setting the Stage: Experiences with Spatial Data Sharing

(Presentations of major points from the pre-conference papers)

9:00am **Local Level**
1. *"Some real-world experiences in sharing geographic information among local government agencies"* - William Bamberger
2. *"Why we can't share data: institutional inertia"* - William Craig
3. Discussion

9:30am **State Level**
1. *"A multi-agency management structure to facilitate the sharing of geographic data"* - David Stage
2. *"An examination of incentives for the exchange of geographic information: A study of the evolving data sharing programs in the commonwealth of Massachusetts*" - Richard Taupier
3. Discussion

10:00am **Coffee/Tea/Soft drink break**

10:30am **Federal Government**
1. *"Development and maintenance of the TIGER database: Experiences in spatial data sharing at the U.S. Bureau of the Census"* - Jon Sperling
2. "*Coordination of spatial data activities*" - Gene Thorley
3. Discussion

11:00am **GIS Consultants**

1. "*A proposed structure for observing data sharing*" - Michael Kevany
2. *"Interrelationship of organizational factors affecting data sharing"* - Rebecca Somers
3. Discussion

11:30am **Private Sector Data Suppliers**

1. "*Sharing street center-line data sets*" - Donald Cooke

Additional Use and Integration Perspectives

2. *"GIS and integrated highway information system"* - Roemer Alfelor
3. Discussion

12:00 **Lunch**

1:30pm **Additional Use and Integration Perspectives Cont'd**

1. *"Why is it so hard to share data?*" - Nancy Tosta
2. *"Sharing data between federal agencies and others"* - John Bossler (paper prepared but unable to attend)
3. *"Facilitators of organizational information sharing: A research framework"* - Jeffrey Pinto
4. Discussion

II. GIS Research and Academic Community Perspectives

(Presentations of major points from the pre-conference papers)

2:00pm

1. *"Antecedents of interorganizational geographic database sharing in multiparticpant GIS: A framework and a proposal for research"* - Lyna Wiggins
2. *"Data sharing and the non-technical user in local government"* - Robert Barr
3. Discussion

2:30pm

1. *"Systems integration: A reason for and a means of data sharing"* - Kenneth Dueker
2. *"The role of bureaucratic flexibility in sharing geographic information"* - Nancy Obermeyer
3. Discussion

3:00pm

1. *Factors influencing the success of coordinating bodies for geographic data sharing at three levels of government"* - Stephen Ventura
2. *"The impact of GIS on British local government"* - Ian Masser
3. Discussion

3:30pm **Coffee/Tea/Soft drink break**

4:00pm

1. *"Distributed GIS: If its time is now, why is it resisted?"* - Paul Meredith
2. *"Computers and horizontal information sharing in the public sector"* - Bruce Rocheleau
3. Discussion

4:30pm **Wrap Up Comments & Announcements** - Gerard Rushton

7:00pm **Buffet Dinner**

Friday, February 28

7:00am **Breakfast**

8:15am **Opening of Meeting and Announcements** - Gerard Rushton

8:30am **GIS Research & Academic Community Perspectives Cont'd**

1. *"Economics of information & incentives to sharing"* - John King
2. *"Who controls the flow of Information, how do they do it, and for what purposes?"* - Earl Epstein
3. "*Role of law in impeding and facilitating the sharing of geographic information"* - Harlan Onsrud
4. Discussion

9:30am

1. *"Elements of a data sharing taxonomy"* - Hugh Calkins
2. *"Sharing spatial information in an imperfect world: understanding the interaction between technical and organizational issues"* - Joseph Ferreira
3. Discussion

10:00am

1. *"Sharing information in Third World planning agencies"* - Michael Batty
2. *" Institutional sharing issues arising out of the integration of remote sensing and GIS"* - John Estes
3. Discussion

10:30am **Coffee/Tea/Soft drink break**

11:00am

1. *" Sharing imperfect data"* - Michael Goodchild
2. *" Sharing Spatial Data in Decision Support Environments"* - Gerard Rushton
3. Discussion

11:30am

1. *" Continuing the role of map libraries in the information age"* - Patrick McGlamery
2. *"Public data access: Another side of GIS data sharing"* - Jack Dangermond (presented by Bill Miller)
3. Discussion

12:00pm Assignment to small groups and instructions for afternoon - Harlan Onsrud

12:15pm **Lunch**

III. Exploring a Research Agenda for Sharing Geographic Information

1:30pm ***"What are the primary impediments/incentives to sharing geographic information?"***

Group 1 - Marina Ballroom A
Group 2 - Marina Ballroom B
Group 3 - Harborside Room
Group 4 - Suite 1
Group 5 - Suite 2

3:00pm **Coffee/Tea/Soft drink break**

3:30pm **Plenary Session: Reports of Small Groups** (Marina Ballroom)

5:00pm **Wrap Up Comments & Announcements -** Harlan Onsrud

6:30pm **Dinner**

Saturday, February 29

7:00am **Breakfast**

8:15am **Opening of Meeting and Announcements -** Harlan Onsrud (Marina Ballroom)

8:30am **Formation of Small Groups in an Open Session**
Each group will focus on a segment of the information sharing problem domain exposed in the previous sessions.

9:00am **Small Group Session of Your Choice**

"For your group's problem area, what are possible means of addressing the impediments/incentives to sharing and what research issues arise?"

Group A - Marina Ballroom A
Group B - Marina Ballroom B
Group C - Harborside Room
Group D - Suite 1
Group E - Suite 2

10:30am **Coffee/Tea/Soft drink break**

11:00am **Plenary Session: Reports of Small Groups**

12:00pm **Lunch**

1:30pm **Small Groups Session Continued** (Return to same group)

"What specific actions might we or others take in making progress in this research domain?"

3:00pm **Coffee/Tea/Soft drink break**

3:30pm **Plenary Session: Reports of Small Groups** (Marina Ballroom)

4:30pm **Wrap-up Comments and Announcements -** Gerard Rushton

6:30pm **Transportation to Seaport Village & Gaslamp District**

Appendix 3

Paper Abstracts

The following abstracts are listed in alphabetical order by the author's last name. For the ordering in which they were presented at the specialist meeting, see Appendix 2. The full text of all or most of the papers is scheduled for publication as either a book or a major NCGIA report.

Roemer M. Alfelor

GIS AND INTEGRATED HIGHWAY INFORMATION SYSTEMS

The application of GIS in Transportation (also called GIS-T) has evolved from simple graphic and map-based representation of roads and geographic features to serve specific functions in a highway agency to a more complex and powerful tool for integrating information and decision-support systems within and amongst agencies. This change is partly driven by the limited budgets and resources faced by highway departments which required them to find means to minimize the cost of managing and operating their transportation infrastructure including the network of highways, bridges and other facilities. An integrated highway information system (IHIS) on a GIS platform does not only avoid duplication of highway data collection effort but also supports integrated decision-making at all administrative and functional levels of the organization. This paper describes the incentives and requirements for spatial data sharing in integrated highway information systems. Some of the issues involved in implementing GIS for data sharing in IHIS are discussed, with emphasis on the impediments arising from institutional, organizational and behavioral characteristics of highway agencies.

Bijan Azad and Lyna L. Wiggins

ANTECEDENTS OF INTERORGANIZATIONAL COOPERATION FOR GEOGRAPHIC DATABASE SHARING IN MULTIPARTICIPANT GIS: FRAMEWORK AND PROPOSAL FOR RESEARCH

This paper explores the various elements that push public (and or private) organizations to overcome the organizational barriers to sharing of geographic databases. First we present our problem definition and suggest a simple typology of possible configurations for geographic database sharing. Second, relevant work from the organizational behavior literature on the antecedents (determinants or preconditions) of interorganizational cooperation is briefly reviewed. Third, we illustrate our synthesis of the literature with three mini-case examples. Fourth, we review a second organizational behavior literature on the process and strategies of interorganizational (transorganizational) development. Finally, a preliminary research framework is proposed to explore the dimensions of the propensity to cooperate in geographic database sharing. In a proposed second phase, we suggest how the research framework might be extended through case study research to fulfill an overall goal of developing a process model of GIS cooperation for interorganizational database sharing.

William J. Bamberger

SOME REAL-WORLD EXPERIENCES IN SHARING GEOGRAPHIC INFORMATION AMONG LOCAL GOVERNMENT AGENCIES

After a brief description and chronology of the Regional Urban Information System (RUIS) in the City and County of San Diego, the paper discusses data sharing within the RUIS community -- the twenty-eight departments in the City and County of San Diego for whom the system is developed and operated. Topics in this section include the organization and management structure, communicating among participants, developing standards, sharing the base map, and several examples of sharing data for specific applications. The next major section of the paper discusses sharing data with organizations outside the City and County of San Diego. These organizations include other cities, special districts and the private sector. The final section provides some generalizations from the experiences RUIS has had in sharing geographic information.

Robert Barr

DATA SHARING AND THE NON-TECHNICAL USER IN LOCAL GOVERNMENT

The application of automated data handling methods to improve welfare provision and the management of the social environment of cities has been anticipated for over 25 years, yet recent developments of geographic information systems have contributed little to such endeavors. This may be attributable to limitations of the technology and its usability by non-technical staff. However the largest barriers appear to be in the ability and willingness of a range of welfare agencies to share both individual and aggregate data to provide a dynamic picture of the needs for services and of their provision in urban areas. This paper proposes an outline methodology based on a range of techniques from the ethnographic methods used by Zubroff (1988) through 'soft' data analysis technologies such as the 'rich picture technique' proposed by Avison and Wood-Harper (1990) to structured data flow methods familiar in the database world. Such a methodology will provide a mechanism to establish the technical, organizational and ethical barriers to data and technology sharing in the field of human services provision.

Michael Batty

SHARING INFORMATION IN THIRD WORLD PLANNING AGENCIES

This paper explores the 'information sharing' paradigm which is rapidly emerging in mature organizations where information technology is being heavily used for communications and decision-making. The particular emphasis in the paper is not upon the ways in which the paradigm is being exploited in developed societies and economies but on the ways in which it might be used in geographic information systems in the Third World. First, typical approaches to learning about such systems are presented, based on comparative studies and case histories and then the meaning of information in its widest sense is discussed. The sharing paradigm is then developed and its applicability to situations where network infrastructures are not well-developed such as those in developing countries is presented. The paper elaborates the argument with some speculations on how the sharing paradigm might aid our understanding of the development of GIS in the Third World; and by way of conclusion, some speculations on the research agenda now needed in this domain are outlined.

John D. Bossler (Paper submitted but unable to attend)

SHARING DATA: FEDERAL-STATE-LOCAL

There is an information infrastructure in the world today. In its broadest terms, it includes not only the databases, standards, linkages, etc., but also institutions, policies, and people involved in the information business. The ideas of data sharing and coordination are essential to a robust national spatial data infrastructure for obvious reasons associated with the elimination of redundancy, economy of scale and other similar ideas. The NAS/NRC Committee on Mapping Sciences is attempting to strengthen this infrastructure by, among other things, suggesting changes to the mechanism(s) of coordination and data sharing. These changes apply to governmental relationships at all levels including interactions among federal agencies; federal dealings with state and local governments; and state and local associations.

A number of ideas have been suggested for strengthening the infrastructure such as increasing the jurisdiction of the Federal Geographic Data Committee and other similar organizations. Other possibilities include creating new organizations to deal more effectively with state and local organizations, changing parent organizations, and restructuring the financial and political bases of the coordinating units. These ideas and their strengths and weaknesses will be discussed at this initiative meeting.

Hugh W. Calkins

ELEMENTS OF A TAXONOMY FOR SPATIAL DATA SHARING

Data sharing has almost always been among the objectives for geographical information systems developed by governmental agencies or private firms. Spatial data sharing is defined as the electronic transfer of spatial data/information between two or more organizational units where there is independence between the holder of the data and the prospective user. To understand the potential spatial data sharing environment and to observe sharing patterns, survey and case study work will be necessary. Any such work requires identification of questions to be asked as well as the set of expected answers. As a starting point, elements of a taxonomy are presented for discussion purposes.in this paper. The elements are divided into four main categories: characteristics of the organization; characteristics of the data exchange; nature of the data sharing arrangement; and characteristics of the spatial data.

Donald F. Cooke

SHARING STREET CENTERLINE DATA SETS

This paper is based on the premise that data sharing or the lack thereof is a complex phenomenon, the study of which may benefit from experiences with a specific example. Street Centerline Data Sets (SCDSs) provide a good example for the study of data sharing, as there is a long SCDS history to examine involving private, quasi-private and all levels of government organizations. Studying sharing of a specific class of data sets also allows us to focus discussion on small and coherent bodies of experience. The history of SCDS use provides examples of sharing both of data and the labor of data preparation and maintenance. Many examples of cost sharing are also apparent in the development of USA SCDS.

William J. Craig

WHY WE CAN'T SHARE DATA: INSTITUTIONAL INERTIA

Public agencies are focused on their own missions and mandates and they have little time or incentive to worry about sharing their data with others. Individual organizations pursue their narrow goals even when a small amount of additional effort would add critically useful data and information to the corporation; e.g., state government. This is my conclusion based on a career of public policy research using data about neighborhoods, cities, counties, and state governments. This "Institutional Inertia" manifests itself in three general ways. First is refusing to cooperate, either outright refusal or setting outrageous conditions such as excessive prices. Second is the selection of technology adequate to meet limited internal needs, but inadequate for others. Third is the use of narrowly defined data items and data definitions. The article expands upon these general barriers and illustrates them with personal "war stories." I conclude that change can come only by expanding the mandates of the organization to include the sharing of data, providing an incentive to do so. The definition of mandates is the authority of elected officials and bodies, so we must learn how best to enlighten these people. Case studies should be undertaken where sharing has been successful to measure the correctness of my hypotheses. We need to learn how critical actors were converted, whom they influenced, and how they plied their influence.

Jack Dangermond (presented by William Miller)

PUBLIC DATA ACCESS: ANOTHER SIDE OF GIS DATA SHARING

There have been many discussions of and experiences with the sharing of digital geographic data between and among various public and private organizations. Most of these discussions have been associated with the topics of joint sponsorship, cost sharing, technical interchange, agency conflicts, and legal as well as administrative conflicts. A completely separate set of issues arises when considering the sharing of data with the public and the distribution of data to the public. The issues deal not only with the needed technology but also with the more fundamental question of how governments should relate to citizens. A number of behavioral, organizational, and institutional issues are covered in the paper. These include: a review of the models and methods that public agencies at the federal, state, and local levels of government have used for distribution of their data (including spatial data) to the public; a description of some of the public issues associated with both the distribution of data and the connection of the public to the databases which governments use in making policy and conducting their operations; an outline of some of the key geographic data-related issues that should be addressed or are of interest to citizens organizations; a review of some of the technical means which could be employed to support government data sharing with citizens; a consideration of some of the institutional mechanisms and barriers which must be taken into account in creating a successful information link between government and the public; and, finally, some indications of the benefits which such citizen participation in government might be expected to produce.

Kenneth J. Dueker and Ric Vrana

SYSTEMS INTEGRATION: A REASON AND A MEANS FOR DATA SHARING

Implementing a systems integration strategy can require organizational restructuring to take full advantage of new information technologies. Efficiency, effectiveness, and enterprise benefits accrue from technological adaptation and systems integration. Each of these benefit types have associated costs in the form of behavioral and organizational resistance which must be anticipated for successful implementation. Some resistance to organizational change should be expected and is proportional to expected benefits, especially enterprise benefits.

This study examines a typology of integration issues as they pertain to the categories of benefits mentioned above. Behavioral and organizational impediments to integration can be illustrated by a series of case studies observed in three different settings in the Pacific Northwest. The controlling factors in these separate settings are organizational structure, type of analytical systems to be integrated, and the degree to which various users access a common database.

Earl Epstein

INFORMATION CONTROL

Those who share data and information are aware that they compromise the advantage suggested in the conventional wisdom that information is power. Therefore, data sharing occurs when there are incentives that arise within the individual, the organization, or from external forces. One possible external force for data sharing is the impact of the impressive computer technology that manages great quantities of data and information is sufficient to induce data sharing. However, this model is not sufficient to explain the complex nature and detail of how people arrange their affairs in regard to use of potential products generated by the technology. This paper considers cultural, non-technical incentives for data and information sharing. Among the issues discussed and contrasted are public values, private values, commercial values, and agency efficiency values.

John Estes

INSTITUTIONAL SHARING ISSUES ARISING OUT OF THE INTEGRATION OF REMOTE SENSING AND GIS

Geographic Information Systems and remote sensing are linked, linked in both an historic context and functionally. GIS technology facilitates the storage of and access to many types of data. Correctly employed, GIS systems also permit data held within a database to be readily updated. Indeed, the synergism between (1) remotely sensed data for updating GIS information, and (2) the use of GIS for improving the information extraction potential of multisensor data is a major advantage of the improved integration of these two powerful technologies.

GIS technologies and databases are gaining maturity as valuable societal tools. Many of the sharing issues which the remote sensing community has had to address in the past and is still addressing (e.g. standards, data cataloging, meta data, networking, etc.) are now gaining greater importance in the GIS community. The GIS research community can gain insights from studying the experiences of the remote sensing community. Communication and cooperative work among the two research communities is required if the substantial benefits promised by sharing geographic information are to reach their maximum potential.

John Evans and Joseph Ferreira, Jr.

SHARING SPATIAL INFORMATION IN AN IMPERFECT WORLD: UNDERSTANDING THE INTERACTION BETWEEN TECHNICAL AND ORGANIZATIONAL ISSUES

Incentives and impediments to spatial data sharing among organizations are often categorized as either "technical" or "organizational." For instance, an agency might not make use of an outside data source for "technical" reasons: it may lack suitable data-conversion software, compatible hardware, or a means to search through a sea of unknown data. At the same time, spatial information sharing is often obstructed by "organizational" issues: "turf battles," the need for bureaucratic reorganization, or institutional inertia. In response, some researchers have focused on such topics as data structures, formats, query languages, or client-server architectures; others, meanwhile, have concentrated on

bottom-up or top-down development strategies, the role of coordination committees, or the design of cost-recovery schemes.

In today's unsettled, rapidly changing technological and organizational context, neither a purely technical approach nor a purely behavioral approach will properly address most problems of spatial information sharing. Rather than isolate technical from organizational issues, research efforts should focus on their overlap. We suggest the following guidelines for research on spatial data sharing:

a) Technological innovations must explicitly address a "messy" organizational context, with multiple actors, organizations, and imperfect coordination.
b) Conversely, organizational research on spatial data sharing must be tightly linked to a "messy" technological context, both to cope with current limitations and to put innovations to use.
c) Finally, research on spatial data sharing ought to identify and emphasize the aspects of the problem which are unique to spatial data.

Michael F. Goodchild

SHARING IMPERFECT DATA

Quality is almost always an issue in working with spatial data, since almost all spatial data are of limited accuracy. Access to appropriate information on quality is essential if agencies or scientists are to share spatial data, since no user is willing to trust data of unknown accuracy. The concept of metadata provides an effective means of ensuring such access, by integrating information on quality with the data themselves. Standards for the description of quality and for metadata are emerging, and procedures for quality assurance and quality control of GIS data are under development. The theme of this paper is that lack of information on data quality, and lack of quality itself, is a significant hindrance to the sharing of spatial data between institutions.

Michael J. Kevany

A PROPOSED STRUCTURE FOR OBSERVING DATA SHARING

That the sharing of information or data is a desirable process appears in the GIS industry to be a universally accepted "truism". Why is sharing so important, inspiring so much interest in research? Perhaps because it offers the opportunity for great financial gain or saving, perhaps the opportunity for compatibility in information, perhaps many other benefits. Nevertheless sharing is treated as very significant when justifying or planning a GIS. One might question the veracity of that "truism" but except for a few unique situations, it is probably true. The purpose of this paper, however, is not to justify sharing but to explore methods for analyzing the environments of sharing.

Since we generally accept the practice of information sharing as a desirable condition, it is important in a GIS project to create conditions that are conducive to sharing. Little is known, however, of what conditions create a conducive environment. The purpose of this paper is to explore factors impacting sharing and to make a contribution toward an analytical structure for improving the level of knowledge. The paper identifies potential factors and proposes and evaluates a structure for measuring the reality of, or potential for, information sharing in a GIS environment. The structure may be used initially to improve the knowledge of factors that affect data sharing and later to apply that knowledge to GIS situations to increase the potential for sharing.

John L. King

PROBLEMS IN PUBLIC ACCESS POLICY FOR GIS DATABASES: AN ECONOMIC PERSPECTIVE

Consider the following scenario. The City of Buena Loma has developed a highly sophisticated geographic information system, with an extensive data base covering the entire jurisdiction with many layers of detail. The GIS took eight years of heavy investment by the City, in talent time, and trouble. Most important, the GIS cost the city a great deal of money- over $5 million. The GIS went live for routine use by city agencies in late 1990. Recently, Buena Loma was approached by several companies seeking access to the GIS database. These companies, which include two powerful regional public utilities, have insisted that under state law Buena Loma is required to provide full copies of the GIS database "for the cost of reproduction." The companies further have argued that the cost of reproduction can include only the price of several magnetic tapes and about $200 of staff time. Three members of the city's seven member City Council, after hearing about the demand, have told the Buena Loma city manager they would consider such "release" to be a giveaway of public property worth millions of dollars, and issued a strong warning against such action. The city has no policy regarding release of electronic records of this kind, and the city manager never faced a situation like this before. What should she do?

This paper reviews the economic rationale necessary to build an understanding of the complexities of the issues involved in a way that will give Buena Loma's city leadership the upper hand in negotiating resolutions to the problem.

Ian Masser and Heather Campbell

INFORMATION SHARING: THE IMPACT OF GIS ON BRITISH LOCAL GOVERNMENT

The arguments for information sharing are discussed in the context of British local government. The case for more corporate approaches which maximize the benefits to be obtained from information sharing is evaluated and an alternative case which highlights the operational advantages of departmental approaches is considered. The advantages and disadvantages of these two approaches are examined both in overall terms and in relation to the preliminary findings of a comprehensive survey of GIS implementation. The findings of this survey show that there is a 50:50 split between more corporate and departmental approaches in current British practice.

Paul H. Meredith

DISTRIBUTED GIS, IF ITS TIME IS NOW, WHY IS IT RESISTED?

Tremendous value may be realized by storing, sharing, merging, and manipulating large scale databases in a distributed processing environment (Toperczer, 1991 and Keen, 1988). Yet there is deep-rooted and widespread resistance to distributed processing of data, even when it is limited to intra-organizational sharing of processing responsibility. When distributed strategies are advanced which transcend organizational boundaries resistance magnifies.

Why is administrative and user resistance so high, and what alternatives exist for managing or overcoming the sources of resistance? This paper responds to that question in the following manner. First, organization theories on three types of organizational interdependence and how organizations respond to them are explored. Second, a theoretical framework for understanding various levels of interorganizational cooperation, and factors influencing their adoption are provided. These theories are linked to a conceptual framework from the field of Management Information Systems (MIS). The MIS material referenced identifies a set of criteria for the organizational evaluation of distributed processing

proposals. Special emphasis is placed on understanding the principal sources of resistance to adopting distributed solutions. Finally, a testable framework for managing and/or overcoming those sources of resistance is proposed. Concepts found in literature on the management of technology and innovation are employed.

Patrick McGlamery

CONTINUING THE ROLE OF MAP LIBRARIES IN THE INFORMATION AGE

The library community is an established purveyor of information in our society. Each branch library in this nation is linked in a complex relationship to the library as institution. Coordinated graduate level curriculum and shared standards assure a common vocabulary in the profession, regardless of the type or size of the library.

Sharing spatial databases and spatially referenced information in other data bases will inevitably be carried out by citizens within library contexts and become part of the library institution in our society. Recently, map librarians and users met to discuss establishing a shared agenda for the emergence of digital cartographic information in libraries. The following agenda items are offered as a point of departure for the discussion and involvement for the library community in sharing of geographic information. The roles of the library institution in the emerging field of spatially referenced information are: (1) collecting/archiving; (2) cataloging/indexing; (3) networking; (4) distributing; and (5) education.

Nancy J. Obermeyer

THE ROLE OF BUREAUCRATIC FLEXIBILITY IN SHARING GEOGRAPHIC INFORMATION

The phrase bureaucratic flexibility seems to be an oxymoron. Typically, bureaucratic routinization and intransigence combine to produce organizational inertia that impedes innovation in the adoption of both new technologies as well as new organizational procedures. The implementation of large-scale geographic information systems requires an openness to both a new technology and new procedures, especially procedures designed to facilitate the sharing of geographic information across organizational boundaries. In an earlier paper, I suggested that negotiation would be an important strategy in establishing inter-organizational information-sharing strategies. The experience of the Cincinnati Area GIS project (CAGIS) supports this concept, and takes it further. Not only is negotiation necessary in the initial stages of building a broad-based GIS, but ongoing readjustments are often required to enable the project to continue to function smoothly. These readjustments are made possible by flexibility within the overall structure of the inter-agency agreement. This paper examines the experience of the Cincinnati Area GIS project, paying special attention to the role of bureaucratic flexibility in the ability of the member organizations to share geographic information across organizational boundaries in a long-term, open-ended project.

Harlan J. Onsrud

ROLE OF LAW IN IMPEDING AND FACILITATING
THE SHARING OF GEOGRAPHIC INFORMATION

The widespread use and accessibility of geographic data sets in combination with the capabilities provided by other communication technologies are raising numerous public concerns. Among these include the effects of such technologies on personal privacy, access to the information used by government, work product protection laws, legal liability for errors and inadequacies in GIS products and services, and concerns that information infrastructure arrangements will contribute to the widening

of socio-economic gaps among members of the social system. As developers and purveyors of a powerful social resource, the GIS discipline needs to identify the consequences of use of the technology and consider those consequences in the light of their general social effects. The policy implications of different geographic information sharing arrangements need to be explored and the legal conditions and constraints that will affect the ability to share geographic data widely among divergent groups of potential users of GIS need to be fully discussed.

Jeffrey K. Pinto and Harlan J. Onsrud

FACILITATORS OF ORGANIZATIONAL INFORMATION SHARING: A RESEARCH FRAMEWORK

The success of organizations in both the public and private sectors can be greatly enhanced by the open exchange of information across organizational boundaries. One of the problems hampering the integration and wide-spread use of Geographic Information Systems (GIS) has been the continued inability of various public agencies at the federal, state, and local levels to develop purposeful and productive collaborative relationships. Specifically, there is a general inability to effectively share GIS information among these organizations, resulting in the duplication of systems and services at different levels. This paper proposes a research framework that addresses the influence of a set of antecedent constructs (superordinate goals, accessibility, communicative proximity, bureaucratization - formalized rules and procedures, the quality of exchange relationships among organizations, and resource munificence/scarcity) on the attainment of both interorganizational cooperation and optimal use of GIS information.

Bruce Rocheleau

COMPUTERS AND HORIZONTAL INFORMATION SHARING IN THE PUBLIC SECTOR

Implementation of geographic information systems requires a great deal of sharing between municipal departments but there is little information available on the nature and frequency of shared information. The study reports on the rate of sharing of information between police and other city departments in Illinois. It reveals that the overall rate of sharing is infrequent, less than monthly. The highest rate of sharing is with the administrative and budget departments. Analysis of the data supports the hypothesis that most sharing is due to survival factors such as hierarchical authority, accountability and funding requirements rather than task-oriented reasons. Regression analysis shows that the use of electronic sharing does encourage a higher overall rate of sharing between departments. Other variables including hardware configurations, departmental size and autonomy, and crime-related variables were not found to be significant. The implications for the implementation of geographic information systems are discussed.

Gerard Rushton and Vinod K. Tewari

SHARING "SPATIAL DATA" IN A DECISION SUPPORT ENVIRONMENT

People and institutions often want access to spatial data to answer one or more of a specific set of questions. Although the current approach is to acquire spatial data to input to a chosen GIS, and then use its functions to provide information to support decision-making; the future approach may often be to request access to a named spatial decision support system. The system will know its data needs for the kind of questions it is asked to support and it will acquire the spatial data it needs from central, state and local sources, according to previously negotiated and approved guidelines. We describe one such system being developed to serve the locational planning needs of all rural districts in India. A collaborative arrangement is being developed with memorandums of agreement that specify the

responsibilities of participating parties. The different components of the system have been tested and validated, separately, though the integrated system does not yet exist.

Rebecca Somers

INTERRELATIONSHIP OF ORGANIZATIONAL FACTORS AFFECTING DATA SHARING

Many GISs are justified and implemented based on the benefits that will accrue from shared data. Once these systems are implemented, however, many of these benefits are not realized. Although hard facts and figures are hard to find, a review of the literature and discussions in the field appear to indicate that the data sharing is not operating as planned. Often, those who are operating the GIS are perplexed that data sharing is not working. When they do analyze the situation, they think they have discovered "organizational problems" that are unique to GIS. This is not necessarily the case. There are many different ways to approach the problem, using concepts and techniques developed in other areas of organization design and development, system development, and the management of technology in organizations. The GIS situation requires that these factors be applied to the specific characteristics of GIS. This paper summarizes the state of the art in organizational techniques for GIS data sharing, the structures and activities required and possible sources for developing a foundation on which to build GIS organizational change strategies.

Jon Sperling

DEVELOPMENT AND MAINTENANCE OF THE TIGER DATABASE: EXPERIENCES IN SPATIAL DATA SHARING AT THE U.S. BUREAU OF THE CENSUS

The U.S. Census Bureau has played and will continue to play a vital role in the development, maintenance and sharing of spatial and attribute data for geographic information systems (GIS) on the local, regional, national and international level. Developing the GBF/DIME (Geographic Base File/Dual Independent Map Encoding) Files for the 1970 and 1980 censuses and the TIGER (Topologically Integrated Geographic Encoding and Referencing) data base for the 1990 census has made the Census Bureau a leading innovator, and these files a major impetus, in the rapid growth and diffusion of GIS technology. These file-building projects were based on close working relationships with people at all levels of government, in the private sector and the academic community over the past two decades. In the process, the Census Bureau has gained broad experience with the behavioral, organizational, and institutional issues acting as impediments or incentives to the sharing of geographic data.

This paper discusses the Census Bureau's geographic data-sharing experiences during three major periods: (1) The development of GBF/DIME-Files (1970-1982), (2) the development of the TIGER database (1983-1990) and (3) the development of intercensal data exchange programs (ongoing since 1991). Emphasis is placed on digital geographic data sharing with the U.S. Geological Survey (USGS), local planning agencies and others in the building of the TIGER data base as well as current experiences in developing a Memoranda of Understanding with Federal and state agencies to update and improve the spatial and attribute data in TIGER. Based on these experiences, preliminary generalizations are made concerning the incentives and impediments to future digital spatial data exchanges.

David Stage

A MULTI-AGENCY MANAGEMENT STRUCTURE TO FACILITATE THE SHARING OF GEOGRAPHIC DATA

The Growth Management Data Network Coordinating Council (Council) was created in Florida to facilitate the sharing of growth management information, most of which is spatial in nature. This paper briefly describes the tools, methodologies and organizational structure that the Council has developed to create a "federation of independently held databases that are linked together by standards and a management structure". This multi-agency management structure is designed to allow experts from different agencies to meet and make recommendations to executive management in regard to data standards and policies on topics that are typically esoteric in nature but are of collective value. Such a system requires a facilitator to manage the multitude of collective activities, multi-agency management tools and structured documentation tools. The multi-agency management tools consists of a project manager (the issue statement) which was developed to facilitate inter-agency coordination, and a consensus group methodology which was created to assist in the development of data standards. Three levels of documentation tools have been created to facilitate communication and the development of standards: a card catalog that tells where information is located: a quality and accuracy report that describes the "goodness" of the information; and a data dictionary that specifically defines the information.

Richard Taupier

AN EXAMINATION OF INCENTIVES FOR THE EXCHANGE OF GEOGRAPHIC INFORMATION - THE THEORY AND IMPLEMENTATION OF DATA SHARING PROGRAM IN THE COMMONWEALTH OF MASSACHUSETTS

The Commonwealth of Massachusetts, like many other states in the U.S., has over the past several years developed a significant base of digital geographic information (GI). Each year additional agencies develop GIS capabilities and improve upon their ability to make efficient use of GI. As a result of the demand for more and better geographic information, data access and exchange policies are of substantial interest. Massachusetts has evolved through various stages similar to those encountered in other states and expects further evolution to occur. An understanding of this behavior and the incentives for exchange of GI requires some basic understanding of the economics of public goods and the nature of efficient public organizations. This paper explores some of the details of those issues and demonstrates that efficient public agencies that are capable of generating substantial value from GI will be inclined to enter into data exchange agreements.

Doyle Frederick and Gene Thorley

COORDINATION OF SURVEYING, MAPPING AND RELATED SPATIAL DATA ACTIVITIES

On October 19, 1990, the Office of Management and Budget issued the revised Circular A-16 titled "Coordination of Surveying, Mapping, and Related Spatial Data Activities." The revised Circular A-16 expands the breadth of coordination of spatial data and assigns leadership roles to Federal departments for coordinating activities related to these data. The revised Circular A-16 also establishes a new interagency coordinating committee named the Federal Geographic Data Committee. The committee has established subcommittees and working groups and is beginning to coordinate different categories of data and to work on issues of standards, technology, and liaison with the non-Federal community. This paper describes the goals and objectives of the Federal Geographic Data Committee and the opportunities and challenges for the community-at-large.

Nancy Tosta

THOUGHTS ON GEOGRAPHIC DATA SHARING

Continued expansion in the use of technology for mapping and other geographic data activities has generated a growing demand for digital spatial data. The use of GIS technology by state agency personnel has grown by an order of magnitude in the last decade. Levels of interest in geographic data have increased even more dramatically. Most agencies realize the value of sharing digital geographic data based on the costs of data capture and maintenance, but implementing the practice is often difficult. This paper examines the development of geographic information system technologies in California state government, and the accompanying interest in, practice of, and constraints to data sharing. Observations based on state government experience, are made on a number of factors that influence the ability to share digital, geographic, data. Factors include the effects of politics, roles of individuals and organizational structures, and changes in technology. Suggestions are offered for practices that may overcome constraints and facilitate cooperative development of digital, geographic data.

Stephen J. Ventura

FACTORS INFLUENCING THE FORMATION OF COORDINATING BODIES FOR GEOGRAPHIC DATA SHARING AT THREE LEVELS OF GOVERNMENT

This paper compares the development and potential effectiveness of over-arching bodies charged with facilitating geographic data sharing at three levels of government - local (Dane County, Wisconsin: DaneLINC, the Dane County Land Information Consortium), state (State of Wisconsin: WLIB the Wisconsin Land Information Board), and national (Trinidad and Tobago: Interministerial Committee on Land Information Systems). Observations are primarily focused on three groups of factors that appear to influence the process of creating the over-arching bodies - technology introduction, practices and structures within organizations, and interagency relations. It is posited that the process of formation and the form and authority of the over-arching bodies will affect the success of data sharing between agencies, though it is too early in their implementation to document such affects. Observation of their formation process raises a series of questions, to study through long-term observation of these and similar situations, which will provide evidence of factors influencing the success of coordinating bodies for geographic data sharing.

Appendix 4
General Listing of Research Topics

After two days of presentations and discussions, participants were asked to reflect overnight on the issues raised and to formulate a subset of research issues they felt were fundamental to the understanding and promotion of geographic data sharing. The following subsets of issues were suggested in an open plenary session:

- identification of sharing relationship variables that promote or inhibit data sharing in distributed system structures

- identification of processes and functions of coordinating bodies in data sharing environments

- identification of process and content models of organizational and political dynamics as related to data sharing

- identification of case study structures that might be useful for examining data sharing

- identification of bureaucracy factors that affect GIS and data sharing

- identification of aspects of group decision-making domains and the impact of group decision-making regimes on the ability or willingness to share data

- examination of pathways, consortia, and cases where data sharing experience already exists (such as RUIS, MassGIS, Teale Data Center)

- examination of the application of organizational theory to GIS data sharing

- examination of the aspects of creating vs. sharing data

- identification of multidimensional analysis techniques to study the affects of time and interrelationships on data sharing

- identification of the aspects of the legal regime that affect data sharing and the political and economic factors associated with those aspects

- identification of the effect of standards on data sharing

- identification of aspects of meta data that promote data sharing

- identification of a taxonomy for data and its relation to data sharing

- identification of intermediate targets for federal/state/local data sharing

- identification of long and short term visions for data sharing arrangements

- creation of a shared vision of a common spatial database infrastructure

- broadening the set of research paradigms to study data sharing to include political and economic aspects of data sharing

- examination of public infrastructure as a system for data sharing