Spatial Consensus-building Through Access to Web-based GIS: An Online Planning Tool For Leipzig

by

Matthias Baxmann

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Signature of the Author ....
Department of Urban Studies and Planning
May 22, 1997

Certified by ....
Michael J. Shiffer
Lecturer and Principal Research Scientist
Thesis Advisor

Accepted by ....
Mark Schuster
Associate Professor of Urban Studies and Planning
Chair, MCP Committee

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Abstract

This thesis examines how emerging information system technologies and consensus techniques can be integrated to overcome barriers to land use planning. Complex planning and decision making require close collaboration among many parties, yet communication and collaboration breakdowns are often at the heart of failed planning efforts. Among other factors, a lack of trust and inadequate institutional support for communication among stakeholders tend to hinder effective spatial planning.

Recent developments in geographic information systems (GIS) and network technology can be combined to enhance communication among multiple stakeholders and their access to relevant information. The use of spatial analysis tools such as GIS can support planners and other stakeholders in the collection, analysis, visualization, and understanding of data in spatial planning processes. Global networks allow stakeholders to share resources and open new communication channels. To take advantage of the opportunities offered by these technologies, a framework that organizes and integrates stakeholders and technologies must be devised. I propose an approach that facilitates joint planning among multiple stakeholders with a focus on early planning stages. As an example of a large-scale planning process with regional impact, I examine the application of computer-supported spatial consensus-building in a mining site redevelopment case in Germany.

My recommended model is organized around a "hub institution" and is based on a Internet client/server architecture. I describe the main components of a "hub homepage" that facilitate communication among stakeholders in a mediated online environment. I conclude with design recommendations for implementing this online planning model.

Thesis Supervisor: Michael J. Shiffer
Title: Lecturer and Principal Research Scientist

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Bibliography

The author has worked professionally as a systems integration consultant in Hamburg, Frankfurt, and Hong Kong. He was awarded a degree in Business Administration from Stetson University in 1991 and a Licence de Sciences Economiques from the Université de Montpellier in 1992.

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Introduction

> *Society has a penchant for leaning on scientists and experts for making the tough social choices that inevitably must be made, precisely because these decisions are difficult, controversial, and many outcomes are possible ... As seen, technical analysis fails at this task. Congressional intervention and judicial rulings have similarly failed. Other means must be found (Wondolleck, 1988: 152).*

Planning processes depend on collaboration among professionals in public and private planning institutions as well as among various parties such as special interest groups, non-governmental organizations (NGOs), and the public. Planning regulations attempt to foster such collaboration, prescribe the collection of relevant data for analysis and decision support, and ensure that information is made available. Yet communication and collaboration breakdowns are often at the heart of failed planning efforts. Among other factors, a lack of trust and inadequate institutional support for communication among stakeholders tend to hinder effective spatial planning.[1] In addition, access to relevant planning information is often cumbersome. Promising approaches to addressing these problems are consensus-building and recent developments in information technologies (IT).

The main research objective of this study is to show how emerging trends in geographic information systems (GIS) and network technology can enhance communication –the flow of ideas upward, downward, and laterally-- among professional stakeholders and their access to relevant information. To take advantage of the opportunities offered by these technologies, a framework that organizes and integrates stakeholders and technologies must be devised. I propose an institutional and technological model that facilitates joint planning among multiple stakeholders in Germany.[2] The model links stakeholders (senders and receivers of messages) and information technologies (channels of transmission and processing of data). The model's institutional aspects deal with how to achieve organizational arrangements aimed at enhancing inter-agency collaboration and

[1] Planning in the context of this thesis encompasses spatial aspects of urban, land use, landscape, and environmental planning.
[2] Stakeholders are all parties that have a legal requirement, are affected by, or have a perceived interest to participate in a planning process.

information access. Its technological aspects concern the IT architecture that links stakeholders to an information network and supports collaboration between them. The main targeted groups are professional stakeholders in government agencies, private businesses, and non-profit organizations. I intentionally excluded special considerations for involving the general public.

While the majority of planning processes in Germany progresses without conflict, many could benefit from enhanced communication channels and easier information access. This study pursues the strategy to integrate consensus-building and IT in order to take advantage of their respective benefits. Consensus-building can be defined as a process whereby "a collection of people coalesce around a perceived common problem to engage in conscious deliberation" (Matthews, 1994). Consensus-building is a way to address conflict in planning, but more importantly a strategy to produce plans that enjoy widespread support from stakeholders. However, the effort currently associated with implementing computer-supported consensus-building will make this strategy only feasibly for large-scale or highly contentious planning processes. As an example of a large-scale process with regional impact, I will examine a mining site redevelopment case in Germany. This case serves as an example of a planning process involving spatial issues such as land use, site location, site closure, and boundary adjustments.

In the first chapter, I put forward the proposition that the integration of consensus-building with recent developments in information technologies can make planning more effective. I argue that their integration addresses some of the typical barriers to effective planning such as lack of communication, collaboration, and information sharing. Consensus-building is described as a key strategy for promoting a more interest-based approach to planning and achieving long-term acceptance of plans. Recent developments in information technologies offer new ways of supporting planning processes, but the integration of the two approaches holds the most potential for overcoming some of the barriers to effective planning.

In the second chapter, I provide some background information on planning in Germany. The overview describes underlying planning traditions, the relevant legal framework, and contemporary planning practice. The planning context in the region south of Leipzig will be explored in more detail. The chapter concludes with an overview of the current status of Internet access in Germany.

Next I provide an overview of the recent role of information technology in planning to show how its use has evolved over past years. I discuss the advantages and weaknesses of computer-based communication and its potential impact on group work. A critical assessment mentions common barriers to using information technology in planning. Finally, I describe some of the functions of IT during early planning stages. This leads into a discussion of how to integrate consensus-building during these early stages and concludes with an overview of key obstacles to consensus-based land use planning.

The fourth chapter elaborates on this discussion and focuses on the integration of GIS and consensus-building. First, I shed light on the perceptions of maps to support the argument that maps can serve as a powerful communication vehicle. Then a brief review discusses the basic functions of GIS in planning. The next section explores the proliferation of GIS in Germany. I also speculate about the impact of using Internet-based GIS on planning. This speculation brings up the question about the benefits of integrating a Web-based GIS into consensus-building processes.

The fifth chapter examines institutional and technological examples for integrating IT into planning and of computer-supported cooperative work. The main focus is on Massachusetts' GIS service (MassGIS) as an example of an institutional GIS implementation. The analysis focuses on the challenges encountered during its implementation. In addition, I describe other examples of GIS and Internet implementations to provide an overview of a few recent efforts in this area.

The sixth chapter develops the characteristics of an online planning model. First, I discuss some recent technological developments that have made Web-based GIS feasible. Then I present three possible model architectures, followed by a description of an online planning model's main components that facilitate communication among multiple stakeholders and provide them with easy access to information. Finally, I assess how the recommended hybrid model addresses the previously identified obstacles to consensus-based land use planning.

I conclude by summarizing benefits and drawbacks of integrating consensus-building with GIS and Internet technologies. I also point out issues that the proposed online planning model does not address. Based on lessons learned from the MassGIS experience and new opportunities offered by emerging technologies, I recommend implementing a spatial consensus-building and online planning prototype to support redevelopment efforts in the area south of Leipzig, Germany.

Chapter 1: Proposition

The integration of consensus-building with recent developments in information technologies (IT) can make planning more effective by enhancing communication among stakeholders and their access to relevant and agreed upon information. A key to successful planning is informed people who work toward mutual goals. But mutual goals are not a given in a pluralistic world; on the contrary, spatial planning inherently involves contentious resource allocation choices. For example, the modification or degradation of human living conditions frequently leads to conflict, many of which are "distributional disputes" focusing on the allocation of funds, the setting of standards, or the siting of facilities (Susskind and Cruikshank, 1987). The resolution of such disputes should involve stakeholders in an analytic-deliberative process, whose goal is to arrive at mutually agreeable solutions. Deliberation in this context is any formal or informal process for communication and collective consideration of issues. However, such processes of transforming data into information and information into knowledge are often hampered by inadequate access to relevant information and communication breakdowns. Figure 1 illustrates these barriers, which can be distinguished into product and process barriers.

Product barriers:	Access to data barrier		Sharing of information barrier		Dissemination of knowledge barrier
Transformation chain:	**Data**	→	**Information**	→	**Knowledge**
Process barriers:		Filtering barrier		Communication and collaboration barrier	

Figure 1: Barriers to knowledge transformation

1.1. Barriers to Effective Planning

Spatial planning has become more complex as shrinking budgets force public agencies to increasingly look to the private sector for partnerships, interest groups have become more organized and sophisticated, and the diversity of participants has increased. For example, these trends have made it increasingly difficult to site regionally necessary, but locally undesirable, facilities such as a hazardous waste treatment plant. In a hypothetical facility siting case, a city's public facilities department might propose several sites for a new plant after having gone through a rational process of identifying the "most suitable" sites. Several other stakeholders such as a regional planning agency, the municipalities with sites located within their administrative boundaries, the department of public health, the environmental management agency, developers, local environmental interest groups, and local residents will be affected by these plans and are likely to have a different understanding of "most suitable." Nevertheless, plans are often drafted without knowledge of interests or involvement of relevant stakeholders (Luz and Opperman, 1993). Among public agencies, this is often exacerbated by historical conflicts of power, authority, and interests, which lead to "systematically distorted communications" (Habermas, 1968). Maybe the state and local agencies simply do not talk to each other. By the time other agencies get a chance to react to plans, the plan's basic structure has already started to solidify in the minds of its proponents. Criticism and suggestions for changes are increasingly likely to be rejected as the process continues. In absence of an adequate forum for communication and coordination, stakeholders quickly dig in to defend their positions and might use available communication channels such as mass media for adversarial argumentation. Similarly, once the plan makes it to public hearings or town meetings, affected citizens take a NIMBY (not-in-my-backyard) or LULU(locally-unwanted-land-use) stand and business groups oppose it, because their concerns were not addressed appropriately before. Chances are that the case will provoke public demonstrations, blockades, or litigation, which delay implementation and significantly increase costs.

This example illustrates how horizontal communications encounter difficulties as a result of conflict or other differences among groups. In addition, vertical communications encounter difficulties as a result of hierarchical filtering. Only very little of the information gathered initially to support the decision to build a new plant at a certain location trickles down to affected parties. The decision-making process becomes less and less transparent the farther removed stakeholders are from the process. The public facilities department might have good reasons why certain sites are most suitable, but their reasoning and scientific arguments are not conveyed in a complete yet concise and understandable way. The formal structure of bureaucracies contributes to this filtering problem. The "horse-blinders mentality" is especially prevalent, where organizational units have a narrow range of responsibility, which promotes the seeking of self-interest without much consideration of other stakeholders. Even within the same agency, several departments with different motivations and interests might get involved. For example, a school division within the public facilities department might oppose the plans, because a site is too close to an existing school. But the public school planners might not usually interact with the public utilities planners. If information is not deemed necessary to be passed on or is intentionally withheld, the right hand might not know what the left hand is doing.

Now imagine that you are the site planner trying to gather information relevant to the facility siting case. Since planning analysis cannot be arbitrary to be credible, you are concerned about objectivity. Questions of objectivity call attention to the adequacy of data collection, processing, and representation (Forester, 1993). You might want to find data about existing land use patterns, which you could get from the land surveying agency. You are also interested in the demographics of the areas surrounding proposed sites. A good place to get this information is the statistics department. Other interesting information about conditions in the areas surrounding the development sites might come from the environmental management agency or environmental non-profit groups. Or you might need some special information about drinking water wells from the water resources authority. These examples give an idea of the various kinds of information to be collected during early planning stages. But what is the best way to find out what data or information exists, to determine their pertinent characteristics, and to obtain them? Some of the sources might only be available in distributed locations far away from where you are. It might take significant time and effort to find the information you need. Maybe one source is so far away that it does not seem worth going there, but attempts over the phone have been unsuccessful. But even if you make the trip, locating the right data or information within bureaucracies can be another challenge. Who has not experienced being passed from one person to the next, before (if at all) finding the person who actually knows where to find what you are looking for.

Related to the data access issue is the issue of information sharing. Information is often regarded as power and is not freely shared. Maybe the statistics department cannot give you the information you need because of privacy issues. Maybe the water resources authority has a map of interest to you, but does not want to hand it out, because it shows controversial high-risk areas that involve designation judgments. Another reason might be that they are afraid of misuse of their data. While there are valid reasons for withholding information, information holders are often simply afraid of losing control and giving up a part of their power. Especially in the case of digital data, institutional information providers are often unwilling to make their information accessible to outside parties. Even if digital data is available and the owner is willing to share it, access might still be an issue, because the data is stored on mainframe computers and difficult to get to.

1.2. Strategies for Overcoming Barriers

In the planning field, information plays a key role in assuring efficient decision-making processes. In general, better information leads to better decisions.[3] However, relevant information is often unavailable, communication between stakeholders is far from perfect, and decisions are often made in spite of strong disagreements among contending interests. Figure 2 illustrates the relationships between previously mentioned planning problems and the subsequently proposed strategies to address them.

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[3] The view that information improves decision making assumes that successive transformations enhance the information content, decrease the amount of data (summarization, abstraction), and add value.

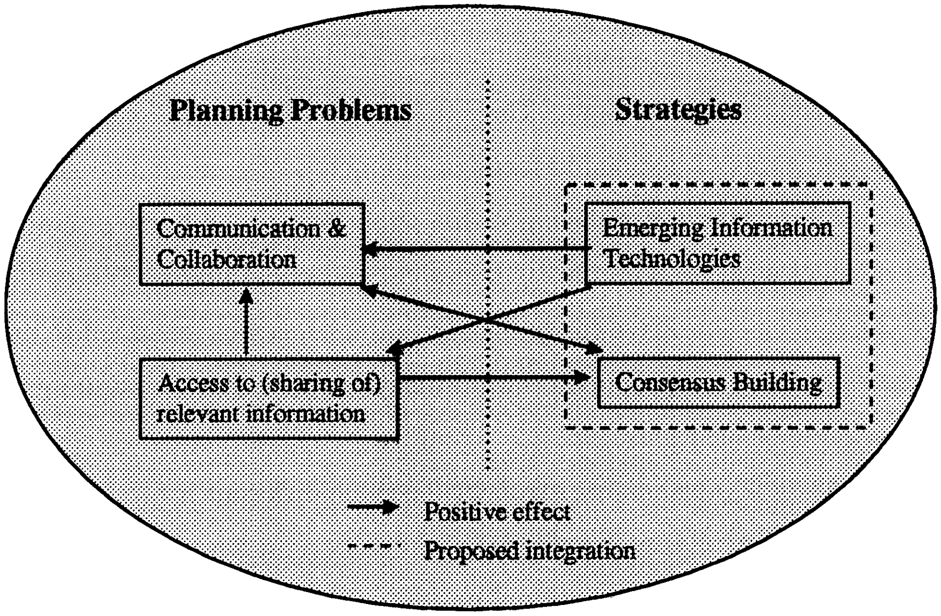

Figure 2: Barriers to effective planning and strategies for addressing them

1.2.1. Consensus-building

In recent years, consensus-building has evolved into a key strategy for overcoming some of the barriers to communication in planning.[4] Susskind and Cruikshank (1987) define consensus-building as a voluntary effort involving informal, face-to-face interaction among stakeholder representatives to resolve disputes. They see it as an "all-gain" supplement to conventional "win-lose" decision-making. Through integrative bargaining, participants seek to satisfy their interests within the context of other stakeholders' interests. The Canadian National Round Table on the Environment and the Economy (Cormick et al., 1996) is an example of an initiative aimed at building consensus among a wide variety of groups. Consensus should not be interpreted as unanimity; it lies somewhere between a majority and unanimity but implies substantial support for a decision.

An important prerequisite for consensus-building is that all stakeholders be allowed to participate in the process. An important step towards identification of the stakeholders who ought to be involved is a conflict assessment (Susskind and Cruikshank, 1987:101). In terms of stakeholder involvement, the redevelopment of

[4] For more detail on communication in planning, see Selle (1996).

mining sites south of Leipzig is a somewhat special case, because no citizens live on the sites. However, residents living in the area are indirectly affected and have an interest in how the region develops. Their interests should not be excluded from planning deliberations. I decided to focus on the needs of professional stakeholders in the public and private sector, because this paper focuses on early planning stages, which deal with predominantly technical aspects of plans. The challenge is to involve them in collaborative consensus-building processes designed to handle complex issues by encouraging open communication, participation, and agreement.[5]

Consensus-building is a promising strategy, because different interests can be better addressed by involving all relevant stakeholders in a multi-party dialogue. In the facility-siting example, consensus-building could have provided a forum for discussion, in which stakeholders could have identified their interests early on in the process. This might have helped them to avoid litigation and delays. Through their involvement in a consensus-building effort, stakeholders are likely to develop commitment to the process and ownership of the outcome. A fair and open process that gives all stakeholders a chance to impact the outcome promotes adequate communication and collaboration, which are necessary to achieve a symbiosis between socio-economic development and the environment --that is, to engage in planning for sustainable development.[6]

The traditional consensus-building approach emphasizes face-to-face meetings, in which a mediator tries to bring parties to agreement by reconciling their interests.

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[5] A practical guideline for the implementation of consensus building processes was published by The Urban Land Institute (1994).

[6] "[S]ustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987). Peter Thacher of the World Resources Institute explains the concept as "living off your income, not your capital." Planning for sustainable development is concerned with the tradeoffs between alternatives to achieve a sustainable environment, economy, and society. It is different from conventional planning in that its strategies for achieving sustainability require involvement of, and understanding among, a wide variety of sectors and groups. Its complexity stems from peoples' diverse interests, visions, priorities, and needs. Planners have an important role in promoting the dialogue about sustainability and conceiving policy solutions to achieve sustainable development. For example, planners are in the position to consider ecological limits and environmental impacts at every step of community development. Sustainable development principles underlie the redevelopment of mining sites south of Leipzig.

My proposed online planning model does not attempt to replace face-to-face meetings but is meant to support an ongoing consensus-building process through the integration of IT.

1.2.2. Information Systems Technology

The goal of integrating information technologies (IT), i.e., geographic information systems (GIS) and the Internet, into planning and consensus-building is to enhance planning professionals' access to relevant information and to provide them with tools for online communication. Emerging GIS applications on the World Wide Web (WWW, also called the Web) are challenging conventional approaches to planning and are giving rise to new tools and services using geospatial information.

1.2.2.1. Geographic Information Systems (GIS)

GIS is a broadly defined term and was first coined by the Canadian Ministry of Energy, Mines and Resources in 1962. In general, a GIS is thought to be a computer-based information system that enables the capture, modeling, manipulation, retrieval, analysis, and presentation of geographically referenced data (Worboys, 1995). The system offers a flexible framework in which diverse file types and data sources can be combined. Georeferenced data is used to create maps and store information about map elements. Maps are topological surfaces, and a powerful GIS can calculate areas, perimeters, and distances between features on the map. For example, a GIS package could combine maps with demographic and environmental data to facilitate planning of natural resources. This would support the creation of a database with basic environmental and socioeconomic data on a region to build an inventory of natural resources and track human activity and impact within the ecosystem.

Geographic applications are known for the volume of the data involved.[7] The most important aspects of a GIS are its database management system (DBMS) and spatial analysis capabilities. A DBMS manages a database --an integrated collection of data. There are many different designs of DBMS, but in GIS the

[7] Researchers have estimated that in less than ten years, satellites will produce one terabyte of information every day (OGIS-Switzerland Workshop, Zurich, 30. November 1996).

relational design has found most favor. A relational DBMS stores data conceptually as a collection of tables. Common fields in different tables are used to link them. A DBMS must address a number of problems, such as security, accuracy, consistency, response time, and memory requirements. Geographic information is collected and managed for numerous purposes, each of which has its own requirements for how data are most efficiently organized, what comprises features of interest, what degree of precision and accuracy is necessary, how information is analyzed and displayed, and so on. As a result, there are many proprietary systems that are largely incompatible with each other.

1.2.2.2. Global Networks (World Wide Web)

The Internet is a worldwide network linking many local and wide area computer networks. Its origins go back to the ARPAnet, which was created in 1969. The initial goals of the Internet were to connect people in various locations and to let them share data on the network. The data sharing is made possible by a suite of communication protocols (TCP/IP), which provide standard addressing schemes for computers on the Internet.

The World Wide Web (WWW) is an information retrieval initiative based on the Internet aiming to give universal access to a large universe of documents (Berners-Lee, 1994). It is a global hypertext information system, which was conceived by Berners-Lee in 1989 at CERN, Geneva. The WWW adds capabilities for data sharing and provides a search and retrieve protocol (Hypertext Transfer Protocol) with a common naming scheme for documents and common data formats. Hypertext markup language (HTML) documents are ASCII files that contain embedded functions and can link to images, video, audio, and other documents. These hyperlinks structure information in an associative manner, linking related documents in distributed locations. The Web also allows dynamic access to databases and returns information based on user queries through the use of a Common Gateway Interface (CGI). The WWW is platform independent, which allows users of different computer systems such as UNIX, Windows or Macintosh to browse its content. Web browsers are well suited to sharing graphic as well as textual information, which is of particular relevance to planners. Common browsers include Netscape Navigator (Netscape Communications), Internet Explorer (Microsoft Corp.), and Mosaic (National Center for Supercomputing Applications, University of Illinois at Urbana-Champaign).

Two current trends are expected to have a major impact on the nature of the Web. First, the ability to charge for access (to pay electronically) and to control access will promote commercialization of Web transactions. Second, the emergence of map servers and virtual reality provides new ways to represent space on the Web. The term 'cyberspace' is often used in relation with the WWW. Benedikt (1991) defines cyberspace as "a new universe, a parallel universe created and sustained by the world's computers and communication lines. A world in which the global traffic of knowledge, secrets, measurements, indicators, entertainment, and alter-human agency takes on form."

Connecting stakeholders through a computer network creates new communication channels. Besides electronic mail, these channels can supplement face-to-face interaction by offering a virtual online forum. In the facility siting example, this might result in new relationships among stakeholders that otherwise would have rarely talked to one another. Over time, people could build trust and exchange ideas more freely. Repeated interactions help to shape a more cooperative environment. The site planner might learn about the public school administrator's concerns and make them part of the selection criteria. The site planner would also have a much easier time to find relevant information, if it would be accessible on the WWW. With GIS maps available on the Web, various stakeholders could develop a better understanding of the sites and issues at hand.

One objective of my research is to propose an institutional and technological model for a Web-based collaborative GIS that facilitates joint planning among professional stakeholders.[8] In combination with other Internet tools, a Web-based GIS can

[8] A collaborative GIS can be defined as the extension of a traditional single-user geographic information system to incorporate group interaction with geographic data sets (Faber, 1996).

effectively support tasks during early planning stages such as defining problems, presenting interests involved, and generating mutually agreeable solutions. The process of designing such a system is as much an organizational as a technical task. One premise of this thesis is that recent developments in GIS technology have made computer-supported approaches to planning feasible, but that institutional unwillingness to collaborate remains problematic.

1.3. Relevance of Topic

In this section I elaborate on the importance of communication, visualization, group conflict, and access to relevant information for effective planning.

1.3.1. Communication in Planning

Planning and communication are intrinsically linked. Analyzing, informing, presenting, participating, discussing, moderating, motivating, coordinating, seeking acceptance, building consensus, searching solutions ... are all aspects of planning. Complex interrelationships between tasks and individuals involved underscore the importance of collaborative planning processes. Communication is at the core of all these tasks, from the problem definition stage to plan implementation.

The discussion of planning and communication has a long history, but it is a history with deficits (Selle, 1996: 11). Professor Klaus Selle's lists several trends that have made the topic relevant again:

- Social scientists have identified a fragmentation of public opinion about the goals of societal development, which adds complexity to planning.
- Political scientists argue that increased use of negotiation, mediation and consensus should replace centralized governmental authority (crisis of governance).
- The mobilization of civil societies through communication is seen as the key to sustainable development.
- Environmental planning has to be based on public education aimed at overcoming existing thought patterns and habits. To make this process successful, cooperative action rather than top-down planning is needed.

- Democratically legitimized planning activities frequently encounter opposition from special interest groups, which leads to substantial delay. This has brought planners to the realization that stakeholders need to be integrated earlier and more effectively into the planning process.
- Finally, many planners have realized that the creation of an innovation-friendly context, in which new ideas grow and habits are adjusted, is a prerequisite for qualitative improvements. Such a context can be achieved only in cooperation with interested parties.

In the 1970s, participation and democratization were seen as solutions to many planning problems. This led to high expectations, which were disappointed by the complexities of planning reality. Past German planning practices tended to see considerations such as public participation, inter-agency cooperation and investor involvement in development planning as stand-alone components instead of integral parts of a more comprehensive process (Selle, 1996). In recent years, the planning field has seen several innovative approaches such as planning workshops (Wachten, 1996), mediation and consensus-building (Susskind and Cruikshank, 1987), cooperative private/public partnerships, and local and regional forums (Baxmann, forthcoming). The proliferation of desktop computers in the 1990s has fueled new discussions of planning democratization (Sawicki, 1996). However, it is important to realize that these approaches, as well as emerging IT, can contribute only in small ways to problem solving and are not answers in themselves.

1.3.2. Group Conflict and Communication

Planning among highly diverse groups whose members represent different preferences and goals faces many challenges. In the United States, there are two schools of thought concerning how to handle such contentious multi-party planning processes.[9] The first comes from a Hamiltonian belief in politicians to conceive public policy and experts to determine appropriate means to address issues. Traditionally, plans have been prepared by experts and decisions have been made

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[9] For a detailed overview of US planning traditions, see John Friedman (1987) and E. Franklin Dukes (1996).

by a powerful few with little involvement of third parties. Public participation and democratization of planning have been seen as obstacles that slowed down planning processes. However, this elitist approach to planning has frequently resulted in court challenges and has been increasingly criticized.

The second school of thought is based on the Jeffersonian vision of a self-governing republic. In recent years, many planners have recognized the inevitability of opposition in pluralistic democracies. This school of thought argues that innovative approaches such as consensus-building are constructive and lead to better outcomes in the long run. Initial delays in the planning stage are more than compensated by more efficient implementations.

Conflict and communication intertwine. While conflict is regarded as unpleasant, it can be useful in clarifying the needs and goals of diverse groups. The way out of conflict depends on the establishment of effective communication channels. The research by Leavitt (1985) has demonstrated the importance of communication channels that are imposed on groups. He compared communication processes and outcomes in groups that are required to communicate in different patterns, some of which are illustrated in figure 3. For example, in a chain pattern, communication has to flow back and forth along the line of members. In a wheel pattern, all communication has to flow through one member occupying the center position.

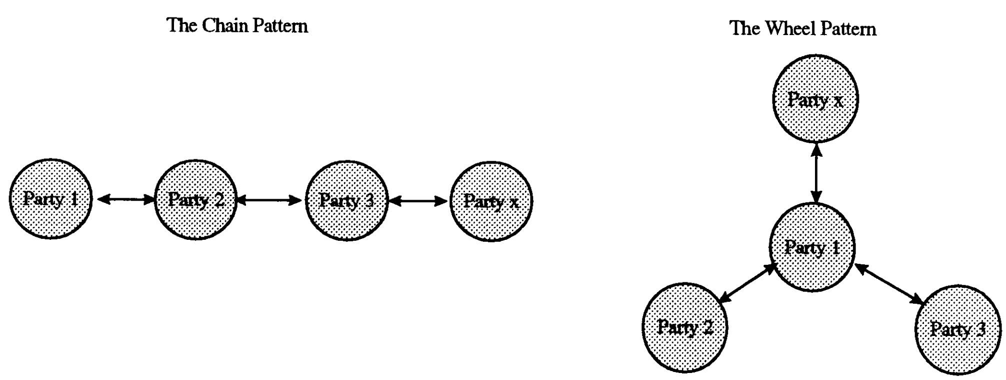

Figure 3: Some of Leavitt's communication patterns

Other patterns included the fully interconnected group with all members able to communicate directly with all others. The patterns determined different outcomes. For example, in the chain pattern communication was slower and less accurate and resulted in less member satisfaction than other patterns. The wheel had the fastest communication transmission with good accuracy but low satisfaction, except for the person in the hub position. The completely interconnected group often saw slow communication but high accuracy and members felt higher satisfaction.

My proposed model combines the wheel with the interconnected group pattern. All stakeholders are connected to a central hub (i.e., a Web site on the WWW), which provides access to relevant information and technical support (technical facilitator). These are the main links that ensure fast communication. In addition, the computer network also connects every stakeholder to all others via synchronous and asynchronous communication channels.

The Wheel-Network Pattern

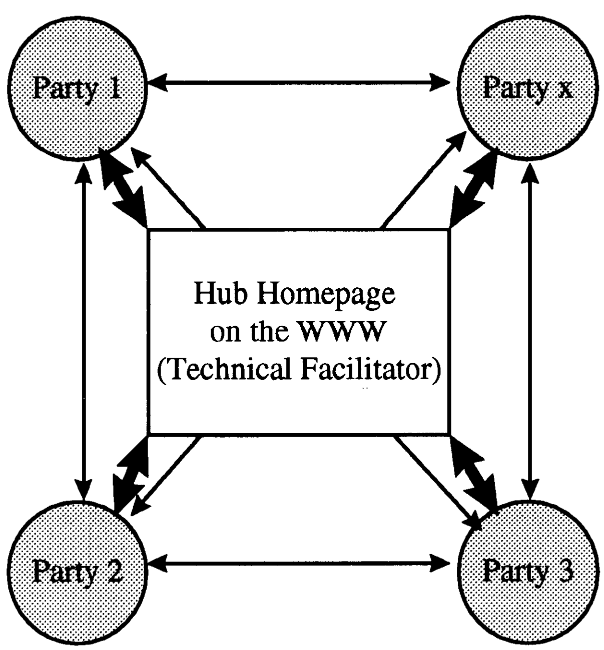

Figure 4: Online planning communication pattern

This pattern takes advantage of important features of the wheel and interconnected group patterns. The main links to the "hub homepage" connect all stakeholders to relevant information. The direct links among stakeholders represent the possibility to communicate, for example, via e-mail or by meeting in an online chat room. A major advantage is that the online communication channels provide a forum for sharing opinions and expertise independent of spatial and temporal constraints. The concept of "distributed cognition" acknowledges that group decision-making can be supported by tools that allow representation and visualization of shared information (Dillenburg and Self, 1992).

1.3.2. Information Access

What should be done in democratic societies emerges from deliberations among multiple informed stakeholders. Access to government information involves a basic right to know what public decisions are based on. In Germany, a recent law (*Umweltinformationsgesetz, 1994*) has acknowledged this principle and gives citizens the right to access environmental information held by government institutions. Concurrently, the growth of the Internet and development of user-friendly browser software for the WWW have created new access channels to planning information. For example, a Web-based model can evolve into a public participation and marketing tool to present the results of planning and implementation efforts and attract potential investors. However, there is a large number of technical, organizational, and legal issues involved. Therefore, it is necessary to develop appropriate rules of access to information in an online environment.

Early planning stages are characterized by the need to gather data at reasonable cost and to make information available in a timely manner in order to reduce the uncertainty of spatial planning and investment decisions. A comprehensive information system can integrate different data sources, improve information availability, help stakeholders gain new perspectives, and support decision-making based on more reliable information. Thus, a central repository that is easily accessible and provides common and updated data to interested parties supports consensus-building. Easy accessibility also increases the likelihood that planners use relevant information in decision-making processes. In terms of conflict resolution, a Web-based GIS application can help to "reframe" spatial issues. In addition, the Internet offers means for distributing GIS services to a vast audience. No other communication medium offers the opportunity to bring so much information to so many people so interactively, rapidly and cheaply.

Special interest groups often challenge controversial developmental impacts, and different stakeholders are bound to have different perspectives on what should happen to a development site. Since most planning processes have a spatial character, GIS offers itself to collect, analyze, visualize, understand, and communicate environmental and other relevant data about places. In the case of mining site redevelopment, GIS can support an ecosystem approach as a step to understand the region's ecosystem, visualize its extent, and analyze activities within it. The GIS can manage an inventory of the natural resources in and human impact on the ecosystem. A GIS is flexible enough to support stakeholders' different perspectives and data needs.

1.3.3. Visualization of Alternatives

The analysis and interpretation of plan alternatives are frequently supported by visualization. Buttenfield (1991) defines visualization as "the process of representing information synoptically for the purpose of recognizing, communicating, and interpreting pattern and structure." For GIS, visualization is part of transforming spatial data into information. The way spatial issues are presented can either exacerbate or alleviate conflict among stakeholders. Whereas traditional paper maps can be very effective in focusing discussion about an area, they are also static and inflexible, which can lead to perceptions of a "zero-sum game." A Web-based GIS allows users to more flexibly display different layers of information to gain a better understanding of various facets of a site. This can lead to a better understanding of alternatives and their respective impacts, tradeoffs, and benefits.

Maps can help users to better understand spatial characteristics and interdependencies of planning sites. However, there has been little research into the design of GIS visualization (Davies and Medyckyi-Scott, 1994). Goodchild et al. (1992) see visualization as a key to user participation in the determination of spatial dependence parameters in models of uncertainty. Taylor (1991) attributes a central role to visualization, linking cognition, communication, and technology. In his opinion, visualization addresses both analytical and communication issues of visual representation.

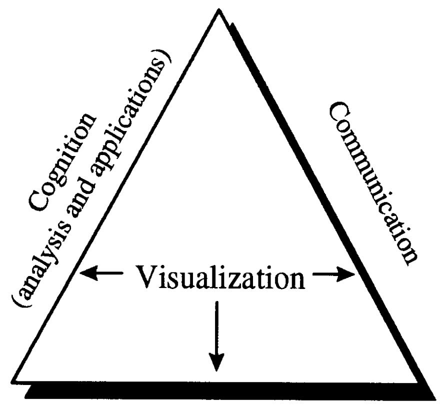

Figure 5: Visualization as a central link between communication, cognition and IT (Source: Taylor, 1991)

Maps visualizing information play a central role in my online planning model. They serve as a vehicle to present large amounts of data and facilitate dialogue about sites among different stakeholders. A Web-based GIS can powerfully integrate visual designs with socio-economic text and spreadsheet descriptions. In general, the trend towards computer-based communication will make visual communication increasingly important in comparison to verbal communication channels. An online planning application can combine visual representation of spatial data with tools to discuss those representations.

1.4. Proposed Online Planning Model

This thesis will propose a Web-based client/server model to facilitate joint planning among multiple stakeholders. A planning information center (PIC) serves as a hub institution to provide planning support services. I will describe the main components of such an online planning model, which combines Web-based GIS and collaboration tools. The recommended "hybrid model" takes advantage of the proliferation of client computers for decentralized data management as well as powerful servers to provide access to an aggregated set of relevant data and to allow for cross-disciplinary analysis. The hybrid model's architecture is flexible and can grow with the number of users connected and their increasing technical capacity. The model and its components are discussed in more detail in chapter six.

Chapter 2: Context

In this chapter, I provide background information on planning in Germany. It is important to take account of a country's legal and institutional framework in designing better ways to use technology in planning. The overview focuses on the contemporary planning practice in the region south of Leipzig. In addition, I shed light on the current status of Internet use in Germany to assess the feasibility of implementing an online planning model.

Before talking about planning legislation and contemporary planning practice in Germany, it helps to consider how they are shaped by tradition. The evolution of planning processes must be viewed in the context of political, social, and economic characteristics of a country. First, planning discussions in Germany have been influenced by a strong anti-rational movement (Wegener, 1983). Rational planning had discredited itself by its insensibility towards human values and natural resources in the name of economic growth and technological progress. The strong anti-rational movement explains why the adoption of information technology such as GIS to support planning in Germany has been slow compared to its neighbors such as Great Britain and the Netherlands.

Second, the government has traditionally had a major role in planning. A large array of public agencies takes care of many aspects of public life. The German Basic Law explicitly mentions the government's responsibility to address and equalize regional differences in living standards.[10] For example, the financial equalization arrangements are aimed at equalizing differences in economic strength between states (article 107 Basic Law) and illustrate the social responsibility of government. The government's involved role has created an elaborate bureaucratic machinery that has grown resistant to changing relationships between the government and citizens. Also, property ownership is seen to have a "social obligation" in Germany.

[10] The German Basic Law is equivalent to a constitution. The reasons for calling the constitution Basic Law are historical. When the foundations for the Federal Republic of Germany were laid after the second World War, the term Basic Law was meant to indicate the provisional nature of the law, which was to be replaced by a "proper" constitution later.

The Basic Law states that ownership implies an obligation and that the use of property must be to the general good. This social obligation provides the legitimization for ordering expropriation where this is required in the public interest.

Third, local self-government, as an expression of civic freedom, has a long tradition in Germany. It can be traced back to the privileges of the free towns in the Middle Ages and the reforms of the Prussian minister Freiherr vom Stein, in particular the Local Government Code of 1808. The following sections illustrate how these traditions have influenced planning law and practice in Germany.

2.1. German Constitutional Background

The Federal Republic of Germany consists of sixteen Länder (states). German federalism, much as in the United States, balances the country's external unity with its internal diversity. The distribution of responsibilities between the Federation and the states is an essential element of the power-sharing arrangement as provided for in the Basic Law. The Federation's law-making powers fall into three different categories: exclusive (e.g., foreign affairs, defense, monetary matters), concurrent (e.g., uniform law for the whole country such as civil and criminal law, commercial law, nuclear energy) or framework legislation (e.g., higher education, nature conservation, landscape management, regional planning and water management). Each state has a constitution that must be consistent with the republican, democratic, and social principles embodied in the Basic Law, but the states have considerable freedom in filling in detailed laws and regulations.

The tradition of civic liberty is manifest in the self-government of towns, municipalities and counties expressly guaranteed by the Basic Law. Local councils have the right to regulate local affairs (such as local road construction, electricity, water and gas supply, sewerage and town planning) within the framework of the law. Local authorities finance their programs through their own taxes and levies, which include land and trade taxes, and charge fees for public services provided. They are also entitled to raise certain local taxes and receive a share of the nation's income tax as well as allocations under financial equalization arrangements. However, many projects are beyond the means of smaller towns and municipalities and can therefore be taken over by the next higher level of local self-government, the county (Kreis). Counties, too, are part of the system of local government through their own democratically elected representatives.

2.2. Planning Authorities in Germany

The distribution of planning authority in Germany reflects the decentralized federal structure. The Basic Law (Article 75, No. 4) grants federal authorities the right to specify a national planning framework, which found its expression in a 1965 "spatial order" law (*Bundesraumordnungsgesetz*), updated on 19 July 1989. This law comprises basic planning objectives such as protection and development of natural resources, the creation of comparable living conditions throughout the nation, a balanced relationship between built and natural areas, the adaptation of social and economic structures as well as the conservation and strengthening of environmental functions (Spitzer, 1995: 22). It also spells out a public information duty for government agencies. The executive planning competence lies with the state and local authorities, which fill the federal framework with details and adapt it to their respective circumstances by creating a number of increasingly detailed plans.

The following table lists the different levels, over which planning competence is distributed. It shows each responsible planning institution and respective plan created on the supranational to the local level.

Table 1: Planning Levels

Level	Institution	Plan
European Level	International Organizations (EU, EROMK etc.)	Recommendations, Guidelines
National Level	Federal Ministry (MKRO)	Federal Planning Framework
State Level	Highest State Planning Agency	State Development Plan
Regional Level	Regional Planning Agency	Regional Development Plan
Municipal Level	Local Magistrat,[11] Construction Agency etc.	Local Development Plan, Land-use/Construction Plan

Source: Spitzer, 1995: 26.

At the supranational level, national plans are coordinated between member states of international organizations such as the European Union. For example, the European Committee for Standards (*Comité Européen de Coordination des Normes-CEN*) created a new technical committee (TB 287) for geoinformation in 1992 (KGSt, 1994). At the national level, the federal Ministry for Regional Planning, Building, and Urban Development provides a planning framework, which is developed into detailed planning and development laws by a number of technical agencies at the state level.[12] Within states, regional plans are developed to adapt statewide plans to regional circumstances. The nucleus of planning authority is at the municipal level. Municipalities are to a large degree independent from state and federal authorities, which is underlined by their legal responsibility for urban land use planning as described in the Federal Building Code (*Bundesbaugesetzbuch*). Since federal and state guidelines have the effect of limiting the sovereignty of municipalities over planning matters, the Federal Regional Planning Act provides for participation by the municipalities in the framing of higher level plans. This cooperation between the planning levels is referred to as the "counter-current principle," which means that reciprocal coordination takes place vertically across levels as well as horizontally on respective

[11] German local magistrats are unique in that they combine legislative and executive functions in one entity.
[12] For more information on involved technical agencies, see Moll, 1985.

levels (Spitzer, 1995: 28). On the one hand, higher-level framework plans have to take local and regional contexts into account; on the other hand, local and regional plans have to concord with higher level plans.

My proposed model is aimed at supporting planning at the local and regional levels, where development plans are most frequently discussed and implemented. It is at these levels that potentially contentious decisions concerning land use, infrastructure, environmental protection, etc. are made. Therefore, involved stakeholders are likely to benefit from frequent coordination and cooperation. In terms of data access, the large-scale spatial data needed for detailed planning is usually captured at local or regional agencies. While the scope of this thesis is limited to a prototype application on a local or regional scale, the model is scaleable to be implemented at higher levels.

2.3. Description of German Land Use Planning Procedures

Planning processes in Germany take place within a framework of legal requirements concerning the sequence of steps to be taken and the coordination with affected parties. The main processes are covered in the "administration process law" (*Verwaltungsverfahrensgesetz*), the Federal Building Code (FBC), and state regulations (*Bauordnung der Länder, Landesplanungsgesetze,* etc.). Concerning agency coordination and public involvement, the requirements determine minimum criteria and differ slightly depending on the process. For example, the requirements for environmental impact assessments (EIA) are more extensive than for land use plans in terms of environmental aspects to be taken into account. However, all processes take place within a general framework and follow some basic steps, which are illustrated in figure 6 for a land use planning process as laid out in the Federal Building Code. The leftmost column gives examples of how an online planning tool can support innovative approaches to planning. The next column shows a sequence of typical steps taken by a planning agency responsible for developing plans. The FBC requires that any "public agencies" affected by the planning measure should be formally involved.[13] When environmental issues are involved, this column also includes environmental NGO. The right column represents all other interested parties, mainly special interest groups and the general public.

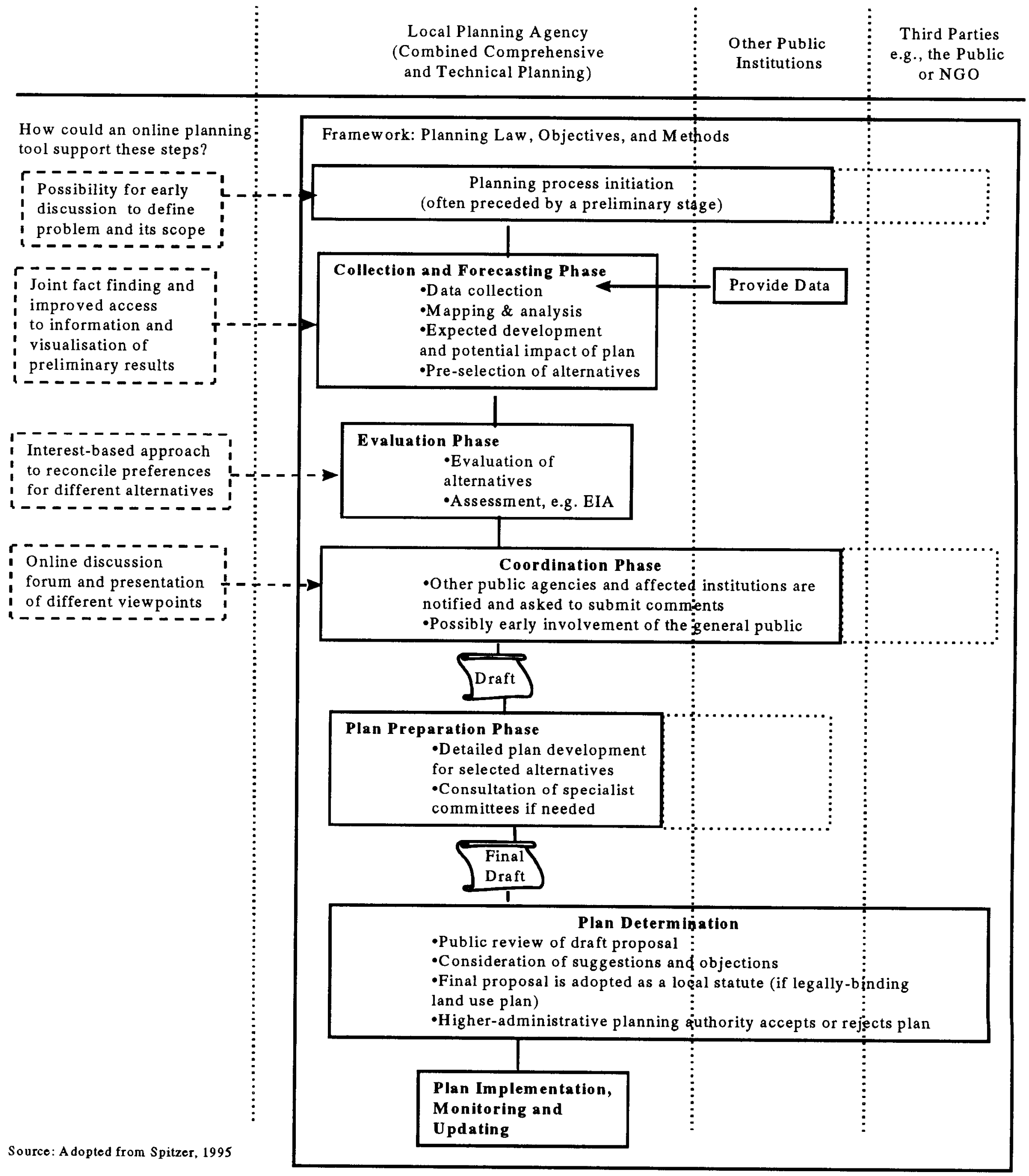

Figure 6: Basic land use planning steps in Germany

13 Public agencies include trade supervisory boards, the water authorities, the departments of nature conservation and the preservation of historic monuments, highways departments, the railways authorities, the post office, the armed forces, churches, chambers of trade and the various crafts chambers.

A land use planning procedure usually begins with a resolution to prepare a plan. This resolution is often preceded by a preliminary stage, in which initial ideas and interests are solicited from and discussed with interested parties, developers, and others who may be affected. During the early stages, historic and existing conditions of the planning area are assessed. The collection of relevant data provides a basis for analysis and forecasts of future trends. The evaluation of possible alternatives and their implementation feasibility results in an initial selection of alternatives. For certain plans such as facility siting, alternatives are further evaluated and quantified to assess their environmental and economic implications, for example by means of environmental impact assessments (EIA) and/or a "spatial order process" (*Raumordnungsverfahren*).[14]

In many cases it is necessary for the plan to be coordinated with other authorities affected by the planning measure. Coordination with other public agencies is prescribed at certain stages of the process, but is usually ongoing up to the final draft. The public agencies are notified of the planning measure and asked to submit comments. The preliminary comments are usually further discussed in planning committees, which often call on specialists and local representative bodies such as local councils to participate. Eventually, the responsible planning agency drafts the final plan featuring development recommendations, maps etc.

The plan becomes legally binding after an official "plan determination process" (*Planfestellungsverfahren*), in which detailed planning results are summarized and presented to the public. The general public is informed and the plan is unveiled for public display. Members of the public can make suggestions and objections, which have to be carefully considered by the authorities. There are specific timing prescriptions and how to publish plan materials. For example, the publication has to be announced one week ahead of time, the plan has to be made available to interested citizens for one month, and citizens can object in writing until two weeks

[14] The "spatial order process" is required for projects expected to have a significant impact on landscape structures.

after the publication period. Citizens' objections are discussed in a subsequent public meeting. Following acceptance by the municipality's representative body, the plan must be submitted to the state supervisory authority. Despite pending objections, which often end up in court, the decision to implement the plan can become official, triggering the implementation phase.

Many redevelopment planning measures are liable to impinge on the lives of the individual people living and working in the area affected. Yet public involvement often takes place at the end of planning processes when agencies have more or less defined plan objectives and means. The German EIA law (UVPG) and FBC tried to strengthen public involvement. For example, the FBC states that "during the preparation of land use plans public authorities and bodies acting as public agencies and which are affected by the planning proposal are to be involved in the planning process from the earliest point possible" (§ 4 BauGB). Furthermore, the FBC prescribes that "the public is to be involved at the earliest possible stage about the general aims and purposes of planning, ... the public is to be given suitable opportunity for comment and discussion" (§ 3 BauGB). It also demands that the plans be represented in an understandable way. Moreover, the FBC requires municipalities to formulate schemes for mitigating or preventing negative impacts caused by the planning measure (social plan) and to discuss these schemes with those affected.

While the importance of inter-agency collaboration and public involvement is widely recognized by planners, the laws define only minimum criteria to be met in these areas. The form of involvement is not specified. The only requirement is that other public institutions submit their comments about a preliminary plan in writing. My proposed model is aimed at supporting the collaboration among relevant public and private institutions from the earliest point possible, i.e., the preliminary and problem formulation stages. The integration of IT and consensus-building offers an innovative way to meet and go beyond the basic requirements. Instead of waiting for one lead agency to present a preliminary plan, which may already contribute to solidifying positions, and then to solicit comments from affected parties, the online planning tool encourages stakeholders to start collaboration earlier.

Once the Internet has gained more widespread acceptance among citizens, an online planning tool can be scaled to embrace a growing audience. The tool should lower the barriers to become informed and involved for interested parties. The use of maps as a communication vehicle can help to achieve the requirement to represent information in an understandable fashion. In fact, planning authorities have an important incentive to inform all affected parties and to consider their feedback carefully, because the latter can legally challenge plan implementation based on disregard of relevant aspects due to insufficient participation. In general, the public should be given the opportunity not simply to express their ideas and objections at designated times but rather to become more actively involved in discussions earlier in the process.

2.4. The Context in Saxony and the Leipziger Land

The Free State of Saxony is one of the five new "Länder" of the former German Democratic Republic. The state has 4.6 million inhabitants, of which 471,418 live in the state capital Leipzig (based on 31 December 1995 census data).

Figure 7: Map of Germany

Following unification in 1989, the state adapted to West German planning law by instituting a 1992 regional planning law (*Landesplanungsgesetz, SächsGVBl.S. 259*). This law defines the responsibilities of state planning, specifies several instruments such as planning cadasters, defines institutional structures, and divides the state into several regional planning entities. In addition, the state development plan (*Landesentwicklungsplan SächsGVBl.S. 1489*) of 16 August 1994 spells out long-term development objectives. It identifies central planning locations, point-axial development areas, urban growth boundaries, and areas that need special support to achieve comparable living standards across the state (Freistaat Sachsen, 1996). In addition, it contains development objectives such as a desired landscape structure, residential structures, the conservation of open space, and the adequate provision of goods and services.

The state development plan is further detailed in regional and technical plans. For planning purposes, Saxony is divided into five regions. Regional plans are prepared by the respective regional planning agencies, which are responsible for all municipalities and cities within their region. If a region contains mining sites, a special coal plan is prepared. All of these plans have a normative character, which means that their stated objectives have to be observed in major public planning initiatives. The regional planning agencies ensure that local development plans are in accordance with broader development plans. Of course it happens that local interests are in opposition to the goals of a regional planning agency. For example, one municipality in the region south of Leipzig wants to stimulate more recreation and tourism at a nearby lake that was created by flooding an old mining site [Interview #6, Bellmann]. Thus, large areas around the lake were designated as beaches in local plans. However, from the broader viewpoint of the regional planning agency, many of the designated areas are not suitable to be used as beaches. This is an example of an interest-based conflict that has not been adequately resolved through existing channels of communication and which would offer itself for a consensus-building approach.

The area south of Leipzig is located in the western Saxony planning region, which has 1.1 million inhabitants of which 61.7% live in cities with a population greater than 10,000 (Regionaler Planungsverband Westsachsen, 1996). It is one of Europe's most polluted industrial areas and faces many economic and environmental challenges. Economically, it is undergoing difficult structural adaptation processes. For example, the municipalities in this traditional mining region experienced the state's worst decline in population during the period from 1990 to 1995. During the same period, the number of jobs in western Saxony declined by about 20% (from 539,000 to 433,000). On the other hand, mining operations have irreversibly destroyed the pre-mining ecology of huge land areas. In western Saxony alone, more than 250 square kilometers were turned into open mining pits, displacing 70 villages and 24,000 inhabitants (Regionaler Planungsverband Westsachsen, 1996). After exploitation, many pits are polluted by phenols, phenol derivatives and polycyclic hydrocarbons created by various pyrolysis processes, which poison the groundwater, river sediments and the soil (UFZ: 20). Yet at the same time, some sites, which have been deserted for years, have become valuable habitats for rare and endangered species (Frotscher, 1996).

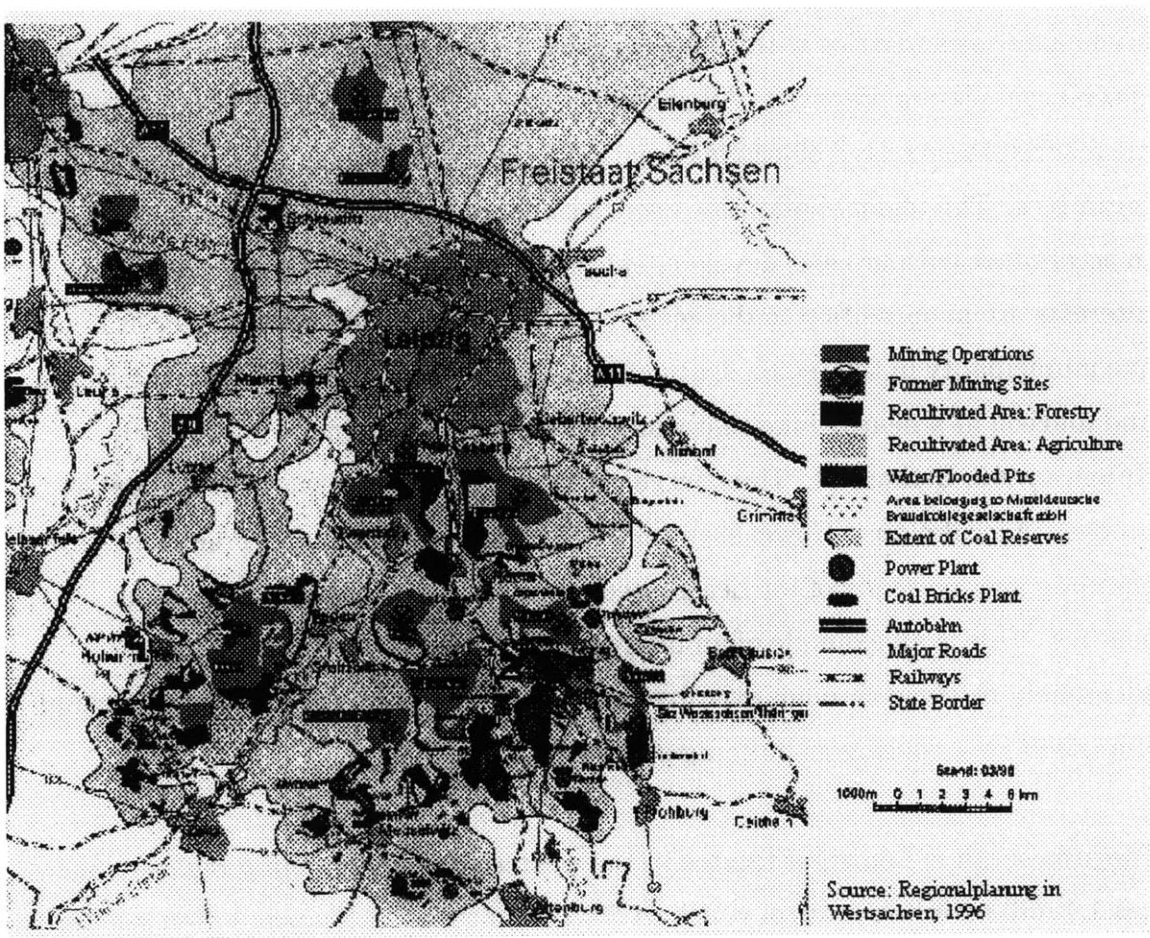

Figure 8: Coal mining sites south of Leipzig

Several research initiatives have looked at regeneration issues of these highly polluted ecosystems and the land's potential for sustainable use. Since large areas and their transportation infrastructure were devastated by the mining operations, unique opportunities exist to shape the future land use and landscape. On the one hand, there is a need for improvements in living conditions and environmental quality to reverse the population decline. On the other hand, economic development is needed to reverse the decline in jobs, for example by expanding transportation infrastructure and attracting new investments. Given the high priority placed on job creation in the region south of Leipzig, the challenge for planners lies in the long-term nature of the symbiosis between economic and environmental goals versus the short-term political priority of economic development (Grossmann et al., 1996). How to simultaneously enhance economic and environmental conditions? An underlying assumption to achieve this symbiosis is that the creation of "social and environmental capital" (i.e., attractive communities and landscapes) are important factors for encouraging economic development (Putnam, 1993). Near the city of Borna, a few communities have joined forces to stimulate local economic development. Borna, designated as a "middle center" in the state development plan, has taken the lead role to promote a commercial district and to take advantage of the opportunities offered by mining site redevelopment.[15] City officials have partnered with researchers at the Environmental Research Center (UFZ) in Leipzig to assess the opportunities for sustainable development and the impact of emerging information technology.

2.4.1. Institutional Framework

There are many stakeholders that ought to be involved in the redevelopment planning efforts in Borna or the region south of Leipzig in general. Figure 9 does not provide a complete overview of stakeholders (they should be identified through a conflict assessment), but it illustrates how an online planning model can interconnect some of the main stakeholders. In the Borna case, the municipalities engaged in the development of the commercial district play a crucial role. While the federal government owns the property rights to the mining sites, the municipalities have the executive planning authority within national and regional planning frameworks. Other relevant public institutions include the state government agencies in charge of municipal relations, the state environmental agency, other public institutions such as the water resources agency, and the regional planning

[15] The state development plan uses a point-axial system to classify cities as upper, middle, lower, or mini centers. "Middle centers" are usually cities of medium size with important goods and services provision functions for surrounding municipalities. The point-axial system also designates development corridors for public investment. Borna is located on such a regional development axis.

agency. In addition, institutions such as the land surveying and statistics agencies have an important role as source data providers. For example, the Federal Statistical Office (*Statistisches Bundesamt*) has developed a "statistical information system on land use" (STABIS). There are also a number of non-profit organizations such as national and local environmental groups, and special interest groups such as an association of displaced citizens. On the private sector side, planning consultants often work for municipalities or developers, for example to prepare local plans or conduct environmental impact assessments. The Lausitzer und Mitteldeutsche Bergbau-Verwaltungsgesellschaft mbH (LMBV) is the main company in charge of managing mining sites in the area. As described in the interconnected hub pattern in chapter one, an online planning tool can connect various stakeholders to a Web site as well as to each other.

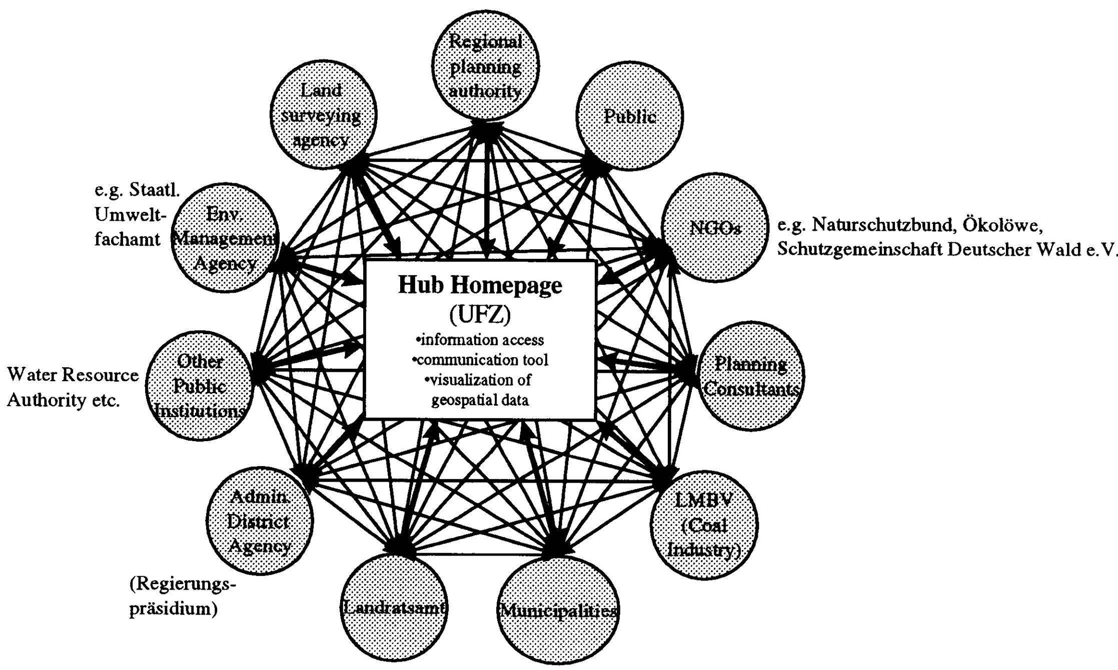

Figure 9: Examples of stakeholders connected to an online planning model

One important question in such a complex institutional context is who serves as the network's hub? The "hub institution" provides the technical infrastructure, acts as technical facilitator, and manages the planning information center (PIC). It ensures that agreed upon quality standards are met, provides technical assistance, and manages data provided by other institutions. Thus, the hub institution fulfills important roles, which it can only do effectively, if the stakeholders trust the people in charge. Neutrality is an important issue to be considered in selecting the hub institution. Obviously, the selection should be based on a consensual agreement among stakeholders and could consider the following alternatives:

- Developer solution: As the main promoter of development, the management organization of the commercial district could finance the technological equipment and skills needed to serve as hub institution.
- Outsource solution: An independent professional organization could be asked to establish and manage the hub center. Stakeholders could create a consensus fund to finance its establishment and operation.
- Government solution: A public institution in charge of planning could become the hub institution.

2.5. The Internet in Germany

Limited access to the Internet is a potential barrier to online communication. Recent Internet surveys show a strong growth in the number of Internet host servers worldwide and in Germany, which has the fifth largest number of servers in the world with 721,847 hosts (January 1997 Internet Survey, http://www.nw.com/zone/www/).

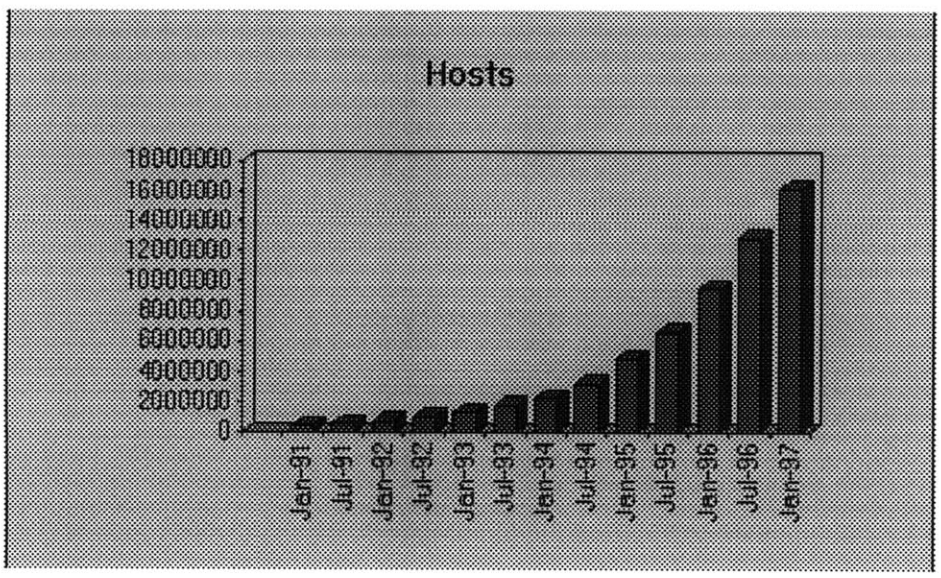

Figure 10: Number of Internet hosts worldwide (Source: http://www.nw.com/zone/www/)

The exponential growth of Internet infrastructure in Germany is encouraging for the feasibility of an online planning system. However, public access is still limited to about 12% of the population according to a 1997 Emnid poll (SPIEGEL special, 1997). The poll also showed that 76% of the population does not intend to install an Internet connection. Besides other factors such as anti-rational traditions, this aversion might in part be explained by the immaturity of the technology. A few years ago, surveys painted the same picture in the US, but public attitude has increasingly embraced the technology over time. Openness towards using computers is greatest among the younger generation (14% of the 18 - 24 year old are determined to buy a PC). The degree of connectivity of government and business entities is in general more advanced than that of individuals. This is another reason why it makes more sense to focus on how an online planning tool can support collaboration among professional stakeholders at this stage.

Chapter 3: Review of Information Technology in Recent Planning History

Environmental management and resource allocation decisions have become increasingly complex. One way to deal with the complexity has been to employ information systems to support planning. In this chapter, I provide an overview of the evolving role of IT in planning in recent decades. The observation that its most recent role has been evolving towards promoting interaction, communication, and dialogue beckons a closer look at the characteristics, including strengths and weaknesses, of computer-based communication. A critical assessment then discusses common barriers to using information technology in planning. I also look at the impact of computer-based communication on group work. Finally, I speculate on how IT can add value to the traditional decision-making cycle. This leads into a discussion of how to integrate consensus-building into early planning stages.

Klosterman (1995) has tracked the evolving use of IT in planning over the last decades. In the 1960s, Mannheim's (1960) vision of "planning as a scientific process" was prevalent. The applied science model assumed that: "(1) information is a value --and politically-- neutral resource; (2) more information is always better; and (3) the planner's most important role is to provide more and better information that can inform and improve the policy-making process" (Klosterman, 1995).

With the realization that planning is not value-free, this vision changed to "planning as politics" in the 1970s (Davidoff, 1962). Information technology was seen as inherently political, reinforcing existing structures of influence and increasing the power of technical experts. The ability to store and access information in a GIS opened the door for information abuse and misuse raising issues of data security and planners' responsibility (Aronoff, 1989: 269-277).

The "planning as politics" view was taken a step further in the 1980s, when more importance was placed on the way planners transmitted information than on the information itself. Planning was regarded as an inherently political and social process of interaction, communication, and social design. The following table provides an overview of this evolution over time.

Table 2: Planning and IT

Time Period	Primary Concern	Nature of Concern	Role of Information Technology
1960s	System Optimization	Planning as Applied Science	Support Value-neutral Process of Rational Planning
1970s	Politics of Planning	Planning as Politics	Information is Inherently Political Resource
1980s	Planning Discourse	Planning as Communication	Information Context is as Important as its Content
1990s	Collective Design	Planning as Reasoning Together	Promote Interaction, Communication, and Dialogue

Source: Klosterman, 1995

In the 1990s, the "planning as communication" view evolved into a more collaborative, interactive, and open process to reach informed consensus. Rationality is seen as being not only based on pure logic and the abstract evaluation of evidence, but also on an informed consensus formed by a community of individuals in a particular place and time (Healey, 1992: 150-152; Fischer, 1990: 217-263).

3.1. Characteristics of Computer-based Communication

IT has played an important role in planning over the past decades. Ideally, a comprehensive information system can integrate different data sources, improve the availability of environmental and socio-economic data, provide new perspectives on the information involved, and support sound decision-making based on reliable information. Besides using data for analysis and decision support purposes, the environmental impact of various policy or project alternatives needs to be explained to interested parties, politicians, and the general public. Networked computers have opened new communication channels among connected users.

Computer-supported communication is not a substitute for face-to-face meetings, but it offers opportunities to increase the speed of communication and the number of participants. The Internet is a powerful vehicle for global communication. Users can send and receive messages or data within seconds independent of time and location constraints. The Internet provides several communication media, which can be classified as synchronous (requiring users to communicate at the same time) and asynchronous (users communicate independent of time constraints). They can be further distinguished in terms of how many people can communicate with each other.

Table 3: Classification of Internet communication media

	Asynchonous	Synchronous
One to one	Electronic mail	Talks
One to many	Mailing lists	Online moderated discussions
Many to many	News groups, bulletin boards	Chat rooms, video conferences

Source: Gouveia, 1996

Most of the communication media in table 3 can support communication among multiple stakeholders within the framework of my proposed online planning model. For example, electronic mail is one of the Internet's most popular tools. It lets users exchange ideas spontaneously and casually, and avoids playing telephone tag by taking the time constraint out of communication. Messages get stored in electronic "mailboxes", so that users can receive and send messages at any time. Anyone with a computer account on the Internet can use e-mail to communicate with other users on the network. For example, this two-way exchange can help users to clarify the planning agency's intent as well as other stakeholders' interests and opinions. E-mail is also used to provide feedback opportunity (many-to-one communication). In the near future, e-mail incorporating graphics, sound, and video will become more widespread.

To make messages publicly available beyond mailing lists, a Web site can offer bulletin boards, where stakeholders post messages that will be accessible to others for commenting. Bulletin boards post messages in chronological order as they are received. The messages can also be grouped by topic. Individuals can post "does anybody know?" questions that tap into the collective wisdom of the online community (Sproull and Kiesler, 1991). However, e-mail and bulletin boards have limitations when users want immediate response and debate. If there is demand for more interactive discussion, a moderated online meeting time could be arranged. This would spare participants the cost and effort of travel, yet allow them to discuss a topic in a moderated environment. For example, such an online meeting could be helpful for question and answer sessions about topics of interest. Participants could question an invited expert, whose answers would be received by all connected participants. If some participants wanted to discuss a topic among each other, they could meet in an online chat room or organize a videoconference. Chat rooms allow users to meet other simultaneously present users in a virtual place.

Another characteristic of computer-based communication is its ability to engage several senses of the user. I will talk about visualization in more detail in the next chapter, but multimedia applications also represent a powerful communication medium. With multimedia, multiple representations of a problem enable the user to view information in different contexts (Rasmussen, 1986). Shiffer (1993) advocated the use of multiple representational aids, which planners –supported by a technically sophisticated mediator-- can employ to make complex information understandable to those who are less technically sophisticated. Multimedia has found its way to the WWW (Shiffer, 1995b). By applying the Web's hyperlinks to multimedia, the term "hypermedia" has emerged. In addition to associative text or "hypertext", hypermedia encompass images, sounds, and movies. Hypermedia structure information in an associative manner and allow an intuitive exploration of the information. For example, a user can select a linked word and thereby access other documents that contain additional information pertaining to that word. Hypermedia links can also include maps, which can effectively translate large and complex data sets into visual abstractions that can more easily be understood by a diverse audience.

A Web-based GIS application could combine the power of maps with some of the other online communication tools described above. An example of this would be a Web site that allows users to analyze the impact of an infrastructure project on surrounding areas through the use of several thematic map layers showing change in land use, demographic shifts, job creation etc. The maps can feature "hot spots" that bring up additional information about the location. Based on the impression they gained, users could engage in dialogue with other stakeholders to discuss aspects of the maps, for example by entering a chat room. Overall, the environmental impact of various alternatives can be illustrated more creatively and memorably.

3.1.1. Advantages and Weaknesses

The use of IT in planning brings with it advantages as well as weaknesses. Some of the advantages of computer-based communication, and particularly the WWW, include:

- Increased efficiency: speed of computer-based communication, geographic independence and convenience of timing (asynchronicity);
- Cost effectiveness: most users pay a monthly fee plus local phone call charges for worldwide communication access. The Internet helps to liberate them from the communication cost associated with distance;
- Power to change conventional patterns of who talks to who and who knows what;
- WWW provides infrastructure for building alliances and continuing relationships among stakeholders;
- Users have more time to reflect before responding than in face-to-face meetings, which offers an opportunity for thoughtful dialogue;
- Attention to content: computer-based communication eliminates potential distractions such as sex, age, race, and handicap biases (at the same time, the lack of nonverbal cues can be a disadvantage). The Web is capable to integrate text, graphics and other media;

- Platform independence of the WWW allows users with different computer platforms such as PCs, Macintoshes, or Unix workstations to browse its information;
- Software tools for the WWW support high-end application developing (by software developers) as well as low-end browsing (by the general public);
- WWW offers a user community a central point of access to potentially distributed resources;
- WWW is an evolving resource: information on a WWW server can be efficiently kept up-to-date.

Some of the major weaknesses of computer-based communication include:

- Issues of accessibility: in Germany, only approximately 12% of the population have access to the Internet. According to the December 1996 GVU Internet survey (http://www.cc.gatech.edu/gvu), access worldwide is biased towards well-educated, affluent, and predominantly male (e.g., ca. 70% of web users are male; in Europe the percentage is even higher at 80%);
- Black box effect: the procedures and models underlying analyses are usually unknown to the users. While some users reject computer-generated outcomes for this reason, others attribute a naïve credibility to them;
- Power imbalance: technologically sophisticated users have an advantage in using computers and are more inclined to do so.
- Users lack a sense of context in a cyberspace environment. In electronic exchanges, the usual social and contextual cues such as age, race, appearance, hierarchical position etc. are missing (Sproull and Kiesler, 1991). Also, it can be difficult to distinguish between formal and casual exchanges. This impacts users' level of comfort of communicating without face-to-face interaction;
- Similarly, it is difficult to gauge other parties' reactions to proposals and ideas. In face-to-face interaction, non-verbal cues are often helpful in gauging the spontaneous reaction to a statement.

3.2. Barriers to Using Information Technology

The use of IT --and particularly Internet-based systems-- in planning is constrained by peoples' unfamiliarity with technology, their access to the Internet, and institutional unwillingness to implement a Web-based system. The access issue has several dimensions. As Bonchek (1995) pointed out, while computer-based communication reduces some cost, it also raises other cost from the use of computers and networks. Stakeholders must possess computers, must know how to use them, and must pay for network connection fees. In addition, inequalities in computer-literacy and network access bias global network users towards young, male, well-educated, and affluent users (GVU Internet Survey, 1996). Less technically oriented people are excluded from planning processes. As has been seen in chapter two, access to the Internet in Germany is still fairly limited and high connection charges impose a barrier to more widespread use.

While the Web's hypermedia structure is supposed to allow users to explore information on their own, the freedom to choose one's own path can also lead users astray: they get lost in cyberspace. In addition, hypermedia can create compelling representations of reality. However, every abstraction of reality involves a value judgment by the producer and misrepresentation can be just as compelling. This can affect the credibility of information portrayed via an online planning model.

In the case of GIS, the availability of public and private data is an issue, because data owners often see it as a source of power and want to recuperate their collection cost. In Germany, public sensitivity to privacy issues restricts access to digital data (Wegener and Junius, 1991). Also, different standards between administration levels prevent similar data collected at different levels to be merged and create data transfer problems between heterogeneous information systems. Similarly, the fragmented responsibility for land surveying across several administrative levels limits access to coherent digital base maps in Germany.

3.3. Impact of Computer-based Communication on Group Work

Electronic interactions differ significantly from face-to-face exchanges. Computer networks have added unprecedented speed to communication and sharing of resources independent of geographic constraints. The increasing use of the Internet opens new channels for communication and information dissemination to government agencies, non-governmental organizations (NGOs), companies, and citizens. For example, the organizers of the United Nations Conference on Environment and Development (UNCED) used EcoNet as an official network to disseminate relevant information to NGOs (Gabriel, 1993). However, Gabriel concluded that the use of the technology to facilitate participation of NGO was not as successful as expected, because many NGO users were not familiar with the technology and were overwhelmed by the amount of information.

Boncheck (1995) studied the use of the Internet for political purposes. According to him, computer-based communication facilitates collective action by reducing group organization transaction costs. This reduction is due to speed, many-to-many communication, and relatively low cost associated with computer-based communication.

The opportunities brought about by computer networks have led Sproull and Kiesler (1991) to ask how communication through computers impacts working relationship between people in business organizations. Their research showed that electronic groups induced the participants to talk more frankly and more equally than participants did in traditional groups. Networked groups also generated more ideas and proposals for action. However, the increase in communication democracy slowed decision-making. Participants expressed extreme opinions and vented emotions more openly, which led to increased conflict in some groups. Another effect of computer-based communication was its attenuation of social and contextual cues such as status, hierarchical position, race, age, or appearance.

Critics of computer-based communication put forward the impersonal nature of electronic communication. Sproull and Kiesler's research showed that, paradoxically, such communication made people feel more comfortable. They are less shy and more playful in electronic discussions. Other perceived benefits included the low cost of responding in terms of time and effort. Participants also felt that sharing of information in an electronic community led to a richer information environment. Employees who used computer networks reported more commitment to their jobs and to their co-workers than did those who rarely used the network. These results are encouraging for the expected benefits of my collaborative online planning model.

3.2.1. Collaborative Planning Systems

The goal of collaborative planning systems (CPS) is to improve the communication of planning-related information and to make the outcomes of complex processes be better understood by the general public. The main assumption is that the consideration of a greater number of alternative scenarios will lead to better informed public debate. Michael Shiffer at the Massachusetts Institute of Technology developed a CPS for an area of Washington DC to explore the potential of hypermedia systems to facilitate group discussions. He also developed a CPS application for an airport in Rantoul, Illinois, using maps, aerial photos, images, videos, and sound to make the user more familiar with the area and the proposed project (Shiffer, 1995a). For example, instead of explaining abstract decibel levels of planes, his system can play back the actual sound an airplane would make depending on the plane type and the observer's distance from the runway. The powerful audio impression prevents users from engaging in a theoretical debate about noise impacts. Shiffer envisioned an "information expert" to operate the CPS during planning sessions. Such a collaborative system can support the recollection of the past, descriptions of the present, and speculation about the future.

Brenda Faber (1995) experimented with a collaborative GIS extension to a commercially available electronic meeting software package. Electronic meeting software is a type of group decision support system that supports electronic exchange between meeting participants. The GIS extension enhances such a system by introducing the ability to construct spatial scenarios. While participants discuss issues verbally, the computer tool serves as an input device to submit comments or votes. For example, such a system supports issue prioritization as well as criteria evaluation and electronic brainstorming, summarizes the input, and immediately displays results. Faber recommends that a collaborative GIS should feature the following functionality:

- a data import and export tool that translates various data formats;
- a geographic exploration tool that allows participants to explore data layers;
- a geographic proposal tool that allows participants to construct annotated data layers;
- a geographic prioritization tool that allows participants to rank the importance of characteristics;
- a database link that keeps track of decision rationale for changes made to data layers;
- a geographic negotiation tool that encourages interaction by displaying data layers on a whiteboard;
- a geographic modeling tool that supports scenario simulations.

Such an interactive and real time system can effectively serve as an occasional supplement to verbal debate in face-to-face meetings, but it is limited to a small number of participants who have to be physically present.

Based on his research, Shiffer (1992) concludes that increased access to relevant information can lead to greater communication among participants, which will ultimately have a positive effect on the quality of plans and decisions. However, many CPS have been platform-dependent stand-alone systems accessible only to a limited number of users. Aware of this, Shiffer (1995b) sees the WWW as a vehicle to overcome this shortcoming of stand-alone hypermedia systems. In many ways, my proposed online planning model builds on the CPS research and tries to implement its benefits on the WWW.

3.4. The Decision-making Cycle and How IT Adds Value

Decision-making follows a few basic steps starting with the definition of a problem and ending with feedback on the implemented solution strategy. Planners are involved all along by shaping problem formulation, anticipating needed negotiations, organizing the relevant facts to be used, calling attention to the political positions inherent in various alternatives, shaping processes of management and implementation, and surveying the effectiveness of decisions (Forester, 1993). Planners' influence on the process stems from uncertainty – decision-makers listen to analysts because they cannot attend to all the uncertainties themselves (Benveniste, 1989). Planners are managers of information and have a *gatekeeper* role that provides them with power.

Shiffer (1992) points out that the quality of plans and decisions is dependent upon the amount of relevant information used during the formulation of problems, the development and evaluation of alternatives, and the making of decisions. The following illustration shows how adding IT to support processes between decision-making steps can enlarge the traditional decision-making cycle. For example, GIS can be utilized to arrive at scientific analyses once a problem has been identified.

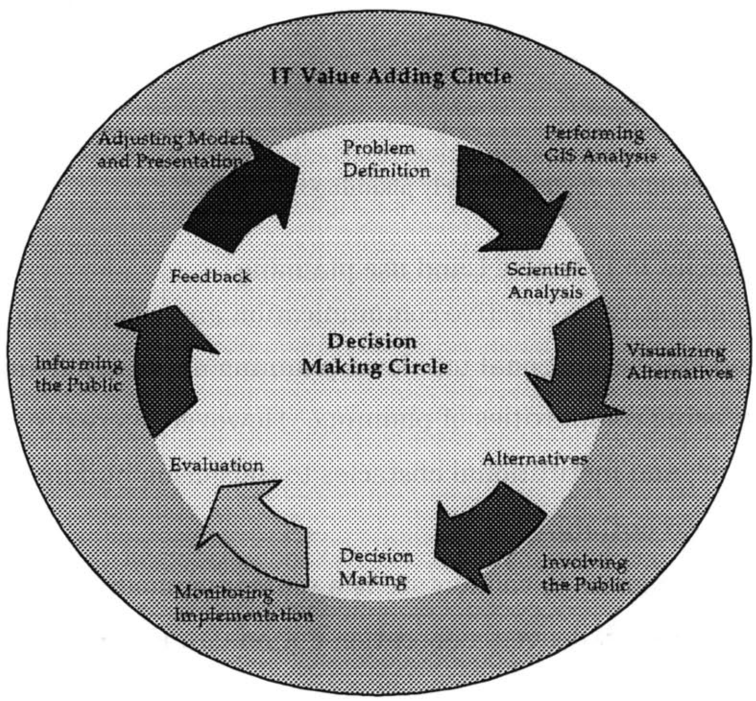

Figure 11: The decision-making cycle and how IT can add value to it

3.4.1. Where Does Consensus-building Come In?

The April 1995 issue of the Negotiation Journal focused on the impact of computers on negotiation and mediation and includes examples of how IT can support consensus-building by providing access to relevant information, facilitating dialogue, and focusing discussions on critical issues. During early planning stages, the focus is on collecting and analyzing data to produce evidence in support of alternatives. Experts from various disciplines and with various opinions perform most of this work. Targeting the early planning stages to build consensus among expert stakeholders can help to build a strong foundation for subsequent stages. The figure 12 illustrates how a consensus-building process fits in the early planning stages to arrive at mutually agreeable alternatives.

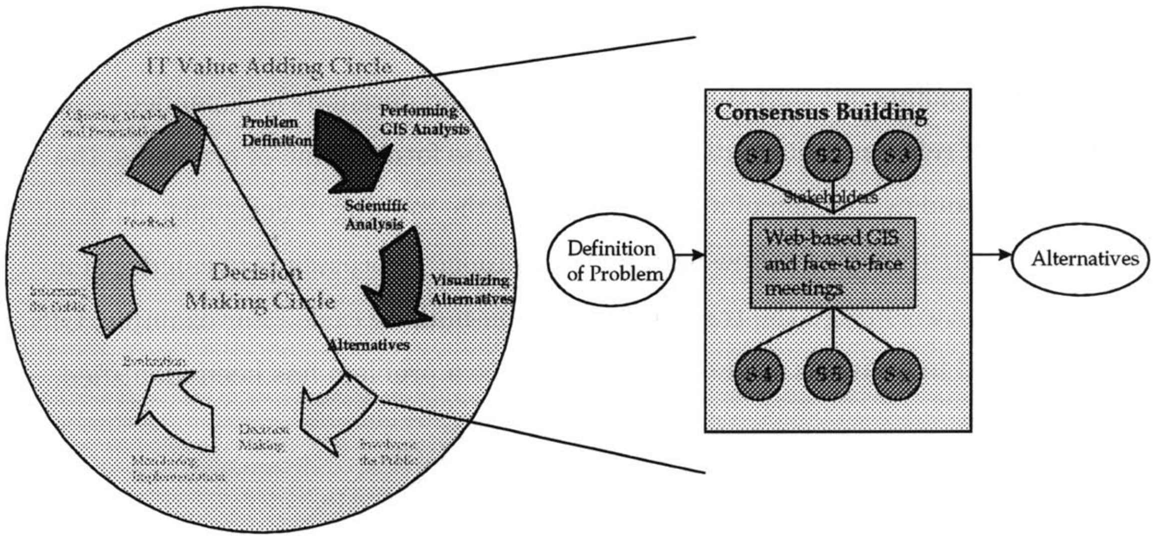

Figure 12: Consensus-building during the early planning stages

3.4.1.1. Key Obstacles to Effective Land use planning

A number of key obstacles to effective communication and collaboration among stakeholders render the traditional top-down planning approach ill suited to address the increasing complexities of planning. However, there are also social, scientific, economic, and institutional obstacles to consensus-building.

- **Unwillingness to collaborate**

  Stakeholders' willingness to collaborate is a scarce commodity. The German land use planning framework leaves cooperation optional during most of the process.

In addition, the geographic dispersion of stakeholders represents an obstacle to frequent meetings.

- **Degree of informedness**

  This obstacle has two dimensions: the lack of access to relevant information and the danger of information overload. The demand for information during planning processes depends on the degree of conflict associated with a plan. In the majority of cases, government officials lament that citizens do not show interest and do not take advantage of public information display. In the case of contentious issues however, stakeholders complain that there is insufficient information beyond the legally required materials. On the one hand, the notion of "information is power" leads potential providers to limit access to information in order to safeguard their influence. Some public agencies are reluctant to make their data publicly accessible, because they fear misuse and misinterpretation [Interview #5, Meiß]. But even if information is made available before the legally required publication of draft plans, it can be a challenge to locate it among distributed locations in manual file cabinets or on mainframe computer tapes.

  On the other hand, stakeholders can feel inundated by a flood of facts (often conflicting) and uncertainty about critical variables. In the case of complex planning processes such as the Transrapid magnetic train route between Hamburg and Berlin, the amount of information prepared for public displays makes it difficult for citizens to gain an understanding of the plans and their impacts. Furthermore, quantitative analyses expressed in bureaucratic terms further increase the communication gap that separates professional planners from the planned-for and thus limit planners' ability to learn from the public (Forester, 1989).

- **Scientific uncertainty**

  Scientific data rarely provides definite answers to justify one alternative over another due to scientific complexity and technical uncertainty. Stakeholders exploit this by using advocacy science to substantiate their arguments. A related issue is information loss due to "filtering" between different user levels. Even if adequate scientific information is collected at the top level, a lot of this information gets lost as it is filtered downward from researchers, to planners, to politicians, and to the public (Luz, 1996).

- **Win-or-lose attitude**

  Consensus-building is difficult if stakeholders perceive an issue as a zero-sum game. In that case, stakeholders emphasize differences and focus on their own needs with little room for compromise. Especially in land use issues, this attitude can quickly radicalize positions. Then the fight against a proposal instead of the attempt to modify it becomes the goal. Losers will exhaust all available means to delay implementation. Some planing conflicts in Germany are politicized, which can make compromise politically impossible.

- **Local versus regional interests**

  Planning processes with important impacts and multiple stakeholders have to overcome differences in goals, interests, values, cultures, and priorities. In the case of land use planning, this obstacle can be exacerbated by decentralized planning authority. While a piece of land might belong to the federal government, local authorities have the executive planning power. Plans with spatial impacts tend to provoke local governments to vehemently pursue their interests, which can be in conflict with state interests at a regional scale.

- **Communication breakdown**

  Luz and Opperman (1993) conducted an "autopsy" of unsuccessful plans in Germany and identified communication deficits as a frequent cause for failure. For example, plans were made without knowledge of interests or involvement of relevant stakeholders; communication between experts, and interested or affected parties suffered from lack of understanding; value-laden plans drowned in emotional debate. Institutionally distorted communication is a problem in Leipzig, because different public agencies compete rather than collaborate with each other.

- **Tradition of exclusion**

  Traditions of bureaucratic processes and interagency rivalry discourage officials to take the consensus-building risk. Government officials often view involvement of stakeholder as creating more problems than new solutions. They argue that the involvement of numerous self-interested groups delays progress. This view favors politicians to conceive public policy and experts to determine the appropriate means to implement it. An attempt to break this tradition of exclusion in Germany in the 1970s introduced public participation legislation (described in chapter two). However, there is a trend in German local government away from rational, comprehensive and long-range approaches towards incremental, discursive ones based on informal rather than on formal information (Junius et al., 1996). While the coming generation of civil servants is more open to public participation and environmental concerns, many citizens have been disappointed by formal participation procedures that informed citizens and gave them an opportunity to voice concerns, but did not accord them real influence.

- **Distrusted information sources**

  People do not trust information provided by parties that are perceived as biased. For example, if a scientific study financed by a nuclear power association shows minimal risks of a proposed new plant, the study is likely to be rejected by opponents on the grounds that the "correct" results were bought. Distrust in Germany is especially pronounced among citizen groups and environmental activists.

- **Unequal power distribution among stakeholders**

  Power inequalities are a major obstacle in consensus-building. Professional planners with statutory power might resist alternative dispute resolution approaches to rely on their perceived power advantage. One of the reasons for this resistance is that short-term protection of their "turf" is more important to stakeholders than long-term acceptance of plans. The identification of competing stakeholder interests in a consensus-building process is helpful in theory, but reaching a solution is also hindered by the stakeholders' protection of their power. Each party fears the others' exploitation, which prompts them to disguise their true priorities and interests. As a result of distorted information, what seems rational on an individual basis can lead to a socially irrational outcome.[16]

[16] Lax and Sebenius (1987) have called this phenomenon "negotiator's dilemma."

Important prerequisites for consensus are agreement on the data used in analyses, access to relevant information, and open communication. The acceptability of alternatives largely depends on the fairness and openness of the planning process. My online planning model is aimed at establishing constructive collaboration among professional stakeholders by involving them in consensus-building from the beginning of planning processes. Online consensus-building can supplement face-to-face meetings by providing an additional forum for stakeholder consultation and discussion, in which they can form new alliances prior to or after face-to-face meetings. In addition, the notion of "information is power" is most pronounced when some stakeholders have relatively greater access to information than others. If previously unknown information about a proposal's negative environmental impact is publicized, more opponents might be mobilized. An online planning system can attenuate information differences. In chapter six I discuss in more detail how an online planning model addresses the above obstacles to effective land use planning.

If the integration of IT and consensus-building is to add value, the online model has to fulfill several characteristics. For example, it has to provide multi-user access, so that all interested stakeholders can meet in the hub homepage's virtual discussion forum. The design of the Web site should be user-friendly to engage a diverse audience. The site should provide access to relevant information, include links to related information, and serve as a feedback tool. Based on her experience with several collaborative spatial decision-making sessions, Faber (1996) points out that the ability to interact with data provided participants with a greater sense of control of the process and seemed to strengthen their ownership of the negotiated results. In the context of a Web-based GIS, this means that the users should be able to interactively create and manipulate maps. A metadata (data about data) catalogue should be provided to help them find data that might be of interest to them. The source data itself should follow specified standards to avoid compatibility issues. The data access of the site should be fast, so that the users do not lose patience and stop using the system. These characteristics will be further discussed in chapter six.

Chapter 4: GIS and Consensus-building in Planning -- How Do They Work Together

Planning support systems have gained importance over the years and IT is also increasingly being applied to consensus-building.[17] Geographic information systems are an important component of what is generally called planning support systems (Harris, 1989; Klosterman, 1995). This chapter will look at how Web-based GIS can support consensus-building processes. First, I discuss the power of visualizing information on maps and their cognitive perception. Next, a basic review of the main functions of GIS illustrates their relevance for spatial planning. This is followed by an overview of the diffusion of GIS in German city agencies. Finally, I speculate on the impact of Web-based GIS applications on planning, which leads to the question of the benefits of integrating Web-based GIS and consensus-building.

4.1. Cognitive Perception of Maps

Cognition is defined as the action or process of acquiring knowledge. Knowledge can be acquired through reasoning, intuition, or through the senses. The old Chinese proverb that one picture is worth a thousand words illustrates maps' power as a medium of communication and knowledge acquisition. In his research on the visualization of quantitative data, Edward Tufte (1983) points out that graphics are the simplest and most powerful instruments for analyzing and communicating quantitative information. His principles of graphical excellence are met if complex ideas are communicated with clarity, precision, and efficiency. Maps can overcome difficulties of filtering information from huge data sources, and at the same time make the presented information more visually appealing and easily understandable.[18]

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[17] Richard Shell (1995) concludes that the technology is available to support online groups in exchanging and analyzing complex information on preferences and needs. William Samuelson discusses the relationship between computer-aided negotiations and economic analysis.

[18] Maps have three basic attributes:

- scale, which tells us how much smaller than reality a map is. The term scale refers generally to the level of detail with which information can be observed, represented, analyzed, and communicated. Since we can never observe the geographic world in complete detail, scale is necessarily an important property of all geographic information. Ratio scales in the form of 1:25,000 are common and relate one unit of distance on the map to a specific distance on the ground;

Maps reveal data. An early example of effective map use is Dr. John Snow's dot map showing the location of deaths from cholera in central London for September 1854. The map revealed that most cholera cases were located close to a certain water pump. A classic for representing several data dimensions on a map is Charles Joseph Minard's depiction of the fate of Napoleon's army in Russia. His combination of a data map and time series shows the losses suffered during Napoleon's Russian campaign in 1812-1813. The width of the band indicates the size of the army at different locations over time.

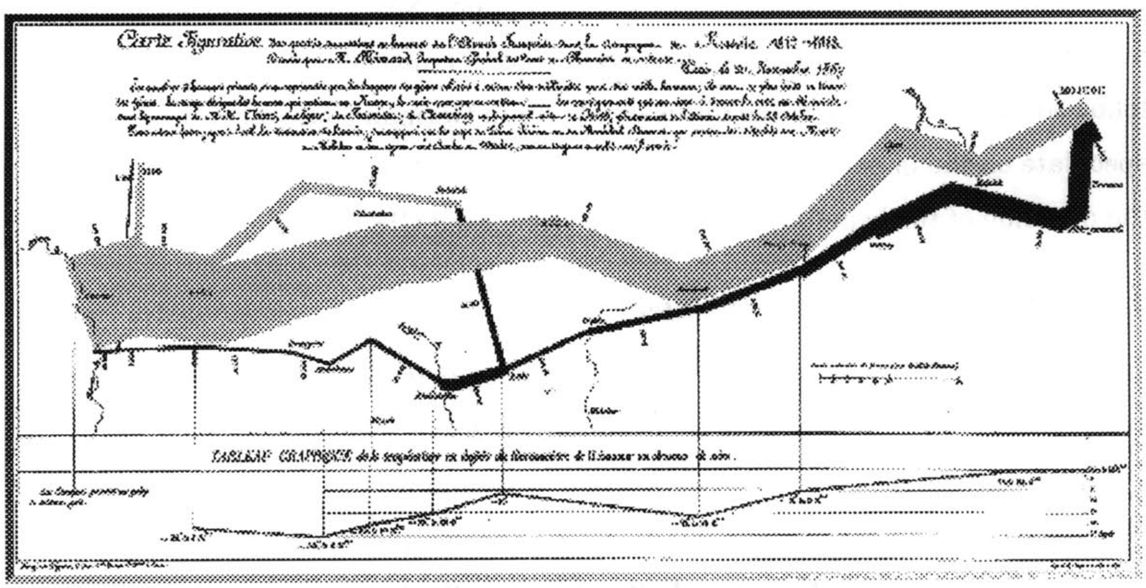

Figure 13: Minard's depiction of Napoleon's army losses during the Russian campaign 1812-1813 (Source: Tufte, 1983)

Maps seem to exert a fascination on people and are accorded respect and credibility, even if flawed. Maps connect a territory with its features. Maps can make both the past and future present by showing what was and what can be (Wood, 1992). The usual perception of maps is that they are a graphic representation of some aspect of

- projection, which transforms the three-dimensional surface of the planet into a two-dimensional plane. Any map projection is a compromise depending on whether the preservation of areas, angles, shapes, distances or directions is important for a given map;
- symbolization, which represents the features, places and other locational information. For example, shape, texture and hue are effective symbols for qualitative differences, e.g. land use, whereas size works better for variations in amount and grayscales are well-suited for portraying differences in intensity. Symbols of orientations are used for representing vectors such as wind or migration streams.

the world, of geographic reality. However, as Wood (1992) points out, every map has an author, a theme --and an interest. In his book *How to Lie With Maps*, Mark Monmonier (1996: 1) warns that maps are "authored collections of information and are subject to distortions arising from ignorance, greed, ideological blindness, or malice." Yet lay users often accept maps as given reality and fail to question their power as a tool of deliberate falsification or subtle propaganda. Monmonier is concerned about the impact of user-friendly mapping software that make map authorship too easy: "How many software users know that using area-shading symbols with magnitude data produces misleading maps? How many of these instant map makers are aware that size differences among areal units such as counties and census tracts can radically distort comparisons?"

A map producer inevitably has to filter out details irrelevant to the map's purpose or theme to promote content clarity. The filtering of information can be achieved through selection and classification. For example, the definition of class breaks to categorize income on a map can markedly effect the outcome. Therefore, generalized maps always reflect subjective judgments about the relative importance of features and details. This opens the door to flawed GIS analyses that nevertheless convince the reader by their scientific appearance. The design of a Web-based GIS has to address these issues. For example, quality standards can be implemented to screen information and maps before publication on the WWW. In a mediated online environment, it would be the responsibility of a technical mediator to advise stakeholders on how to avoid the pitfalls of mapping and to ensure the quality of map publications.

4.2. Functions of GIS in Planning

Local governments are increasingly required to operate with the efficiency of private business while facing more complex political and regulatory issues. They must digest an immense amount of information to perform their duties. A GIS provides a set of tools that can help government agencies to accomplish their diverse functions. A networked GIS allows data sharing among departments and facilitates the work of multidisciplinary project teams. For example, GIS can support the following applications:

- The planning of spatial development activities. For example, GIS are commonly used for modeling of land use and environmental conditions. Preparation and analysis of multiple "what if" scenarios are possible to ensure that the perspectives of the public and the developer are fully considered. In an online system, map layers can be linked with, for example, land use regulations using hypertext, so that the policies and regulations that govern development and use are instantly accessible. Linkages to similar case files, maps and documents can be readily accomplished in the same manner.
- Economic development programs. For example, GIS are commonly used to manage inventories of available sites and buildings suited for industrial and commercial development. Also, demographic characteristics of the community and labor force can be maintained as part of the economic development database. Economic development applications are often used to proactively market a locale to prospective companies interested in expansion or relocation of their facilities.

The main functions of GIS can be described as data capture, storage and manipulation, analysis, and presentation. Furthermore, GIS can be employed to identify conflict potential and thus help in the prevention and resolution of disputes.

4.2.1. Data Gathering and Manipulation

If no or insufficient data is available for a project, data sources need to be found or data captured, for example through scanning of raster data or digitizing of vector data. If data happens to be available, it is likely that data types required for a particular GIS project will need to be transformed or manipulated in some way to make them compatible. For example, geographic information is usually stored in different scales. There are many other examples of data manipulation that are routinely performed in GIS such as projection changes, data aggregation, and generalization.

My online model proposes that responsible agencies continue to collect and manipulate master data sets of the data relevant to them. A copy of the master data sets could be made available to other stakeholders at the PIC's hub homepage.

4.2.2. Data Analysis

A major strength of GIS systems is the analysis of geographic data.[19] Geographic analysis (also called spatial analysis or geoprocessing) uses geographic properties of features to look for patterns and trends and to undertake what-if scenarios. Modern GIS have many powerful analytical tools, for example:

- Network analysis: A network is a configuration of connections between nodes. Network operations include connectivity analysis, path finding, and flow analysis;
- Terrain analysis: Based on topographical elevations at point locations, degree and direction of slope can be calculated. This allows for determining paths of least resistance, watersheds and viewsheds (points visible from a given point);
- Location/Proximity analysis: Buffering is used to create areas containing locations within a given range of a set of features and to determine the proximity relationship between features. The integration of different data layers involves Boolean overlays such as union or intersection, which physically join one or more data layers.

It is important to recognize some of the limits of spatial analysis. Fotheringham and Rogerson (1993) point out eight general difficulties unique to handling spatial data. For example, spatial analyses are sensitive to variations in aggregation levels. Furthermore, geographical study areas are bounded but spatial processes are not. The boundaries are often defined where there are discontinuities in the underlying data, but they cannot represent the fuzzy reality found in natural environments. The arbitrariness of defining boundaries can also be illustrated by the fact that different people usually define spatial regions in different ways. Other issues include the occurrence of spatial autocorrelation when the value of an attribute at one location is influenced by the values of that attribute at other

[19] Geographic data encompasses any digital representation of natural or human-made spatial features.

locations (e.g., the price of a house is likely to be dependent on the prices of surrounding houses).

The proposed Web-based GIS would ideally enable users to perform the above analysis tasks online. They could take advantage of the GIS server's processing power to perform complex spatial analyses. As the technology evolves, this goal will become more feasible, but at the beginning only a subset of functions will be available over the Web. Sophisticated users with access to local GIS technology will want to overcome functional limitations of a Web-based GIS by downloading data sets to their local computers in order to perform more in-depth analyses.

4.2.3. Information Presentation

Urban and regional planning rely on maps to present spatial relationships of a plan's components. Maps are very effective at communicating geographic information and are helpful in conveying technical concepts to non-scientists.

Edward Tufte (1983, 1990) has paid particular attention to the theoretical issues underlying visualization and describes a number of successful and failed examples. One of the most popular map visualizations is the thematic map. Different regions are shaded with various patterns or colors, usually selected to convey some quantitative concept. For examples, the values of the metric being shown are divided into ranges, and a color or pattern is assigned to each range. Each polygon on the map is shaded based on its value for the metric. However, the primary disadvantage of thematic maps is that they emphasize regions according to their area, not just theme. In his book *The Visual Display of Quantitative Information*, Tufte (1983: pp. 69-70) cautions that careless use of areas to represent data with only a single dimension may lead to misleading maps.

Mark Monmonier (1996) describes many ways of how maps can be manipulated to serve a special purpose. While any two-dimensional map on paper or screen must distort reality, the hiding or selective view of critical information has become much easier with computer cartography. The use of color can be very effective but only if employed appropriately. For example, contrasting colors are not a good substitute for ordered graytones to symbolize increases in population density, because few people are familiar with how to organize colors into an ordered sequence.

Maps are an important communication vehicle of a collaborative Web-based GIS for spatial planning. They can present a wealth of data in an understandable format, represent stakeholders' perspectives on an issue, and focus discussion on spatial aspects of an issue. As discussed earlier, a Web-based GIS has to avoid the danger of visual misrepresentation.

4.2.4. Dispute Anticipation, Prevention, and Resolution

As an inherently selective view of reality, maps are often used in adversarial negotiations. The same data can be used to produce various maps showing many interpretations of reality. On the other hand, GIS technology has been successfully used to present information at public meetings, help to resolve territorial disputes, and site pylons in such a way as to minimize visual intrusion (Worboys, 1995). One of the strengths of GIS is that the information can be presented succinctly and clearly in the form of a map and an accompanying report. Because GIS products can be produced quickly, multiple scenarios can be evaluated efficiently and effectively.

My planning model seeks to strengthen planners' capacity to anticipate, prevent, and resolve disputes by integrating online consensus-building and GIS. This integration addresses weaknesses of traditional stand-alone GIS by adding opportunities for collaboration.

4.3. Geographic Data and GIS in Germany

This section looks at the use and proliferation of geographic information systems in German city agencies. In comparison to other European countries, the implementation of GIS in Germany has been slow. National institutional contexts are one explanation for differences in GIS diffusion, for example between Germany and the United Kingdom. While the United Kingdom has a central coordination body (Ordinance Survey), Germany's federal structure complicates coordination among different administrative levels and delays technological innovation (Wegener and Junius, 1993). Another explanation for slow diffusion is the importance of privacy issues in Germany.[20] Especially in many small municipalities most planning information is still maintained manually.

For historical reasons, surveying and mapping in Germany is highly decentralized. The collection and management of basic geometric data in Germany is the responsibility of federal, state, and local land surveying agencies (*Vermessungsämter*): (1) the federal Institute of Applied Geodesy (*Institut für Angewandte Geodäsie)* prepares 1:200,000 and 1:1,000,000 scale maps; (2) state surveying agencies produce the 1:5,000 German Base Map (*Deutsche Grundkarte)* as well as medium-scale topographical maps; and (3) local or county land surveying departments are in charge of 1:1,000 city maps. Land surveying, with its requirement for high geometrical accuracy, has a strong tradition in Germany. This tradition can be counterproductive in areas such as planning or environmental assessment, which are characterized by complex but poorly definable spatial phenomena.

Land information in Germany is maintained in two registers: (1) the land cadaster (*Liegenschaftskataster*), which contains information on physical characteristics of property such as size, land use, location, etc.; and (2) the land register (*Grundbuch*), which contains information on the ownership of properties and property rights. Since changes in one register affect the other, the two systems are linked by a numerical code. In 1971, the state land surveying agencies agreed to automate the two registers. The automated cadastral register (*Automatisiertes Liegenschaftsbuch, ALB*) was followed by the automated cadastral map (*Automatisierte Liegenschaftskarte, ALK*), which is a nationally standardized vector-based spatial information system for large-scale applications. Today, these two

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[20] The anti-terrorism campaign of the 1970s sensitized the German public to state privacy intrusion. Public mistrust delayed the 1980 census by seven years, and even then the census results were not published except in highly aggregate form and not made available to researchers.

systems are integrated in a land information system (LIS), which includes a complex set of procedures for generating and updating land information in a multi-user, multi-agency environment. However, implementation of the ALB/ALK systems in terms of base map digitization by municipalities has been slow. Also, the land use information in the cadastre is notoriously out of date and there is no guarantee for consistent updates of both systems (Junius et al., 1996).

A system similar to ALK was launched in the late 1980s as an initiative of several state surveying agencies. This official topographic-cartographic information system called ATKIS (*Amtliches topographisch-kartographisches Informationssystem*) was developed for small to medium scale applications (KGSt, 1994: 17).[21] In addition, the Association of German Cities (*Deutscher Städtetag*) has outlined an organizational structure for a municipal spatial information system (*Maßstabsorientierte einheitliche Raumbezugsbasis für kommunale Informationssysteme, MERKIS*) that regulates the provision, maintenance, and use of geographic data within local governments.[22] This framework defines a unique spatial reference system for all local government GIS, integrates topological and spatial object data, specifies that each geographic data base should be maintained by only one authority in each municipality, and makes the data available for cross-agency use.

4.3.1. Proliferation of GIS in German Municipalities

A recent study has investigated the extent to which GIS tools were employed by large to medium size European cities between 1992 - 1995 (Klamt, 1996). Representatives from 15 German cities included in the study were asked about existing, developing and planned GIS applications ranging from water resources network analysis to tax assessing applications. Only 25% of the total applications mentioned were in use, while the majority of applications was planned (50%). In

[21] For more information, see KGSt-Bericht Nr. 2/1991 "Vermessungs- und Kastasteramt, Einsatz von Informationstechnik", Ziffer 2.
[22] Deutscher Städtetag (Hrsg.): "Maßstabsorientierte Einheitliche Raumbezugsbasis für Kommunale Informations-Systeme (MERKIS)", DST-Beitraege zur Stadtentwicklung und zum Umweltschutz, Reihe E, Heft 15, Koeln 1988.

general, cities in Western Germany started to implement GIS applications earlier than cities in Eastern Germany.[23]

A similar study focused on the proliferation of GIS in German cities with more than 100,000 inhabitants (KGSt Report, 1994). 78 cities –unfortunately not Leipzig-- responded to the survey, which was often filled out by land surveying agencies. The results confirm the delay in GIS diffusion in local governments. Only 44 of the cities had a comprehensive GIS in 1994, but the number of implementations has increased rapidly since the mid 1980s. All cities presently without a GIS stated their intention to adopt GIS technology. Surprisingly, not the largest cities but those in the upper mid-range of the city sizes are the most active in adopting GIS technologies. In general, the proliferation of GIS was more advanced in larger cities. Geographic information systems were well established in the area of land surveying, but were in preliminary stages for planning applications.

In terms of computer hardware used to run GIS applications, there is a clear trend away from mainframes towards workstations and PCs. The relatively large proportion of mainframes in table 4 can be explained by the fact that the leading GIS software for land surveying (SICAD by Siemens-Nixdorf) only ran on mainframes. Promising for my proposed online model is the large (and increasing) percentage of networked multi-platform solutions.

Table 4: Hardware used by German cities for GIS by application area in1994

Application Area	Mainframe (in %)	Workstation (in %)	PC (in %)	Multi-platform (in %)	Multi-platform connected to a network (in %)
Land Surveying	16.2	26.5	2.9	17.7	36.8
Statistics	17.5	20.0	20.0	17.5	25.0
Utilities	23.0	20.7	16.1	21.8	18.4
Planning	13.3	34.0	20.2	10.6	21.8
Others	31.1	16.7	13.3	8.9	30.0
Total	19.2	26.0	15.6	14.0	25.2

Source: KGSt, 1994

[23] For example, Kassel (202,000 inhabitants) built its GIS in 1991-1992, while Chemnitz (286,000 inhabitants) undertook its GIS implementation between 1993 - 1994.

4.4. Impact of Web-based GIS on Spatial Planning

The emergence of GIS applications on the WWW is likely to significantly change the impact of GIS on planning. Planning is about how we perceive and learn about places and environments, which a Web-based GIS supports by improving the accessibility and dissemination of such information. Some authors have looked at how GIS and the Internet can empower community groups (Sawicki and Craig, 1996; Bonchek, 1995). In general, these technologies support the observed trend towards increased communication and dialogue in planning (Klosterman, 1995) and enable decision-makers to better assess the impact of development scenarios, policies, and regulations. Figure 14 illustrates a paradox of planning, characterized by two trends that move in opposing directions: as a planning process progresses in time and plans take shape, stakeholders tend to become increasingly interested, yet they can exert less and less influence on the process.

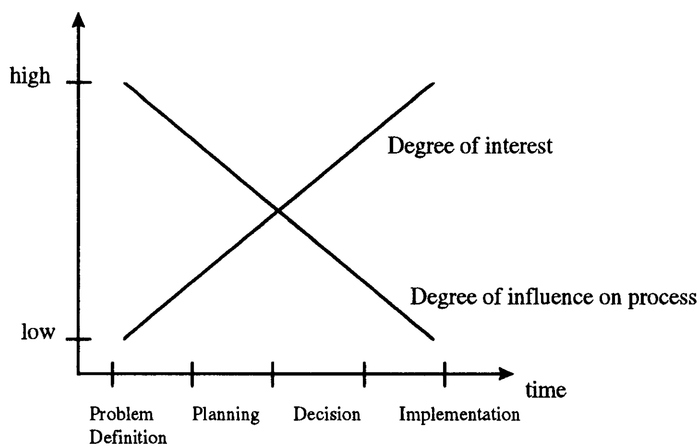

Figure 14: The planning paradox

An online planning tool has the potential to shift the two curves in figure 14. Especially the degree of influence curve could be shifted upwards and parts of both curves could be shifted into a more horizontal position. Besides opportunities for collaboration among professional stakeholders, a Web-based GIS tool offers new ways of public involvement.

4.4.1. Why Internet and GIS?

An online planning model provides information providers with a tool to make their information sources available to a wide variety of users. Changes and updates of traditional maps often do not reach all relevant parties in a timely and reliable manner. Thus, online access to GIS maps provides more up-to-date information.

The Internet and GIS have relative strengths that nicely complement each other. For example, GIS offer the capability to integrate and manipulate spatial data from a variety of sources. This capability can lead to increased efficiency, for example due to reduced duplication of effort (Grimshaw, 1988). By creating a shared database at a planning information center, one stakeholder can benefit from the work of another --data can be collected once and used many times. On the other hand, the Internet enables one to one and one to many communication, so that users can ask questions, receive feedback, present their perspectives, and discuss issues. In addition, simple Internet browser interfaces shield users from the complexities of data models, database languages, operating systems, and GIS. Yet the trade off is the Web browser's limited functionality. A Web-based GIS prototype is better at publication than at analysis of data.

An online planning model combines these relative strengths into one powerful system, which can facilitate the understanding of spatial information and promote coordination, cooperation, and new partnerships among stakeholders. For example, the exploration of maps (e.g., zooming) can improve users' understanding of spatial patterns and trends. The system can let users asks questions such as: Where is something located? Where is a certain condition or spatial relationships found? What if certain conditions were changed? Furthermore, the use of image maps provides the ability to define events specific to an area of a given map and to link attribute data associated with map features. This allows for the development of powerful hypermedia applications integrating graphs, pictures, video, and sound. The combination of these tools can help stakeholders to understand each other's concerns by airing political, economic, environmental, and emotional concerns in a moderated online setting in addition to mediated face-to-face meetings.

Another expected benefit of my proposed model is the achievement of higher information density in planning. An online planning model can enhance municipal capacity to respond to public requests and communicate with citizens. The use of common spatial data and the access to up-to-date information should make decision processes more transparent for interested parties. Finally, such a system is highly scalable, because anyone with Internet access can connect to it. The Web-based GIS itself can be centrally maintained and flexibly expanded to adjust to new and changing user demands.

4.5. The Benefits of Integrating Consensus-building and Web-based GIS

The integration of consensus-building with a Web-based GIS application has the potential to support spatial planning by enhancing communication and access to relevant and agreed upon information. The combination of the two technologies can create a powerful symbiosis, bringing together the analysis and visualization strengths of GIS with the access and communication strengths of the WWW. However, as pointed out by Susskind and Elliott (1983), an increase in information flow among stakeholders frequently sharpens conflicts between groups with competing interests. That is where consensus-building as a tool to manage such conflicts comes in.

During the early planning stages, initial GIS analysis might result in the creation of maps representing stakeholders' perspectives. Though inherently biased, these maps can serve as focal points for discussion of spatial issues. Since this kind of computer-supported analysis can backfire, for example by locking stakeholders into his or her view of an issue or by promoting positional bargaining, Michael Wheeler (1995) recommends that the technology should be visible and accessible to all parties. A Web-based system achieves this and enables stakeholders to criticize the presented interpretations and to present alternative interpretations on the system's hub homepage. Consensus-building can be used to get stakeholders to agree about what information should be made available in the first place. This removes one source of conflict early on in the process and focuses disagreement on interpretations rather than on the underlying data. Again, online communication about the spatial issues is not designed to completely replace face-to-face meetings but rather to supplement ongoing consensus-building efforts with additional and powerful communication channels.

The proposed online planning model recognizes that not all information is equal: there are certain and uncertain facts, which lead to interpretations based on different judgments, priorities, and values. Besides some certain facts, all other information is prone to be disputed. A similar duality exits in GIS: the two fundamental ways of seeing the earth are as entities and phenomena. On the one hand, entities are discreet, identifiable units that have well-defined boundaries and unambiguous descriptions such as buildings, water bodies, and property parcels. Spatial entities are represented by features on maps. On the other hand, phenomena such as air pollution can vary over space and time and their description is only meaningful at a particular point. Spatial phenomena are represented by coverages. These relationships are illustrated in the following figure.

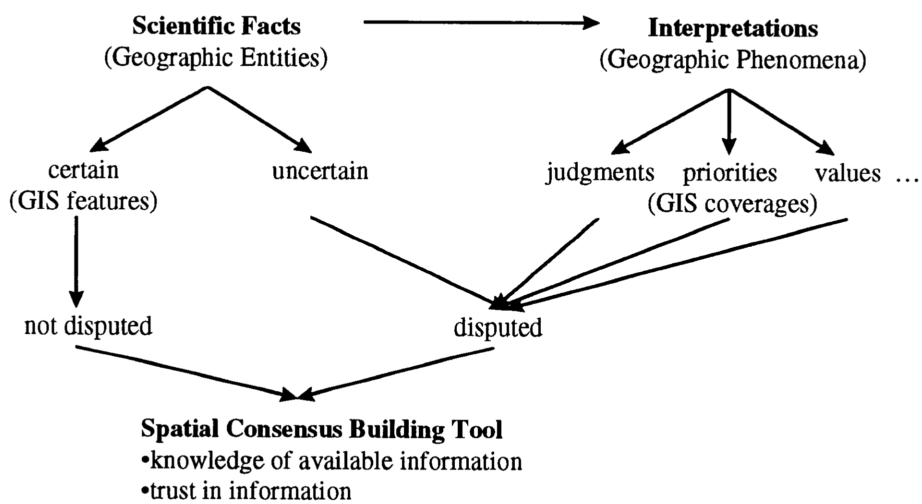

Figure 15: The duality of information in consensus-building (and GIS)

An online spatial consensus-building tool can help to clarify the nature of available information, so that stakeholders know what data and information is accepted by other stakeholders. This knowledge builds trust in the information, which is an important step towards overcoming differences. However, a remaining issue is how to represent data of varying exactness and degrees of reliability, and how to handle the fuzziness and imprecision that is inherent in digital geographic data. This becomes particularly important when multiple layers of data from varying sources are combined.

The Harvard Negotiation Project developed the concept of *principled negotiation,* which aims at replacing traditional bargaining over rigid positions, where the focus is on power, with problem-solving negotiation, where the focus is on creatively reconciling interests. Fisher and Ury (1981), have outlined four characteristics of principled negotiations, which can be adopted to spatial issues.

Table 5: Negotiation of spatial issues

	Mutual Gains Approach	As adopted to spatial issues
People	Separate the people from the problem (attack the problem, not each other)	Separate the people through the online planning tool (attack the problem via the maps)
Interests	Focus on interests, not positions	Focus on maps to represent interests
Options	Generate a variety of alternatives	Simulate what-if scenarios on maps
Criteria	Base the result on some objective standard	Base the result on evaluation of impacts

Source: Adopted from Lemberg, 1996

The integration of consensus-building and Web-based GIS can lead to resolutions of spatial issues that fulfill Susskind and Cruikshank's (1987) four criteria of successful outcomes:

- fair, because perceived fairness depends on participation and relevant stakeholders were given more opportunities for input, discussion, and access to information than in traditional processes;
- efficient, because a Web-based GIS helps to create a climate of trust and problem solving, which pays off in the long term;
- stable, because the outcome is based on common and agreed upon information and stakeholders are likely to "own" the agreement and hence support its implementation;
- wise, because the multitude of perspectives generated along the process is likely to have considered many relevant facets of an issue.

One characteristic of consensus-building is the presence of a mediator. In an online environment, a technical mediator/facilitator can help to bring relevant issues into the discussion, help stakeholders to explore alternatives, support them in presenting their viewpoint, and ensure the quality of the information published on the Web. The facilitator can also help stakeholders to organize themselves and to take advantage of technology, for example to effectively present their perspective. Once an online spatial consensus-building system is put in place, it becomes easier to deal with future conflicts more effectively.

Specific examples of how a Web-based GIS application can support spatial consensus-building are given in chapter six.

Chapter 5: Past to Present -- Implementation Examples

In this chapter I discuss examples of how GIS and Internet technology have been implemented in different institutional settings. The first part of the chapter analyzes an established multi-agency GIS service in Massachusetts. I also provide short overviews of attempts to integrate emerging information technologies into institutions and planning. The overviews describe an innovative planning process in the German town of Visselhövede, the emergence of environmental information systems in Germany, an example of a Web-based mapping system as well as initiatives to promote the diffusion of GIS technology in the United States.

5.1. Analysis of an Institutional Example: MassGIS, Boston

MassGIS is an interdepartmental state agency that provides GIS services to several government and private parties in Massachusetts. It was one of the early statewide GIS efforts and was recognized as one of the leading initiatives in the United States. First, I describe aspects of the Massachusetts planning context and briefly review MassGIS' short history. Then I discuss the institutional and technological framework of MassGIS' operations. Finally, I evaluate the impact that MassGIS has had on planning in Massachusetts. The objective of the analysis is to derive lessons for an implementation strategy in the Leipzig case from the experiences of institutionalizing a GIS in Massachusetts.

5.1.1. Planning Context in Massachusetts

The provision of public services in Massachusetts is divided among state agencies, county and regional bodies, and municipalities. This highly decentralized structure of local government in Massachusetts is similar to the structure in Germany, where the power of state and regional agencies is also constrained in favor of municipalities. Another similarity between Saxony and Massachusetts is that federal and state authorities own much of the land, yet the land use control lies at the local level. In Massachusetts, there are 351 municipalities, of which 39 are cities, with a population ranging from 534,283 people in Boston to less than a hundred in Gosnold (refer to Appendix A to see a map of cities and towns in Massachusetts).

5.1.2. Brief History of MassGIS

In the early 1970s, the Land Records Commission was established to recommend actions to modernize land records and related technology use in Massachusetts (Warnecke, 1992). However, it was not until 1985 that the Executive Office of Environmental Affairs (EOEA) and the Water Resources Division (WRD) signed a cooperative agreement to begin GIS activities for the state.[24]

The EOEA originally justified investment in a GIS with the need for producing scientific evidence to locate sites for a hazardous waste treatment facility. In 1986, a report investigated the feasibility of implementing a GIS in Massachusetts.[25] Originally, twelve data layers most important for conducting site suitability assessment were identified (hydrography, public water supply, flood plain, wetlands, surficial geology, public open space, aquifers, transportation networks, land use, drainage basins, zone II aquifers, soils), which were digitized based on USGS quadsheets. A 1988 report by the Massachusetts Senate's Special Committee on Long-Range Policy Planning gave the efforts a boost when it recommended to strengthen vertical and horizontal information links between state governments and municipalities. The Committee saw GIS as a strategic tool for planning at the state, regional, and local levels.

Over the years, EOEA has taken a lead role in promoting the use of GIS in Massachusetts. In early 1990, the agency created the Massachusetts Geographic

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[24] The EOEA is a cabinet level office responsible for the coordination of five environmental and natural resource departments:

- the Department of Environmental Management (DEM);
- the Department of Environmental Protection (DEP);
- the Department of Environmental Management (DEM);
- the Department of Fisheries, Wildlife, and Environmental Law Enforcement (DFWELE);
- the Department of Food and Agriculture (DFA);
- the Metropolitan District Commission (MDC).

[25] "Data Assessment for Land Suitability Analysis" prepared by M.L. Sena for the Hazardous Waste Facility Site Safety Council, 1986

Information Council (MGIC) to coordinate GIS related activities undertaken by state agencies, regional planning associations, municipalities, academia, and the private sector. The MGIC promotes interagency collaboration and the use of digital geographic data of the physical, social, and economic environment of Massachusetts. MGIC also provides a forum for the formulation of standards and technical assistance.

5.1.3. Institutional Framework and Issues

The main users of the MassGIS services are state agencies, regional planning agencies, municipalities, and the private sector. Agencies within EOEA have free and unrestricted access to MassGIS data resources. There are about 40 specially trained GIS personnel in EOEA agencies [Interview #5, Jacqz]. The provision of data to parties outside of EOEA is generally fee-based. For example, the Office of Real Estate Redevelopment pays for MassGIS data to support its analysis and decision-making regarding the acquisition, use, and disposition of state property and buildings. MassGIS also cooperates with a variety of other state and regional planning agencies (RPAs). The main responsibility of RPAs is the provision of technical assistance to their member municipalities. According to Michael Terner, Vice-President of Applied Geographics and founding MassGIS staff member, whose company provides GIS services to many local governments in Massachusetts, only about 50 municipalities currently use GIS technologies [Interview #3]. One obstacle to closer cooperation between state and local levels is their different scale requirements. As MassGIS moves towards detailing existing data layers, its director anticipates closer cooperation with municipalities [Interview #5, Jacqz]. His strategy is to provide monetary incentives to the municipalities for building local GIS capacity in return for closer cooperation and adoption of statewide standards.

MassGIS has grown from two to 12 staff members, who perform five primary functions:

- Management of system software;
- Maintenance of core database;

- Delivery of GIS services (for example, MassGIS prepares about 8000 maps/year for other agencies and 5000 maps/year for outside users such as engineering firms) [Interview #5, Jacqz];
- Provision of training, project evaluation and technical assistance to users;
- Data distribution to other agencies and the private sector on a cost recovery basis.

An interdepartmental model such as MassGIS has to overcome many barriers to successfully integrate formerly isolated spatial data. Besides technical problems such as different data standards, many agencies are reluctant to transfer control of their data to a centralized body. Hence, a major early implementation issue was the agencies' tendency to protect the scope of their activity and the associated data. According to David Weaver, one of the MassGIS founders, a similar issue was agencies' unwillingness to cooperate [Interview #4]. The theoretical advantage of sharing data may not be shared by agencies fearing to lose independence and power. As a result, MassGIS had to overcome suspicion and concern about the implications of GIS adoption. The MassGIS team adopted a strategy of developing prototype applications to show results within the first six months of operation. The display of prototype maps increased MassGIS' visibility and helped to convince other agencies to cooperate. The unwillingness to cooperate was exacerbated by historical mistrust of local communities about attempts to centralize information and therefore power at the state level. Despite many successes in convincing agencies to cooperate with MassGIS, the integration of GIS services to support planning activities is still limited. Joan Gardner, who headed the Hazardous Waste Siting Facilities Council in 1986, sees the lack of institutional backing as one of MassGIS' main issues today [Interview #2].

5.1.4. Technological Framework and Issues

Initially, three system management alternatives were considered for setting up the GIS service: (1) purchase consulting and system time externally, (2) lease or purchase equipment to be placed within some or all user agencies, and (3) established a centralized computer system. The tradeoff associated with each alternative was between accessibility and level of service. The final decision was in favor of a centralized system operated by EOEA's data center. Since 1989, EOEA has operated the Environmental Systems Research Institute's (ESRI) Arc/Info software on a VAX 6000-440 mainframe computer. The MassGIS database includes statewide data layers of key environmental information at a 1:25,000 scale and is currently over 1.8 gigabytes in size. The data center is connected with other EOEA offices by a wide area network (WAN), so that EOEA users can access the system running terminal emulation software on their personnel computers. However, the network suffered from performance issues, so that MassGIS has distributed its data on magnetic tape and currently on CD-ROM. MassGIS director Christian Jacqz frequently hears private sector complaints about insufficient access to government data [Interview #5].

The MassGIS experience suggests that the issues encountered change the implementation life cycle. Initial problems centered on basic technical issues such as system compatibility. Once the system was operational, data-related issues such s lack of consistency came to the forefront. Some organizational issues such as data ownership and control are still not resolved [Interview #3, Terner].

5.1.5. Impact of MassGIS on Planning in Massachusetts

Depending on who you talk to, MassGIS has had more or less discernible influence on the decision-making process in Massachusetts. According to its director, the establishment of MassGIS has led to an increased use of information in policy development [Interview #5, Jacqz]. It has also changed expectations of the extent and quality of available baseline data. A notable impact of GIS has been in terms of visualization of spatial relationships. For example, when legislation was proposed to create protected areas around water supplies in Massachusetts, GIS analysts produced maps that provided a visual forecast of what the development impact on land use would be. The forecasts were instrumental in passing the legislation.

Plotted GIS maps have also been important tools used in public meetings. The flexible production of maps is a major benefit of GIS and provides considerable savings to EOEA. In general, geographic data in Massachusetts are utilized in many typical planning applications such as site review, the dissemination of information regarding regulated areas, analysis of land acquisitions, historic zone protection, or land use planning. It supports the identification of problems and evaluation of alternatives. For example, the Department of Environmental Protection commissioned a GIS-based watershed tool kit to model impacts of actions in order to support its decision-making.

Planners frequently need a variety of information during the early planning stages. Getting this information from distributed sources can be an important obstacle to data collection. In this respect, MassGIS' central data repository offers users comparatively easy access to relevant data. The MassGIS implementation highlighted how much information planners and other users did not have, for example to effectively support implementation of the Wetlands Protection Act [Interview #3, Terner]. Over the years, MassGIS has built up valuable data resources and this effort increasingly pays back as the system becomes more versatile. A major challenge for MassGIS is to ensure that the available geographic data is utilized in decision-making processes. One hope of the MassGIS founders was to use GIS as an economic development information utility to assist communities in attracting business and to assist the private sector in locating new sites, but there is little evidence that this has happened so far [Interview #2, Gardner].

A founding MassGIS staff argues that the availability of GIS and a central data repository at the state level has made analysis for decision-making easier than before [Interview #3, Terner]. For example, GIS has become an important tool for the Department of Environmental Management, which has a program for areas of critical environmental concern. This program utilizes GIS to identify potential areas of concern and to evaluate which ones to protect. On the other hand, the use of GIS as a tool to support planning and build consensus inherently has the potential to increase conflict as stakeholders generate a greater number of proposals or interpretations of a proposal. At the same time, the capability of quick iterations of alternatives and evaluation of different scenarios to assess their impact can help to speed up the process of reaching a solution. In addition, Terner notes that a GIS does not necessarily point out the best solution, but it can effectively prove a proposal to be a bad idea [Interview #3]. For example, one state agency once proposed to regulate that no landfill can be placed within a one-mile buffer of town boundaries. While it intuitively makes sense to protect the interests of neighboring towns, a GIS analysis demonstrated that such a restriction would practically eliminate any possibility to build new landfills in Massachusetts.

Ms. Gardner sees standardization, data availability, and cost efficiency as the main benefits of MassGIS, but its effectiveness still suffers from several weaknesses such as its weak institutional position [Interview #2]. For example, there has been limited success to build up GIS expertise in other agencies, which can be partly attributed to the insufficient availability of GIS services over the network. While MassGIS' impact has improved at the state level, cooperation between state and local agencies is still very limited, yet the majority of planning decisions are made by local government.

5.2. Other Examples of IT Implementations

I now broaden the overview of IT implementations to other examples that have made use of GIS and Internet technologies.

Campbell (1992) investigated the implementation of GIS in Massachusetts and Vermont in order to derive lessons for the United Kingdom. In her interviews, she pursued questions such as what the main types of problems faced by GIS-user agencies in New England were, or to what extent these agencies were implementing GIS as an intergovernmental resource. For example, the need to cope with development pressure led to the 1988 Growth Management Act in Vermont. The law recommended the development of an intergovernmental GIS to facilitate data sharing between all levels of government with the expectation that such an initiative would enhance coordination of planning throughout the state. As a result, an Office of Geographic Information Services (OGIS) with powers to establish data standards and develop procedures for data collection and sharing was formed. Asked about their experiences with GIS, representatives from both states agreed that the main advantage to be gained from GIS adoption lies in enhanced information-handling capabilities. In case of advantages for environmental planning applications, improved decision-making was ranked second and cost savings third.

As recent developments in information systems technology have significantly enhanced the capabilities and usability of GIS, technological weaknesses become less important whereas institutional considerations of GIS implementations gain increasing importance (Huxhold, 1990; Innes and Simpson, 1993). Only if the users adopt the technology will they utilize it to its potential. Hence, computer technology should be seen within a broader human and institutional context as a comprehensive package which includes not only hard- and software, but personal skills and operational practices.

The most dramatic information technology developments have occurred around the Internet. In January 1997, a major international consulting company announced to use Netscape Communicator to meet company-wide knowledge management needs and to increase internal collaboration as part of an enhanced knowledge-sharing environment. The company plans to take advantage of the Internet's potential to let project team members work on shared documents, extend discussions to clients, send and receive Web-based mail messages, hold cyber town hall meetings, engage in chat sessions, and access information in company databases. (Netscape, 1997: http://home.netscape.com/newsref/pr/newsrelease325.html). This example of a planned implementation illustrates Web-applications' potential for facilitating communication and collaboration among a large number of people across geographic and organizational boundaries. While companies are generally at the forefront of embracing Internet technology, many cities and towns are taking initiatives to assess how to handle the advantage and challenges of emerging information technologies.

5.2.1. The City of Visselhövede

Visselhövede is a small city of 10,000 inhabitants in Northern Germany, located between Hamburg and Hanover. This predominantly rural region faces economic challenges as traditional manufacturing companies are leaving along with workers and know-how. In an attempt to assess the chances and challenges of emerging information technologies for new forms of living and working, the city worked with a research group at the Umweltforschungszentrum (UFZ) Leipzig-Halle, GmbH. The objective was to develop a new land use plan that takes information infrastructure into consideration and strives for an ecological redevelopment of the regional landscape (Meiß et al., 1996). The project consortium chose a cooperative approach, which involved citizens, politicians, and experts in different focus groups. After initial skepticism towards new technologies, the focus groups generated many ideas. For example, citizens requested to take advantage of information technologies to make municipal processes more transparent and to improve municipal services. One product of the project has been the establishment of a city Web site on the WWW (http://www.visselhoevede.de). The project encouraged citizens to make use of online information resources, and the number of ISDN and Web-service connections increased significantly as a result.

The experiences and results of this project are relevant for the region south of Leipzig, which faces more severe economic challenges. In both cases, the researchers at the UFZ hope that the opportunities of Internet connections can help to overcome the economic disadvantage of rural isolation (Meiß et al, 1996). For example, emerging technologies offer new job opportunities (e.g., telecommuting) as proximity to central business districts becomes less important for business transactions: "Real time beats real space". However, this is a global development that increases competition for investments and jobs among many locations. The researchers see the provision of an attractive natural and social environment as important soft factors in the competition for investments.

5.2.2. Online Environmental Information Systems in Germany

Public interest in information about conditions and development of the environment in Germany has grown in recent years. Yet the search for relevant governmental information can be a time-consuming task, especially if it is managed in several agencies and within several agency departments. The increased interest has prompted policy makers to target public accessibility of environmental data. In 1990, the European Union issued a directive concerning free access to environmental information. This directive was translated into German law on 19. July 1994 (*Umweltinformationsgesetz*). Paragraph four gives citizens the right to free access to environmental information held by government institutions. The German legislature still lags behind the US "right-to-know" law, which promotes a more active government information policy, for example by creating online databases for public access.

As one result of the German environmental information law, a few state agencies have created online environmental information systems on the WWW. Some examples of state initiatives are[26]:

- the Berlin Environmental Information Systems (http://klondike.icf.de/UISonline/);
- the Hamburg Environmental Information Systems (http://www.informatik.uni-hamburg.de/ASI/ASI_Projekte/BLAK_UIS/Profile/Profil_HH.html);
- the Environmental Information Systems of Lower Saxony;
- the Environment and Transportation Information System of Baden-Württemberg (http://www.uis-extern.um.bwl.de/).

These environmental information systems provide a rich information resource for public use, but so far most do not offer spatial representations. A notable exception is GEOSUM, which was developed within the framework of the online Environmental Information System of Lower Saxony. GEOSUM integrates

[26] The University of Hanover (Institut für Landesplanung und Raumforschung) provides an extensive overview of environmental information systems in the German Länder (http://www.laum.uni-hannover.de/uis/zwbericht/inhalt.html).

information sources from various agencies into a widely accessible database. Initially, the integration of spatial data sets proved difficult due to different data formats. This has been addressed by standardized interfaces and by enforcing a standard projection system (Gauß-Krüger centered on the ninth meridian). GEOSUM allows users to perform spatial analysis and visualization and is frequently used by employees of the state environmental ministry.

5.2.3. Examples of GIS on the World Wide Web

Besides GEOSUM, there are several other examples of providing GIS services on the WWW. Early attempts often used the Common Gateway Interface (CGI), which is a WWW standard for external programs to communicate with servers, to send user commands to a GIS server. For example, users can take advantage of forms on HTML-documents to enter their input. CGI-compliant scripts then accept the user input and transfer it to a GIS application that is running on a server. The result of such a query is GIS data translated into map image files in HTML format displayed by the browser. For example, EPA followed this approach in its SITEINFO application. SITEINFO started as a support tool for regional staff to create map displays of and reports for relevant aspects such as regulated sources, human health, and ecosystem information of a given location. The Superfund Site Discovery program routinely uses the application to provide preliminary screening information to their site evaluation contractors. The application was later extended to the WWW to serve other interested agencies and the public. The system produces 5 to10 page text reports and 14x11-inch color plot, but the processing of a user request can take between five to 30 minutes. WWW users can retrieve their report and map via file transfer on the Internet.

A more interactive example is the United States Geological Service's (USGS) TIGER Web site. Users can use the Web browser to select a geographic location, select various data layers to be displayed, pan in compass directions, zoom in and out, place custom markers, and query map census statistics such s population density or family income by different aggregation levels. The following figure shows the Web site's user interface.

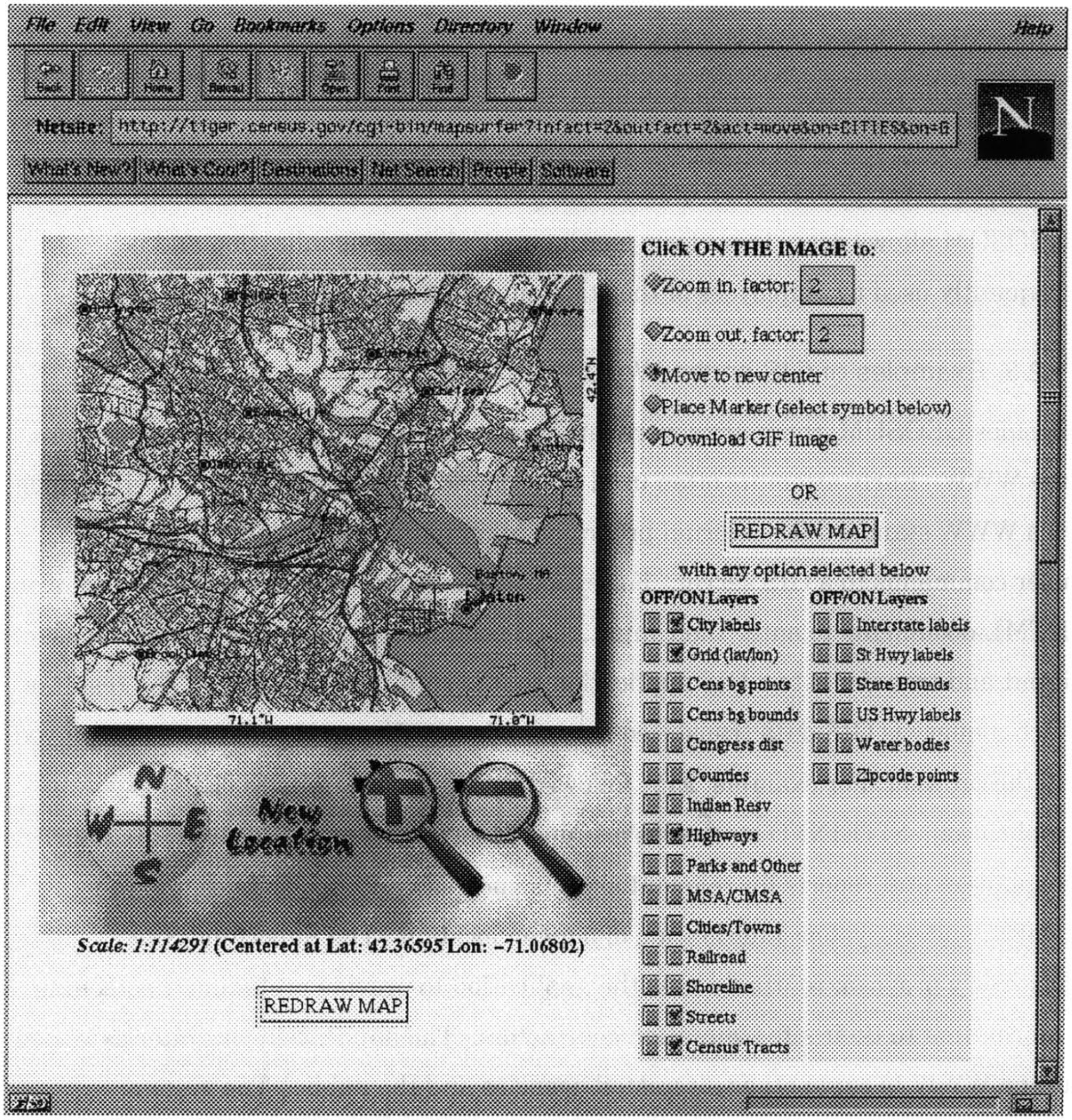


Figure 16: USGS TIGER Mapping Service Version 2.5

Most existing GIS applications on the WWW create raster image maps that are displayed by the Web browser. An alternative approach, which transmits vector data, is beginning to appear. Vector data have several advantages over raster images. Linear features such as boundaries can be represented more precisely with vectors using fewer data bytes than a raster image. In a network environment, the smaller vector files can be transmitted and displayed faster. However, the vector approach is not suitable for privacy-sensitive data as the data is sent to the requester.

5.2.4. US National Spatial Data Initiative and Open GIS Consortium

Diffusion of GIS and Internet technology is most advanced in the United States, where many public agencies such as the Census Bureau have adopted these technologies. Under Executive Order 12906, federal agencies must document their geographic data according to federal metadata standards, post the data electronically and participate in industry standards activities. For example, the US Census Bureau has made a wealth of census data available to the public in digital format. Its digital TIGER files provide data on street blocks, political boundaries, etc. The proliferation of spatial data handling prompted the U.S. National Research Council's Mapping Science Committee to articulate guidelines about how to standardize spatial information.

5.2.4.1. National Spatial Data Infrastructure

The National Spatial Data Infrastructure (NSDI) was established in April 1994 as a result of the Mapping Science Committee's initiative to develop policies, standards, and procedures for more efficient use, management, and production of geospatial data [FGDC homepage, 1997]. One objective of the Federal Geographic Data Center (FGDC) is the development of standards to facilitate data collection, documentation, access, transfer, and improve the means to search, query, find, access, and use geospatial data. To achieve its objectives, the FGDC involves state and local governments, the private sector, and academia in the NSDI process, which tries to establish forums for communication, facilitate access to data, and foster partnerships for data sharing.

The FGDC has defined a metadata standard, which is a framework for listing the characteristics of spatial data, such as the date on which it was created, its map projection, and the geographic base to which the data is registered. The metadata standard is the first consistent way to determine the accuracy or quality of spatial data and to make structured spatial data searches over the Internet. In the future, users will be able to run keyword or geographic searches against the metadata. In some cases, the metadata will even provide electronic links to spatial databases for immediate access. The NSDI online clearinghouse provides links to federal, state, university, foreign, and commercial spatial databases and other geographic information. For example, users can access Agriculture Department data, maps from the Defense Mapping Agency, links to the Centers for Disease Control and Prevention data, the Environmental Protection Agency gopher server, and maps developed by the Army Corps of Engineers.

The NSDI is an important initiative to promote the diffusion of GIS in the US. It helps to consolidate many independent data sources and thus to avoid redundant data capture efforts. The NSDI represents a model for German authorities to overcome the fragmentation of geographic data due to the country's decentralized structure. As GIS become more widely used, the federal government should facilitate cooperation among various parties to adopt national standards for searching and accessing geospatial data over the Internet.

5.2.4.2. Open GIS

Open GIS represent an important building block towards collaborative Web-based GIS applications. They are an evolution from traditional GIS solutions and address the latter's shortcomings such as monolithic applications, and platform-dependency with limited ability to share computing and data resources. In addition, geographic data are frequently captured and stored in different projections, coordinate systems, or geodetic reference system. These shortcomings greatly limit the potential of geoprocessing technology. The goal of open GIS is to overcome the limitations of proliferation of different data types and applications and to facilitate the sharing of information.

The Open GIS Consortium (OGC), founded in 1994, is a not-for-profit alliance of government agencies, research organizations, software developers, and system integrators in the United States. It is currently defining a set of standards and specifications to promote new approaches to "interoperable geoprocessing". The term interoperability refers to a bottom-up integration of existing systems and applications that were not designed to be integrated when they were built. The Open GeoData Interoperability Specifications (OGIS) project provides an object oriented architectural framework for distributed access to geographic data and geoprocessing resources (OGIS Project Technical Committee, 1996). The objective is to let users access and query remote data servers on the Internet, independent of the specific data structures and file formats, as well as to let them take advantage of the server's processing power. For example, if a user requests to see all parcels within a five kilometer radius of a certain designated development site, a query service could provide basic spatial operations such as intersect and clip, and semantic operations such as selection by range or equivalence, and descriptive operations using keywords.

Chapter 6: Where to Go From Here -- An Online Planning Model

In the previous section I have discussed several efforts to take advantage of GIS and Internet technology and to advance their diffusion. In this section I build on some of these examples and recent technological trends in Web-based GIS to recommend how emerging technologies can be applied to support consensus-based planning. Recent technological developments hold promise for GIS to become a widely accessible and effective tool for consensus-building in planning. However, to take advantage of the opportunities offered by these technologies, a framework model of how to organize and integrate their use in an institutional context needs to be devised. In chapter two I have discussed some of the model's institutional aspects; in this chapter I focus on its technological aspects. We have to recognize that the implementation of these technologies does not necessarily lead to better decisions -- but hopefully to an improved process of making decisions.

The question to be addressed here is how to construct a model for an online collaborative planning tool that overcomes some of the barriers to effective planning and fulfills the following main objectives:

- be widely accessible;
- provide multi-user access;
- make relevant information easily accessible and present it in an easily understandable fashion;
- facilitate the search for relevant information;
- query geospatial data and allow users to interactively create maps;
- facilitate cross-disciplinary and -organizational collaboration;
- build trust in security and quality of data;
- be based on a scalable architecture that can handle increasing numbers of users and increasing quantity of data.

6.1. Recent Developments in GIS Technologies that Make Web-based Collaboration Feasible

The explosive growth of the Internet has provided a global information infrastructure. The maturing of this infrastructure triggers a new phase of network computing with interactive information access via Web applications. Commonly, a GIS data server receives requests from Web browser clients, retrieves the geospatial data, creates a raster image map, and sends it to the Web browser for display. This is beginning to change as the demand for serving dynamic maps and related information on the Web is increasing. More than simply viewing static maps, users want to browse, explore, and query maps. For example, in a sophisticated application, users might zoom in on items of interest and the map automatically displays more detailed information matching the scale of the view. They might select any object on the map by clicking on it, select multiple objects from lists, or use a spatial selection technique, such as radius or polygon. They might then view selected information in reports, or click on an object with an embedded URL link. Selecting a URL link attached to map objects could cause the browser to jump directly to other maps, documents, images, or Web sites. Some recent technological developments have made these examples more feasible.

6.1.1. Databases

A database is the foundation of a GIS. Most of the currently used GIS databases are relational.[27] However, the functionality of spatial databases goes beyond the standard functions of a general purpose database as the combination of spatial and non-spatial data adds complexity to data management. Geodata are typically voluminous and have added topological data for spatial analyses that do not neatly fit within the format of normal relational tables. This complexity slows down performance even of sophisticated systems. The Environmental Systems Research Institute (ESRI) has recently introduced its Spatial Database Engine (SDE) in the most recent attempt to take advantage of relational DBMS architecture without sacrificing performance due to its handling of spatial data.

[27] For a review of database basics, see chapter 2 in Worboys (1995).

SDE provides an advanced architecture for supporting high-performance client/server access to spatial data by multiple users across computing platforms. Instead of storing GIS data in a separately maintained proprietary database, it uses a centrally maintained database built on open relational database management system (RDBMS) standards (ESRI, 1996). SDE was designed for a shared multi-user environment and developed for applications with large spatial databases (1-10 million features) for which fast access is required.[28] Data are organized as feature types, which correspond to layers in traditional GIS. Each feature type has a single relational table with the associated attribute data. A major difference to traditional GIS systems is SDE's object entity model. For example, whereas a traditional GIS stores a land parcel as a number of node-to-node lines with the attribute data indexed to a place within the parcel, SDE stores each parcel as one object. This reduces the number of disk accesses required to reconstruct a parcel polygon. The overall increase in access speed is achieved by simplifying storing of spatial objects, avoiding tiling of large data sets, and creating spatial and attribute indexes on feature types. For every client application that uses SDE, there is a unique server process running on an SDE host computer that services all data requests. Other leading GIS vendors are moving in a similar direction (e.g., Mapinfo, Intergraph, etc.).

6.1.2. GIS Internet Servers

Another recent development is the emergence of dedicated GIS Internet servers. For example, ESRI's Internet Map Server features client/server request management and load balancing capabilities. With the ArcView Internet Map Server extension, users can easily publish maps created in ESRI's desktop GIS ArcView on the Web using a Java applet that is delivered with the software.[29] Interactive maps can be created from a number of different types of spatial data

[28] For example, SDE speeds up dynamic polygon overlays without the requirement to extract data subsets.
[29] The term applet was coined for small software applications that can be downloaded from the WWW to client computers as needed. This makes it unnecessary for the client computers to store the application locally. The applet's functions are encapsulated in the package and shipped to the client on demand. The applet is executes inside the client's Web browser.

including shapefiles, coverages, SDE layers, and a variety of graphic images stored on servers that support NSAPI/ISAPI Web server extensions.

The following example illustrates an application of the ArcView Internet Map Server software for locating places in the world. The application allows the user to search locations such as cities by name. It displays a main map that displays the results of a user query. For additional orientation, a reference map shows which part of the world is currently displayed in the main map. The user can select from a number of predefined data layers to be displayed. In addition, (s)he can request the display of attribute data, which appears at the bottom of the page.

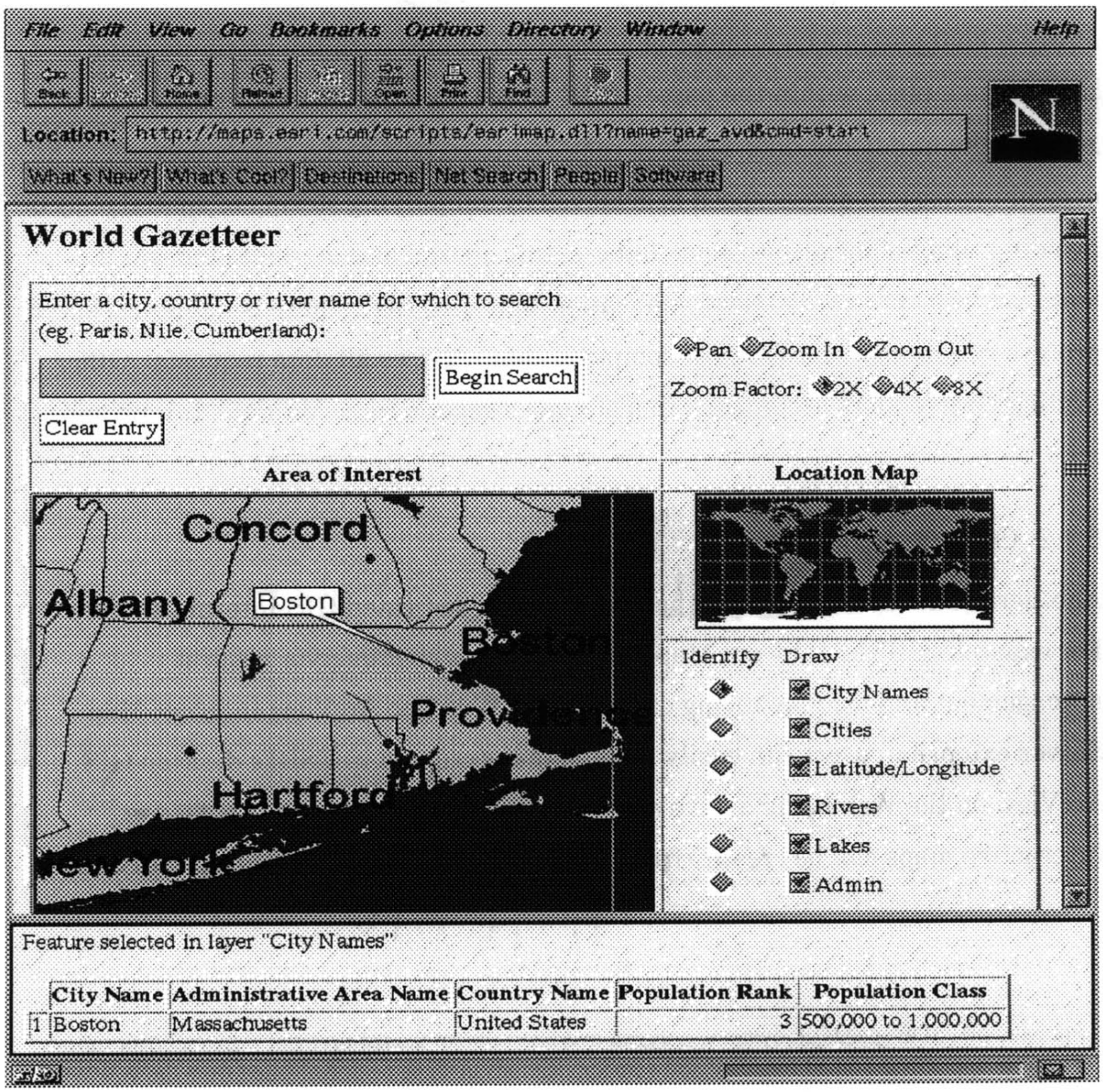


Figure 17: Example of an ArcView Internet Map Server application

This GIS Internet server application supports the institutional implementation of a planning information center. It provides the hub instituion with a tool to make spatial data from various sources available to all stakeholders. The latter can then query the data, generate maps interactively, and publish GIS maps.

6.1.3. Java-based GIS

A new approach to delivering GIS data across the WWW is to use Java applets for a front-end graphic user interface. Java is an object-oriented programming language that was developed by Sun Microsystems. Over the past two years it has emerged as a simple yet powerful "distributed computing environment" based on the Internet. Java computing is a major improvement, because it offers cross-platform support over heterogeneous networks and what-you-need-is-what-you-get service.

An example of the Java approach is the ActiveMaps software developed by InternetGIS.com, Oakton, Virginia. ActiveMaps takes advantage of object-oriented component design and is platform independent. Unlike server-side CGI implementations, ActiveMaps transfers the GIS functionality and data to the client-side Web browser to reduce subsequent network traffic and processing burden on the server. It currently has functions for panning, zooming, searching, and querying of vector maps and related attribute data.

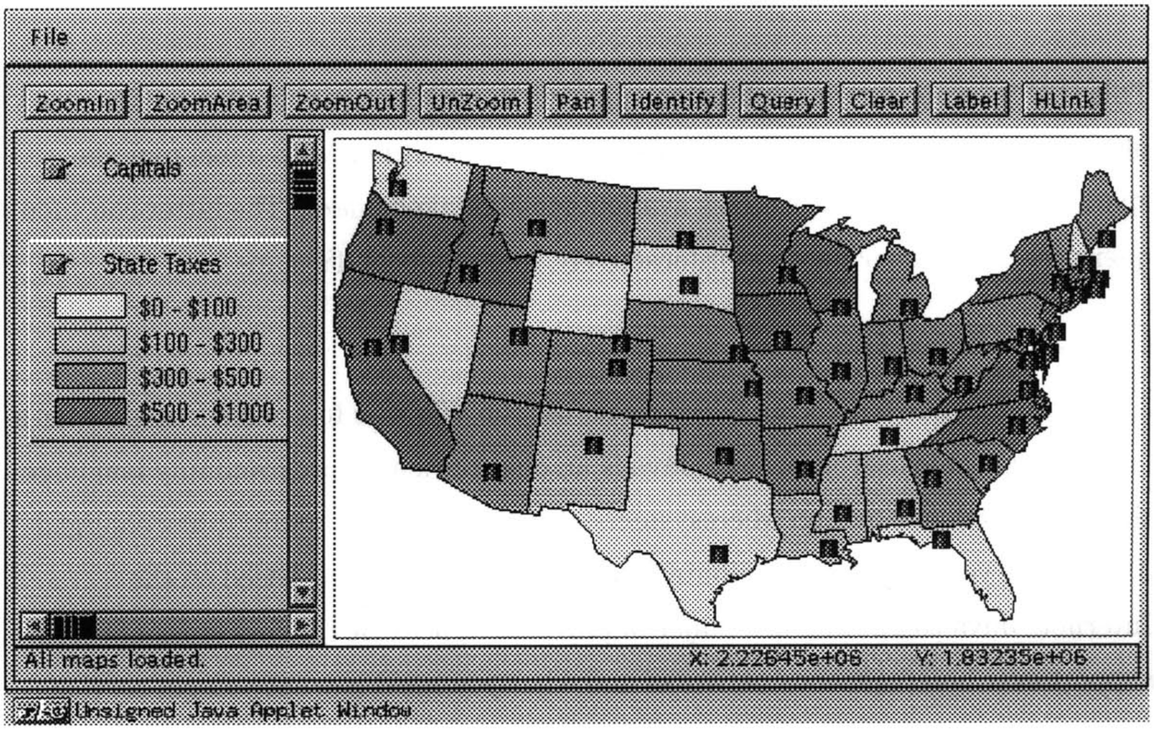


Figure 18: Example of ActiveMaps application

The Java language is also a promising tool for implementing applications that support communication between stakeholders. For example, there are applications that provide users with real-time chats or an online whiteboard, on which they can type and draw in real time. All logged-in users see the activities on the whiteboard at the same time. Such a tool would be of value for an online planning application. For example, if it is possible to load a land use image into the whiteboard, then stakeholders could edit on top of the land use map to visually point to the areas they are talking about.

6.2. Building an Online Planning Model

The objective of an online planning model is to offer a large number of participants access to the system in order to allow them to share, analyze, and talk about available information. Computer networks and standard communication protocols have made such distributed systems possible and let users work across geographic and organizational boundaries. Since an important component of my online planning model is a Web-based GIS tool, I now outline three network-centric computing models that distribute GIS functions in different ways by taking advantage of the Internet's client/server architecture. Since the client/server field is currently characterized by many changes, which leave terms ill defined, I do not attempt to illuminate all facets of the field, but describe some basic trends and provide one way of representing concepts.

The simple idea behind client-server technology is a division of duties among several computers. In the 1980s, the IT industry developed PCs with graphical user interfaces (clients), high-end servers that could manage large databases, and Ethernet local area network (LAN) to connect them. In general, client computers provide the interface to allow users to request services of and to display the results returned by servers. Client computers usually do some local preprocessing, for example putting user commands into a format such as the hypertext transfer protocol (HTTP) required by a Web server. The network connects the clients and servers to each other and lets connected computers communicate via standard protocols such as TCP/IP and HTTP. Servers provide the processing power to handle numerous client requests. Web servers extend the traditional services such as data or print servers by providing multimedia services.

The client/server architecture distinguishes presentation, application, and database layers. The presentation layer handles local preprocessing and presents the graphical user interface, the application layer executes processes, and the database layer performs database processing. There are many degrees of decomposing tasks between client and server computers. The trend has evolved from a one-tier (distributed presentation model) to a three-tier (distributed database model) architecture. The three-tier architecture off-loads presentation, applications, and some aspects of database layers to the client side. However, even though PC clients were a low-cost alternative to mainframe computers, the client/server architecture has revealed a few disadvantages. For example, clients have become "fat" demanding a lot of software and hardware. In addition, the management of versions of multiple software packages on many clients requires significant resources.

The Web client/server model introduced "thin" clients (browser). Of course, a "fat" client can still feature a variety of applications in addition to the Web browser. The trend towards a three-tier Web model introduces an effective way to handle the application layer on the WWW. For example, a "thin" client handles presentation, a middle tier contains application logic, and the database tier executes queries. The following figure illustrates this trend from an early client-server model to the currently favored three-tier Web architecture.

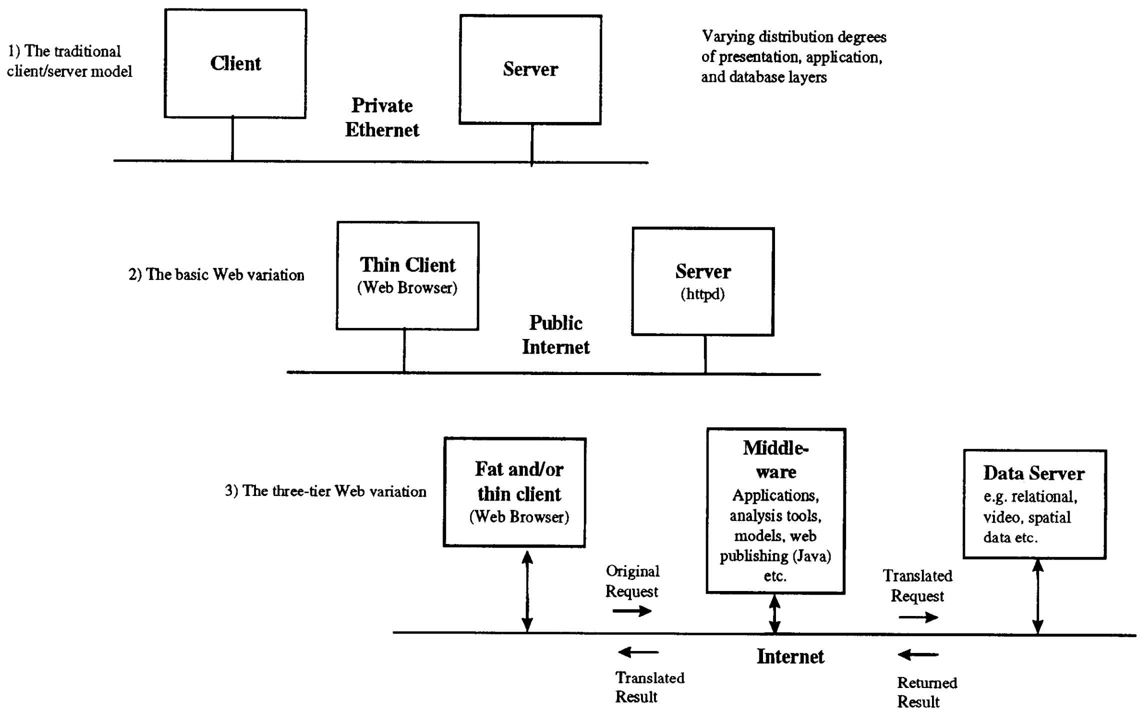


Figure 19: Trend towards three-tiered Internet client/server architecture

The three-tier Web model is a relatively new concept that is not yet well defined. The ideas behind it are promising, but its implementation still suffers from a lack of standards. The "middleware" layer allows for thin-clients by taking over the complexities of translating requests and results. On the server side, this intermediate layer allows dedicated servers such as a data warehouse server. The client browser might send queries to a Common Gateway Interface (CGI) on the intermediate Web server. The CGI script interfaces to Common Object Request Broker Architecture (CORBA) services using standard Interface Definition

Language (IDL) statements to reach the geographic data stored on the data server.[30] The results are then sent back to a client browser for display. The intermediate server has the crucial function of ensuring interoperability.

A client/server architecture based on the Internet offers several options for dividing tasks between network computers. For a Web-based GIS, the division of tasks can take advantage of the processing power of servers and the proliferation of simpler client computers. For example, access to a GIS Internet server with sophisticated spatial analysis functionality would spare small planning firms from investing in their own system. Instead, the planning firms could use a cheaper desktop GIS and access the server for more complex spatial analyses. The following three examples illustrate different ways of allocating the main GIS functions between clients and servers. The models represent examples from a broad spectrum of possible models.

6.2.1. Server-centric Model

The first model places emphasis on the server side, which, from a user perspective, means that most processing is done on a remote server computer. All user actions, including every mouse click, have to be passed to the remote server through the network and handled by the server. For example, a GIS Internet server stores all relevant spatial and non-spatial data sets and provides the GIS functionality. Source data is captured, managed, and maintained by the server staff. Users can send inquiries to the remote GIS Internet server, which processes the request and returns query results in form of a digital map and possibly associated attribute data. The client computers' browser then displays these results.

[30] CORBA stands for Common Object Request Broker Architecture. It is a specification of a consortium called the Object Management Group (OMG). CORBA defines a distributed architecture with an open software bus through which objects from multiple vendors, running on different operating systems, can interoperate. A necessary communications protocol (Internet Inter-ORB Protocol) helps provide object interoperability.

Table 6: Allocation of GIS functions in a server-centric model

Local Client	Central Server
	Data Capture
	Data Management
	Data Maintenance
	Analysis
Presentation	

An example of the server-centric model is ESRI's ArcView Internet Server, which has been described above.

The server-centric model offers itself for large government or other proprietary databases. The control over the data remains with the organizations that make them available to third parties on a server. The organization can control which data layers it makes available. However, this model makes only limited use of the advantages of distributed GIS. Relevant data would be made available yet remain distributed on several servers. Cross-disciplinary analysis is hindered. A server-centric model can generate a lot of network traffic and put a burden on the server.

6.2.2. Client-centric Model

The client-centric model places most emphasis on the client computer and takes advantage of the increasing power of desktop GIS applications. For example, both desktop GIS such as ESRI's ArcView or ArcInfo provide facilities to capture, manage, maintain, and present geo-referenced data. With the ArcView 3.0 version users can perform limited spatial and network analysis. In such a model, a remote server could provide access to data files. In a more sophisticated architecture, a database server would replace the file server to increase analysis flexibility by adding DBMS functionality.

Table 7: Allocation of GIS functions in a client-centric model

Local Client	Central Server
Data Capture	
Data Management	Data Management
Data Maintenance	
Basic Analysis	(Complex Analysis)
Presentation	

The client-centric model could also take advantage of a trend towards distributed computing services. For example, a specialized service company could offer the server-side processing power to perform analysis that is too complex for the client computer. Users such as small planning companies could register with a service to get an account, upload their data sets to their directory, and then access the server over the Internet to send analysis instructions. In a more advanced model, the server could also provide base maps or specific-purpose data. This model extends the abilities of desktop GIS users to perform complex and time intensive analyses. However, the data sources remain proprietary and users must have their own, even if basic, GIS system. While this model is useful for some users such as small planning firms, it excludes stakeholders who do not usually work with GIS systems.

ActiveMaps, which was discussed above as an example of a Java applet, takes the client-centric model a step further. All its GIS functions are encapsulated in the package and shipped to the client on demand. The data set is also completely downloaded at the user's request. Hence the server only provides the applet, acting like a file server. Once the software and data are downloaded from the Internet, the applet executes inside the client's Web browser. This reduces network traffic, because once started, the Java applet doesn't depend on the server anymore. It initially takes a while to download ActiveMaps, but once it is started, it has better performance than server-centered dynamic Web-GIS applications. ActiveMaps takes advantage of local processing power –the faster the client computer is, the better ActiveMaps performs. Since ActiveMaps is downloaded and executed dynamically, the end users do not have to install the package on their hard disk.

6.2.3. Hybrid Model

The hybrid model combines characteristics of the server- and client-centric models. On the one hand, this model recognizes the benefits of decentralized data management responsibilities. Most of the work is performed locally at client sites, where the original transaction data is captured and stored. This mirrors the responsibility many public agencies have for collecting and maintaining data relevant to their operations. On the other hand, the model strives to provide access to an aggregated subset of this data, present a visual user-interface, and allow for cross-disciplinary analysis. To achieve this, data providers would have to agree to place copies of relevant source data on the PIC's GIS Internet server to make them available to all stakeholders. In fact, this would help public agencies to implement the stipulations of the 1994 German environmental information law that gives citizens the right to access environmental information held by public agencies. Table 8 shows how GIS functionality could be distributed in this model. However, the question of what data should be made available and how is complex, especially with GIS data.

Table 8: Allocation of GIS functions in a hybrid model

Local Client/Server		**PIC Server**
Data Capture		
Data Management of Master Data	Middleware (supporting Web-based collaboration and analysis)	Management of Copies of Relevant Summary Data
Data Maintenance		
Analysis (if local GIS available)		Analysis
Presentation		

The inclusion of a "middleware" layer moves the hybrid model towards a three-tier architecture. One goal of the hybrid model is the establishment of a data warehouse to store planning relevant summary data. An example of a distributed data warehouse is British Columbia's Environment System Services Branch's (BCE) system, which is a "set of disk files and database tables organized to facilitate distribution of data to a diverse group of users" (Mackenzie, 1996). The implementation of a data warehouse would separate database functionality from other services (i.e., middleware). The PIC staff could thus focus on enhancing its middleware services to support Web-based collaboration and analysis. In addition to a Web-based GIS tool, the Web server's hub homepage provides non-spatial information and collaboration tools. All stakeholders who have an Internet connection have access to the resources of the hub homepage and can take advantage of the functions offered by the GIS Internet server.

The question of how to distribute GIS analysis functionality is an issue. How much GIS functionality should be done on the Internet server versus GIS applications on client computers? On the one hand, stakeholders with in-house GIS capabilities are likely to want to download data sets from the PIC to analyze them on their local computers. Yet the idea of making data freely available for downloading and local analysis is likely to face resistance from data providers. They worry about manipulation and misrepresentation of "their" data. On the other hand, it is not feasible to make a sophisticated set of analysis functions available on a Web-based GIS from the beginning. An online planning model has to be built slowly and incrementally. In the beginning, a prototype system's lack of sophisticated functionality can be compensated by preprocessed data layers such as overlay or buffer data layers that are typically of interest to stakeholders. For example, the PIC staff could perform a point-in-polygon operation to create a coverage that shows the number of schools that are located within a five-kilometer buffer of development sites. Over time, the prototype can be extended in terms of scale, functions offered, and amount of data provided.

The hybrid model requires advanced technical skills at the decentralized data providers as well as at the PIC to coordinate network operations. Each data managing site should train and designate a data/GIS specialist, who could work closely with other representatives on data issues. In Leipzig, one possibility would be for the UFZ to host the PIC to take advantage of existing infrastructure. Besides its "neutral" status as a federal research organization, it has the most advanced technological infrastructure of all parties to offer the server services. Nevertheless, even a limited prototype implementation would require additional technical skills. In comparison to the status quo, there will be new cost incurred due to offering technical facilitation services such as expanded disk space or data management tasks. One possible way to cover the cost associated with the online planning tool is to establish a consensus fund.

6.3. How Can an Online Planning Tool Enhance Communication And Improve Access to Information?

In the description of the above models, I have focused on the Web-based GIS component of an online planning model, but there are other important components that should be part of the model. Besides spatial and non-spatial source data, there is other relevant information such as expert advice that should be brought to stakeholders' attention. Having access to that data/information is a necessary but not a sufficient condition for online planning and consensus-building. The model should allow stakeholders to discuss spatial representations. This discussion can take place online in real time, in asynchronous mode (e-mail etc.), or in face-to-face meetings. Some of the tools that support online communication are discussion forums (e.g., HyperNews), online meetings and chats, or whiteboards.

These tools, in addition to others, are integrated in the overall online planning model illustrated in figure 20. In the following, I discuss the model's main components in more detail.

- At the heart of the model is the **hub homepage**. It provides the point of entry and welcomes users. Depending on how open the stakeholders want to make the application, they could be requested to register. From the hub homepage, users can directly jump to any of the main component pages via hyperlinks.
- To help users orient and gain an overview of the Web site, a **navigation overview** provides a visual depiction of the arrangement of the site's contents and how they relate. The overview can be presented as an image map, which allows users to click on the name of a page (s)he wants to go to next.
- **Introduction and background** pages provide new users with an overview of what the Web site is about and what has happened in the planning process so far. Here users find a description of the process' main objectives and issues. A picture and video gallery can be included to let users take a look at the physical characteristics of a planning site.
- The **stakeholders' contact list** makes it easy to locate other stakeholders. Besides addresses and phone/fax numbers, the page includes each stakeholder's e-mail address, which users can click to immediately send a message. A

stakeholder group represented by several people can have a list of individual members' addresses. Stakeholders also have the opportunity to post their bibliographical information.

- The **question & answer** pages feature answers to frequently asked questions. In case of contentious questions, different stakeholders probably have different answers. Contentious questions can have multiple answers to represent their different viewpoints. In addition, users can access a representative range of expert opinions on some contentious issues.
- The **information center** provides access to a wealth of relevant information. A search function allows users to search the Web site for keywords. Users can access an archive of official and other shared documents. If the process has produced preliminary results, these are posted here. Second, a front end for database contents provides metadata information. Metadata is information about the data itself and should contain such information as to when the data was created, who is responsible for them, how accurate and large they are, what attributes they have, etc. The metadata information can contain hyperlinks to immediately download the data set. Third, users can branch out to other Web sites that have information related to the planning case.
- The **feedback** page allows users to comment on various aspects of the planning process. The comments would be taken into account by the PIC staff. The page can offer different formats of feedback input. For example, stakeholders could send a simple e-mail, fill out a structured form, or rank attributes of given alternatives. The latter format, for example, can be modeled after Edwards (1979) multiattribute analysis based on simple multiattribute rating techniques (SMART). Furthermore, Lowe (1986: 97) developed a method in which users cooperatively rank alternatives in terms of significance and relevance.
- **Stakeholders' position presentations** offer them the opportunity to present their viewpoint and arguments to others. The design and content of the position pages are the responsibility of the respective stakeholders. The technical facilitator can assist them to set up their pages and how to use tools that can make the presentation more effective. For example, stakeholders can employ multimedia applications or a map carrousel to integrate preprocessed maps into

their presentation. Software tools such as Allegiant's Roadster let users enhance maps with pop-up text or picture windows. For example, a land use base map can pop up descriptions of land use codes as a user points at various locations. A map carousel provides a more efficient way of presenting a number of maps than the traditional way of inserting map images in a document. The carousel takes a while to load, but then users can quickly flip through a sequence of maps.

- The **HyperNews forum** provides stakeholders with a mediated discussion forum. HyperNews is free software provided by the National Center for Supercomputing Applications, University of Illinois at Urbana-Champaign and is a sophisticated online bulletin board. The mediator can establish a number of discussion forums to focus the discussions taking place within each forum. This also makes it easier for users to find relevant comments concerning a certain topic. Users can post messages, respond to other messages, follow a line of argumentation over several levels, publish maps etc. Users can be automatically notified if another user posts a response to their message. The HyperNews administrator can define a limited life span of messages to keep the forums from expanding indefinitely. For example, only the messages of the last 30 days could be displayed. The mediator can archive messages that are worth preserving in the question and answer pages.
- The **Web-based GIS** tool provides users with a selection of data layers and functions to interactively explore different aspects of planning sites. For example, they might want to display the location of towns in relation to redevelopment sites, query the towns' population, zoom in to a site proposed for development and display the occurrence of endangered species in the area. Users should be able to store maps they have created interactively for later reference or to show them to other stakeholders. For example, an archive of user maps could store time stamped copies of map images. Similar to the HyperNews messages, archived user maps would be stored for a limited time only. The PIC could offer a service to print large format maps.
- Finally, the **real time meeting center** lets users discuss their opinions and differences, as well as brainstorm alternative approaches. They have to register to use the real time communication tools in order to verify their identity. Users

can use audio-conferencing capabilities (Internet telephones), or meet other users by appointment or by chance in a chat room, where they type comments which are immediately replicated to all users present in the virtual chat room. If a small group of users wants to have a discussion undisturbed by other users, they can meet in a separate side chat room. The chat session can be combined with a whiteboard, which lets users draw symbols, type text, and annotate images on a "whiteboard" area on the screen. Every user present around the whiteboard sees what any other user draws or writes in real time. A helpful feature might allow users to load images of previously created and archived maps. Then they can draw on top of the image to direct other users' attention to certain aspects.

One of the PIC staff's responsibilities is to create and develop the services described above. They maintain all homepages except the stakeholders' presentations. Stakeholders should have a strong self-interest to keep their position presentations up-to-date and to make them impressive. The following figure provides an overview of the model's main components.

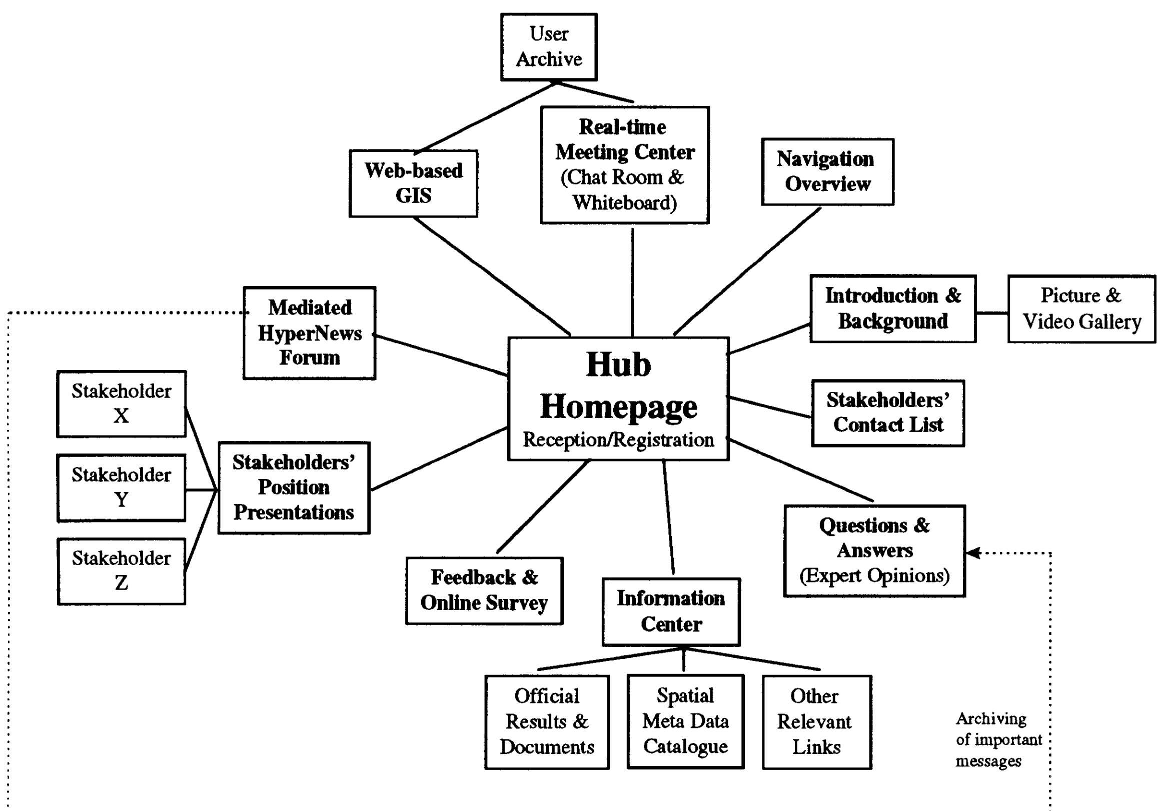


Figure 20: Components of the planning information center hub homepage

The rapid development of Web applications will make new tools that can effectively support online planning available in the near future. For example, Microsoft is developing LiveSites as a shared project space for collaboration. Netscape's next generation Web client (called Constellation) promises to provide a universal interface for users regardless of the platform they are using. This Web client will offer a personal workspace based on HTML and JavaScript that is location-independent. This means that users will be able to log on to a network, go through a verification process, and receive their personalized desktop interface complete with bookmark references etc. Other features include Realtime Notification, which sends a point-to-point message that immediately pops up on the receiver's screen.

6.4. Recommended Model for Online Planning

The hybrid model is best suited for an online planning and consensus-building model as described in the previous section. It can provide access to a relevant selection of resources to a wide audience while keeping data responsibilities decentralized. Any stakeholder connected to the Internet can access information that is relevant to ongoing planning processes. (S)he can benefit from using Web-based GIS functions to help her/him better understand spatial relationships. While the range of data layers and Web-based GIS functions will be limited in a prototype application, many stakeholders would not have access to GIS at all otherwise.

The hybrid model takes advantage of client computers' processing power where possible. In the Leipzig context, the majority of stakeholders will use Web browsers to access the planning information center's GIS Internet server. Some of the stakeholders (for example, public agencies such as the land surveying offices) collect and manage their own data. Since these stakeholders might also act as data providers, the system might include several databases residing on different network servers. While not all interested agencies and stakeholders will have relevant data to contribute, a few public agencies that capture and maintain data to support their operations are likely to have an overwhelming amount of data. These agencies are responsible for maintaining their respective data sets, but periodically transfer aggregated data relevant for planning purposes to the PIC server. By making only summary-level data available, the PIC can avoid many complexities of handling administrative, transaction-oriented data while building a series of snapshots of summary conditions relevant to environmental planning that will eventually provide useful time series.

Stakeholders' data needs are likely to change during on-going consensus-building processes as issues are reframed and new perspectives taken into account. Some baseline data such as transportation infrastructure are less likely to be subject to volatile data needs. Thus a selection of relevant baseline data can support many decision-making processes, but the model also needs to be flexible enough to adjust to changing data needs. In the mining site redevelopment example, nonvolatile base maps of topography, infrastructure networks, land use, etc. are needed. In addition, more volatile aggregated attribute data about demographics, socio-economic variables, and pollution levels would be helpful. Mirroring aggregated data to the PIC server as opposed to leaving it on distributed servers has performance advantages.

Depending on data provision issues, the planning information repository could contain read-only copies of source data sets, stored in standard formats. The data could, for example, be stored as ArcView coverages in a latitude/longitude coordinate system.[31] Most users would access the data coverages through selecting them via the Web-based GIS tool. They could only display already existing data layers and would not be able to modify them, but could send revision requests to the responsible data provider. The following figure illustrates how an online planning model could connect multiple stakeholders.

[31] The advantage of such a coordinate system is that ArcView can project it into other projections on the fly.

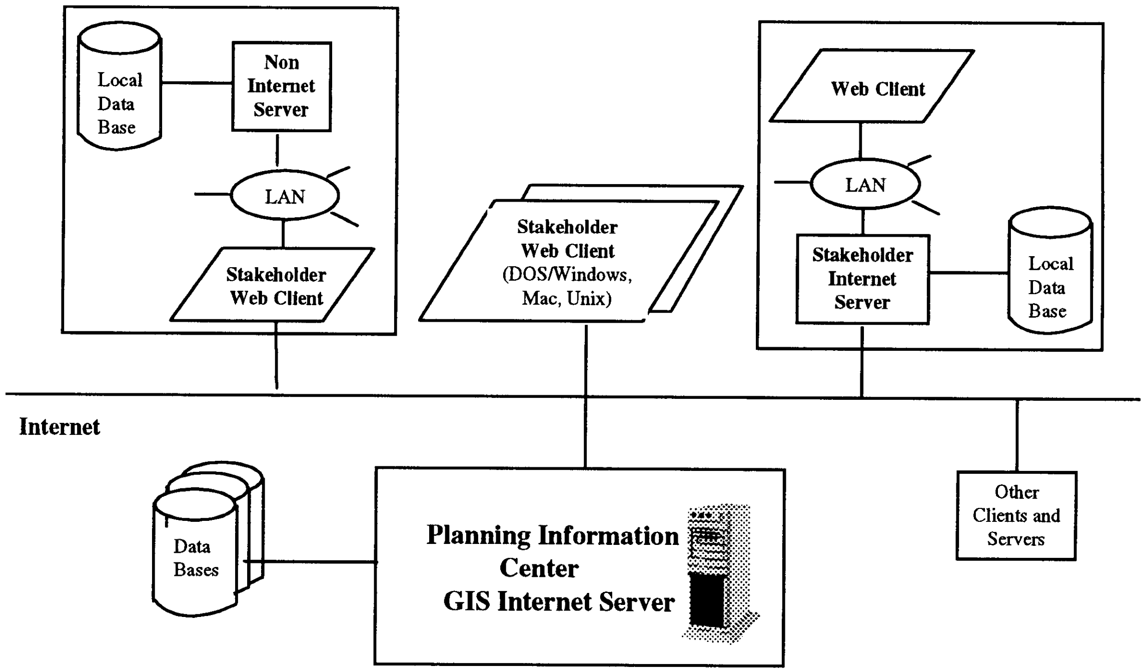


Figure 21: Online planning architecture based on hybrid model

The recommended hybrid model addresses most of the key obstacles to consensus-based land use planning.

- Unwillingness to collaborate: A prerequisite for collaboration and cooperation is the parties' anticipation of their benefits. The online planning model provides an incentive to collaborate through access to previously unavailable information. It offers stakeholders mutual benefits derived from being able access information across organizational boundaries. For example, all parties benefit from the early reduction of uncertainty and the enhanced ability to flexibly consider alternatives. By freeing stakeholders from many time and location constraints, the system can help those, who previously might have been unable to participate adequately, to get involved. The PIC staff would try to address providers' fears of data misuse as much as possible.
- Degree of informedness: The online planning model provides users with a single access point to relevant information. The PIC staff would try to translate difficult to understand information into a more easily understandable format. The visualizations of spatial patterns and relationships can effectively serve this purpose. In addition, the danger of information overload can be addressed by the

Web's hyperlink structure. A manageable amount of information can be displayed at the top level, from which users interested in more detail can branch to linked Web sites. Finding the fine line between lack of information and information overload will be a constant challenge for the PIC staff.

- Scientific uncertainty: The online planning model makes information easily available in a timely manner. This information can reflect expert opinions on contentious issues. In cases of scientific uncertainty, the model can try to provide access to a representative range of expert views. This supports users in forming their own opinion and making decision based on more reliable information.
- Win-lose attitude: The integration of consensus-building into the online planning process can overcome parties' zero-sum game perceptions and foster an atmosphere of integrative problem solving. Consensus-building can help stakeholders better understand their own as well as others' interests. The model provides a place in which stakeholders can work together to clarify differences and to produce joint gains. These gains stem from a process of identifying tradable things that parties value differently. The capability of creating different combinations of map layers supports the reframing of issues. Negotiation aims at replacing traditional bargaining over rigid positions, where the focus is power, with problem solving, where the focus is on creatively reconciling interests. Successful negotiation is a process of joint problem solving involving all relevant groups (Fisher and Ury, 1981).
- Local versus regional interests: The online planning model makes information of common interest available beyond organizational boundaries, which opens the door for better-informed collaboration. The model can be easily scaled to include regional interests. The different parties can then use the online planning tool to learn about each others' interests, brainstorm ideas, and discuss solutions.
- Communication breakdown: The model provides additional communication channels, which can support planning processes. The additional channels can establish closer contacts and encourage new contacts between parties who did not communicate previously. All connected stakeholders can quickly be informed about events, new developments, etc. The model provides a mix of Web-based publication and analysis facilities and fosters continued engagement.

- Tradition of exclusion: The online planning model opens the planning process to a greater number of stakeholders. The support of consensus-building enhances chances for widely supported solutions. The model enables cross-disciplinary collaboration and is easily scalable. It helps public agencies to fulfill the legal requirements of the 1994 environmental information law.
- Distrusted information sources: The identification of what information is needed and available helps to resolve disputes over scientific facts and predictions. The rigorous examination of the input into the system provides a common and solid foundation for building consensus during subsequent process stages. A consensus-building process will suffer from distrust, but it provides opportunities for independent third parties to talk about what different experts have to say about a contentious issue.
- Power distribution: Consensus-building can attenuate power differences, but it lacks formal democratic legitimacy and outcomes are not legally binding. However, mutually agreeable solutions with broad support are much more likely to be adopted and promoted by legitimate decision-makers. By providing formerly disadvantaged stakeholders with equal access to relevant information, my online planning model can help to level the negotiation playing field among stakeholders. Fisher (1983) identified six factors that can change the distribution of negotiation power among stakeholders: (1) skill and knowledge; (2) good relationships; (3) good alternatives to negotiating; (4) elegant solutions; (5) legitimacy; and (6) commitment. Despite historic power distributions, these factors can drastically change power distributions during negotiations; for example, an elegant solution proposed by a "weak" party might trigger new alliances against a powerful party.

Since data collection and maintenance make up the largest part of total cost for a GIS, a GIS implementation will not be economically feasible for many agencies. For example, a report on municipal GIS use in Germany estimated, that the cost for data collection and maintenance versus hard-and software cost stand in a 80% to 20% relationship (KGSt, 1994: 44). A Web-based GIS integrates distributed data sources to make relevant summaries of the data available beyond one agency's use, offers access to GIS functionality, and extends the benefits of map presentation to stakeholders with or without GIS capabilities. Users can access maps and information through Web browsers, interact with the maps, manipulate views, and access underlying information. However, it has to be recognized that such a system can quickly become very complex. Therefore, its scope of data and functionality should be limited for management sake.

While it is advantageous to make data accessible to all stakeholders, the responsibility for agency-specific data rests with the respective data owner, who maintains the data and guarantees its accuracy and reliability. In such a model, mutual trust and data quality become crucial. Only if the provided data meets users' expectations in terms of quality criteria such as accuracy, richness of attributes, correctness of attributes, and up-to-date maintenance will they continue to use the system.

Similar to the MassGIS case, the PIC staff would be responsible for addressing issues of data security, building trust in the model, and convincing potential data providers of the benefits of making some of their data available for decision-making purposes. One strategy might be to place read-only copies of an aggregated subset of relevant data on the PIC server. Users could then perform limited spatial queries to create maps. Instead of the data itself, only images of the query results would be send to the user. If data providers agree to make their data freely available, stakeholders could download data sets for detailed analysis on their client computers. However, in cases that involve a large number of data layers and require advanced GIS analysis such as the identification of all schools that are located within a certain radius of contaminated sites, the model's limited GIS functionality will be insufficient, and it will be unlikely that all needed data will be downloadable. Instead, stakeholders could request PIC staff to perform such analyses at the PIC and then make the results publicly available.

Chapter 7: Conclusion

The described online planning model has the potential to address some of the barriers to effective land use planning. It provides stakeholders with additional channels for communication, encourages cross-disciplinary collaboration, frees users from time and location constraints, and takes advantage of information visualization. Furthermore, it improves access to relevant information that can be tailored to specific requirements of a planning case. The goal of addressing distorted communication is not to create completely new organizations but rather to effectively network their members in order to improve communication and foster an environment of collaboration. However, such a model will face difficult institutionalization barriers and challenging technical complexities. It has to be recognized that an online planning model cannot be built overnight and has to be skillfully managed.

The Web-based collaboration model facilitates joint planning among multiple stakeholders by linking them through a global network. This supports consensus-building, which is a key strategy for promoting a more interest-based approach to planning. Emphasis is placed on introducing informal consensus-building during early planning stages instead of falling back on it once a process has resulted in a stalemate. I have argued that complementary integration of IT and consensus-building holds the most potential for overcoming some of the barriers to effective planning. My proposed online planning model does not attempt to replace face-to-face meetings but is meant to support an ongoing consensus-building process through the integration of IT.

In the previous chapters, I have discussed potential benefits of an online planning model and pointed out drawbacks of integrating information technology into consensus-based planning. Keeping in mind that my descriptions are often speculative and that IT is only one of many tools to support planning, I believe the following observations to be valid. In summary, some of the main potential benefits of an online collaborative GIS include:

- **Opportunity for early data mediation and scoping of alternatives**
  Stakeholders can identify important issues and interests early on in the planning process and thus develop a better perception of their own priorities as well as those of other stakeholders. This allows them to develop and consider conflict-minimizing alternatives at a stage at which these alternatives still have implementation potential.
- **Access to relevant data**
  The model reduces the effort associated with researching whether data exists, where they are stored, and how to access them. It can offer enhanced access to accurate and up-to-date data or information.
- **Open and fair planning processes**
  The integration of IT and consensus-building can foster fair, efficient, stable, and wise outcomes that stand the test of time. My online planning model can help to level the negotiation playing field among stakeholders by establishing a network that makes participation in the planning process easy, which helps to minimize the risk of interest bias. One expected effect is that knowledge of the online planning tool's impact will change stakeholders' behavior. This expectation is supported by results of a doctoral thesis by Pedro Ferraz de Abreu (1996), who investigated the impact of a multimedia computer system on public participation in environmental impact assessment processes in Portugal. Opening the process to more intense public scrutiny changed power balances and agency behavior. Ferraz de Abreu concludes that public agencies took public participation more seriously and tried to anticipate (and/or manipulate) the public's concerns, which had ripple effects on what kind of analysis and discussion they performed earlier in the process.
- **Less data redundancies and contradictions**
  The identification of what information is needed and the rigorous examination of the input into the system provides a solid foundation for continued consensus-building in subsequent process stages. In addition, a concerted effort involving multiple stakeholders reduces the risk of duplication of data capture and storage, inconsistency of spatial reference systems, and incompatibility of base map geometry.

- **Increased information sharing**

  The model encourages information sharing, because it offers mutual benefits of easy access to relevant yet previously hard to come by information. Stakeholders who intentionally hold back information relevant to other parties face a greater risk of losing credibility. The increase in information sharing can promote awareness of what alternatives are available and shed light on the nature of difficult choices to be made.

- **Enhanced communication**

  Additional communication channels lower barriers to collaboration. They can establish closer contacts between parties who are required to cooperate (such as government agencies and developers) and encourage new contacts between parties who used not to communicate. An online planning system facilitates preparation for, as well as on-going communication between, face-to-face meetings.

- **Long-term perspective**

  Through more involvement in consensus-building and planning processes, stakeholders can develop a higher degree of ownership, commitment, and acceptance of plans. However, it is important to realize that consensus cannot be forced, but that participating stakeholders must have common concerns and believe that a consensus-building process offers a good way for addressing them. The online planning builds a network of relationships between stakeholders, which will persist after a specific project is finished and benefit future planning processes.

Some of the main potential drawbacks include:

- **Danger that newness is confused with effectiveness**

  Just because new technology becomes available does not mean that it should be implemented. The technology's ability to address existing problems, enhance current procedures, and fulfill users' needs has to be scrutinized before funds are committed to implementation.

- **Organizational complexity**

  The institutionalization of informal online planning and consensus-building will face significant barriers. Determining who builds, maintains, and contributes to the coordinating structure is itself a complex organizational task. In addition, the online planning model is aimed at incorporating a growing number of stakeholders, some of whom have historically grown bureaucracies without a history of close collaboration with other stakeholders. It has to be recognized that building a comprehensive model will take time.

- **Users do not accept or use the system**
  A collaborative model depends on user participation. However, some users' resistance to change brought by new information technologies and others' lack of confidence in handling geographic information might prevent them from taking advantage of the system's features. Also, users might avoid increasing the complexity of their workload by learning to operate new technologies.
- **The system does not fulfill expectations**
  Proponents of new technology tend to promise magical functionality and radical improvement in order to get project proposals accepted. The Web-based GIS component of the online planning model prototype will have only limited functionality. However, some users are likely to wish to perform more sophisticated spatial analyses than provided by the Web-based GIS. If data providers have not made agreed to make their data available for downloading, these advanced users will be disappointed by the system. Furthermore, the model has to find the fine line between insufficient information and information overload, which is complicated by various stakeholders' needs and expectations.
- **Technical complexity**
  In addition to organizational complexities, the model's promoters have to be conscious of how technically complex it can get. By trying to take advantage of emerging technologies to merge Web-based publication and analysis functions into one system, the complexity of data management, transfer, and access issues can jeopardize the effectiveness of the model. The system has to be flexible enough to accommodate changing needs during on-going consensus-building efforts. Again, it has to be recognized that it will take time to build the capacity needed to deal with the technical complexity. This point is aggravated by the fact

that many stakeholders would not have adequate internal capacity to deal with technical issues on their side.

- **Dependence on technical skills**

  The potential technical complexity increases the model's dependence on technically proficient staff. The management of the PIC and data providers' sites requires advanced data handling and processing skills. The devil is in the details when it comes to data transfers and upload protocols. The technical infrastructure underlying the model has to operate smoothly to let users make effective use of it.

- **Data issues**

  If stakeholders refuse to provide relevant information or do not accept provided data, the online planning model lacks its basis. To be effective, it is crucial that data be shared across organizational boundaries and information provided be accepted as valid and perceived as relevant to the needs of the users. To be shared, data have to meet defined standards.

- **Investment in technology**

  The introduction of IT into planning comes at a significant financial cost. Bonchek pointed out that, while computer-supported communication reduces some cost, it also raises costs associated with the use of computers and networks (1995): Stakeholders must possess computers, must know how to use them, and must pay for network connection fees. In an online planing environment, there are additional costs associated with technical management and mediation. The necessity for establishing a significant technical infrastructure brings up the issue of its sustainability and continued funding.

This discussion hints at the challenges of integrating the complexity of emerging technologies and consensus-building. Any attempt to build a new system should take lessons from similar system implementations into account.

7.1. Some Lessons Learned for Implementation

The MassGIS case demonstrated how entrepreneurial government led to impressive results. The enthusiasm of its staff has overcome many barriers to establish a multi-agency GIS service. The major strategies pursued and lessons learned are summarized below:

- **Define the problems to be addressed and goals to be reached.** For example, the distribution of strategy papers provides an opportunity to manage users' expectations.
- **Identify "collaborating early adopters and problem agencies."** Instead of getting all agencies to participate in the implementation process from the beginning, the staff focused on working with agencies that were willing to collaborate in order to build initial examples of the system's potential.
- **Develop presentable results early.** The publicity of the system's potential created momentum triggering a bandwagon effect that convinced hesitant agencies to join the effort [Interview #2, Terner]. Once there were a few maps to illustrate applications, the system sold itself.
- **Do not underestimate the time and resources required for data maintenance.** Key success factors of a centralized GIS are its data quality, accuracy, and timeliness. If data maintenance is neglected, the service can quickly lose its credibility.
- **Define common data standards to ensure smooth data exchanges.** Some basic spatial data standards should encompass, for example: (1) data formats (e.g., for exporting); (2) projection and datum; (3) scale/accuracy; (4) naming conventions; and (5) metadata content. However, standards that attempt to be too comprehensive can become too complex and turn into a hindrance.
- **Provide adequate staff training and build expertise in participating institutions.** Training should not only focus on teaching computer skills but increase general information awareness by demonstrating how geographic information can be integrated into decision-making processes. Users should be involved from the start of implementation to ensure that the system will meet their needs and will be accepted by them.
- **Address organizational issues from the beginning of implementation.** These issues should not be delayed until a technically operational system exists. Campbell (1992) pointed out that organizational issues (such as ownership and

control of information, securing general commitment to a GIS project, and ensuring that user needs are met) can be best achieved through a realistic understanding of the role of information in decision-making.

- **Demonstrate overlapping areas of interest among users.** For example, a simple matrix (that shows users and data layers) as illustrated in table 9 can quickly convey the idea of mutual benefits derived from a GIS implementation that provides different users with common baseline data.

Table 9: Example of a matrix overview of interest overlaps among stakeholders

Data Layers	*Stakeholder 1*	*Stakeholder 2*	*Stakeholder 3*	...
Land use layer	X		X	X
Roads	X	X	X	
Hydrography		X	X	X
...	X		X	

7.2. Remaining Issues

In previous chapters I have discussed key obstacles to effective land use planning and pointed out how my proposed online planning model addresses them. But my model is not a cure-all, and several issues remain:

- **Institutionalization and acceptance of consensus-building**
  To effectively use consensus-based planning and implement its outcomes, consensus-building processes have to be integrated into existing political and administrative decision processes. But historically grown procedures and relationships are difficult to change. Simply offering online planning services does not guarantee that innovative approaches are taken advantage of and outcomes are accepted as inputs into formal processes. Broader political and societal forces have to help pave the way for the online model to become effective. The model's effectiveness depends on institutional willingness to embrace a consensus-building approach and its technology. It takes time to overcome historical mistrust within and among institutions, address stakeholders' perception of losing control in consensus-based planning, and create a spirit of collaboration.

- **Legal framework**

  Related to the previous point is the integration of informal consensus-building into the German legal framework. The controversy regarding the legitimacy of informal consensus-building processes is part of the traditional controversy about the role of public participation in a representative democracy. The legal planning and administration law framework allows informal consensus-building processes, but only in as far as they do not undermine formal administration processes. For example, the informal negotiation of issues that have to be treated in formal processes such as the plan determination process (*Planfeststellungsverfahren*) in case of spatial impacts is problematic.

  The question to what degree assisted mediation can be integrated into the German legal framework has been treated by Wolfgang Hoffmann-Riem (1983) of the Department of Justice in Hamburg. In his book, he raises the question whether the "legalization" of informal consensus-building processes would be counter-productive, since formalization is usually achieved through standardization. However, important characteristics of consensus-building processes are their informality and flexibility. Instead of writing a normative consensus-building law, administrative processes should be modified in such a way as to ensure the transparency of informal consensus-building processes and to open them to public scrutiny.

- **Infrastructure**

  The model depends on the availability of an information infrastructure that allows stakeholders to connect to the Internet in order to take advantage of the PIC's services. National efforts to build such an infrastructure are currently under way in Germany. In addition, the Web-based GIS component depends on the availability of digital baseline data. Initiatives in this direction are also under way (I talked about the ALK and ATKIS systems in chapter two), but the current status leaves improvements to be desired. Moreover, the a consensus-based planning process requires mediation skills, for which there are few educational opportunities in Germany. Professor Zilleßen (1996) has outlined requirements to build educational capacity to train mediators.

- **Limitations of model**

  The online planning model does not guarantee that consensus or mutually agreeable solutions will be achieved. Consensus-building processes involving multiple stakeholders can convey the impression of taking more time than traditional planning approaches. While the benefits pay off in the long run, short-term concerns over efficiency loss may jeopardize continuation of a consensus-building process. We also have to recognize that there are conflicts in which attempts to build consensus will be futile. For example, if plans deal with highly antagonistic interests or politicized issues that leave no room for compromise, or involve basic societal/individual values, consensus-building adds little value to the process (an example would be the siting of nuclear power plants).

- **Cost versus benefit**

  It is difficult to perform a benefit-cost analysis that could be used to convince stakeholders to support the implementation or operation of the PIC. The main issue is that the predominantly intangible benefits of a consensus-based online planning model are difficult to quantify. Furthermore, the establishment of the center requires high up-front investment, whereas the payback occurs with a significant delay. One way to address this issue is to convince a few champions in key positions who believe in the model's long-term benefits, so that they are willing to support the implementation during the difficult beginning. There are many future benefits such as strengthened communication channels, but few immediate tangible benefits. Related to this issue is the question of sustainable funding. The PIC would be dependent on financial contributions from the stakeholders or other sources such as foundations.

7.2. Recommendations

Having studied within a "technology-friendly" environment, in which emerging technologies were abundant, has probably skewed my initial expectations of what is possible and feasible in a spatial planning context. In this academic setting, I experienced the benefits of powerful client/server networks and enjoyed easy access to the Internet. In this spirit I developed my ideas for an online planning system.

Then I learned about the state of information systems technology in the study area. The majority of stakeholders does not have access to the Internet, many local governments have not computerized their planning operations, and digital spatial data is hard to come by. However, a recent survey of local government in Germany (KGST, 1995) has shown that the diffusion of GIS technology is spreading fast. The proposed model provides an institutional and technological framework to coordinate IT initiatives on a regional scale, avoid redundancies, and prevent individual agencies from developing multiple standards and applications.

While my experience as a systems integration consultant has exposed me to resistance to change in organizations as well as turf battles between departments, the task to convince multiple institutions or individuals with possibly adversarial relationships to collaborate and share resources still seems daunting. However, drawing from my conclusions, most of which are admittedly speculative, I see potential for an online planning model to build consensus in spatial planning processes and recommend the following initiatives for Leipzig and beyond. In concluding, I develop a scenario for implementing my proposed online planing model for sustainable land use planning in Leipzig.

Assuming that I were asked to implement a prototype system, I would start with a limited planning problem such as the land use dispute surrounding a flooded mining pit (to recall, local and regional agencies in an area south of Leipzig were at odds about how to balance environmental versus economic interests in the case of an old mining pit that had been converted into a lake; while regional planning authorities were more concerned with balanced use of the resource, local interests wanted to maximize its benefits for recreation and tourism.). I would establish collaboration among a few "early-adopters" who have an interest in the problem, collect an initial set of crucial information, and incrementally build the prototype's capacity to incorporate additional stakeholders and data sources. While this implementation approach is similar to the approach MassGIS has taken, technological developments during the last ten years offer new opportunities for establishing an open planning process that has the potential to incorporate various stakeholders, strengthen their commitment to outcomes, and build long-term support for a mutually agreeable solution. To get things started, financial support for experimenting with an innovative consensus-based online planning approach might initially come from state or federal sources such as the Ministry for Education and Research (*Bundesministerium fuer Bildung und Forschung, BMBF*).

My vision would be to develop the model from a limited online planning center into a widely accepted environmental planning system that builds stakeholders' capacity to flexibly provide and access relevant data and information within two years. By incrementally enhancing and expanding the model, it has the potential to evolve from a local, specific-problem system to a regional system, which would be adequate for more comprehensive environmental planning (ecosystem view). As the IT infrastructure and stakeholders' technical capacity improves over time, the hub institution could increasingly focus on providing facilitation services and implementing a data warehouse concept to reduce the complexities of its data management services. The following main initiatives illustrate in more detail how this vision could evolve.

Establish planning information center

- I would hire a cross-disciplinary team to staff the planning information systems. The three to five team members would bring complementary technical and functional expertise in the areas of data management, GIS, mediation, environmental planning, and public relations.
- While some team members would set up the hub institution's technical infrastructure, others would start building relationships with stakeholders to identify early adopters and to identify relevant data. For example, in the lake land use dispute, PIC staff would work with directly affected stakeholders and try to understand the local environmental and economic context and how it fits in the regional context.
- The goal would be to quickly connect stakeholders in a networked hub configuration as illustrated in figure 20 (components of the PIC's hub homepage),

at whose hub the PIC team provides technical facilitation and management services.

Introduce technical facilitation service

- I would work as a "technical facilitator" to support consensus-based planning. In this capacity, I would promote an information-rich environmental planning approach and perform many of the tasks a "traditional" mediator would perform as described by Susskind and Cruikshank (1987:142). For example, in the land use dispute I would (1) meet with potential stakeholders and data providers to get familiar with their interests (e.g., sustainable landscape, recreation, tourism), data needs, and willingness to provide data; (2) identify stakeholders such as environmental groups and how to connect them; (3) support joint fact finding efforts to collect relevant data or to aggregate existing data into a more easily analyzable format; (4) encourage online brainstorming; (5) help stakeholders to reframe issues by letting them explore different views, etc. The main distinction from a traditional mediator lies in the focus on technical aspects, their translation into an online planning model, and the offering of online services.
- As technical facilitator, I would have to convince potential stakeholders to participate. This kind of technical advocacy should not be misunderstood as substantive advocacy. Hence the technical facilitator not only has to be technically knowledgeable but also has to skillfully deal with stakeholders' concerns. I would be less concerned with the substance of the issues but with the process for reaching a mutually agreeable solution. Initially, I would concentrate my efforts on the early adopters and would point out the benefits of consensus-building and the advantages of emerging technologies. To gain support, it would help to show how a certain percentage of overall cost invested in an online planning model might result in expected savings due to a more successful implementation process.
- The technical facilitator and PIC team would manage the hub institution to assist stakeholders in areas such as (1) helping them to structure their perspective and to present it on the position homepages; (2) building links to relevant information; and (3) offering training sessions. I am advocating an

activist technical facilitation, which purists will reject as non-neutral. However, I believe that the introduction of information technologies into a consensus process requires activist intervention to attenuate differences in technical sophistication and to address questions on the quality and validity of newly available online sources and methods. If the online planning model supports traditional mediation processes, the technical facilitator should work closely with a "neutral" mediator to capitalize on synergy effects and to avoid duplication of effort.

Provide GIS and data management services

- Initially, the PIC would provide access to a limited number of data layers and have a powerful GIS installed, so that it could provide GIS services to stakeholders who do not have access to GIS otherwise.[32] In addition, the PIC staff would try to extend a limited set of GIS functionality to the Web by taking advantage of GIS Internet software. For example, in the land use dispute, an environmental NGO might commission the PIC to do a GIS analysis of environmental impact of several land use alternatives. By making some data layers available via a Web-based GIS and providing collaborative tools, other stakeholders could gain a better understanding of the complexities involved in the dispute. Through providing such services, the PIC can incrementally build local and regional contacts and data sources.
- I would also establish a data committee consisting of technically knowledgeable stakeholder representatives to get agreement on acceptable source data. After having identified early adopters, PIC team members would work with these representatives to define early objectives and identify initially required key data sets such as existing land use, hydrography, or infrastructure network data layers. The PIC team would incrementally assemble an inventory of available data and information sources.

[32] An example of an IT service provider in the US is the Milwaukee Neighborhood Data Center, which was initiated in 1992 by an association of more than 200 local nonprofit organizations. This Data Center uses GIS to provide many community services, and offers training and consultation on community organizing, nonprofit management and other areas (Barndt and Craig, 1994).

- The technical facilitator would then try to convince potential data providers to make summary data available, and outline the subsequent update process (providers retain control of data, specification of appropriate aggregation level). While some of the source data such as base maps will not change frequently, the committee could establish update protocols for more volatile data such as water pollution time series to ensure that the stakeholders deal with reasonably up-to-date data. Eventually, the move towards data warehousing will enhance the flexibility of data provision. The warehouse could store data sets that are restructured for analysis in a standard format in a single database. Data providers could put their updated copies into their respective directory on the warehouse server. Depending on the model's scale, this could trigger automated processes to replicate the new data to regional server sites.
- The data committee would also work out what to standardize (data formats, frequency of updates, metadata, etc.), how to make data available (e.g., who can view and/or download data), how to manage large data sets (e.g., tiling), and how to deal with cases in which additional processing by the PIC would be required. The committee representatives would define quality standards, ensure that aggregate data meet them, and approve data for release. The process of identifying data needs and agreeing on standards and source data is likely to be a time-consuming task at the beginning of the consensus-based planning process, but it is crucial for the success of the model.

Promote integrated process management and focus groups

- In an effort to make planning processes more effective, I would promote the idea of a process management team. Instead of having several agencies with limited responsibilities involved at different stages, this multidisciplinary team would be responsible for accompanying a complete planning process, from beginning to end. Team members would work with specialists in organizations, which become involved at different stages of the planning process. This would take advantage of synergy potential in planning, reduce overall coordination effort, and facilitate the building of relationships.

- In addition, I would organize focus teams to work on important aspects of a plan. These teams could be composed of representatives from different stakeholders and would provide an opportunity for constructive public involvement. Figure 22 illustrates these interdisciplinary teams as part of the online planning model.

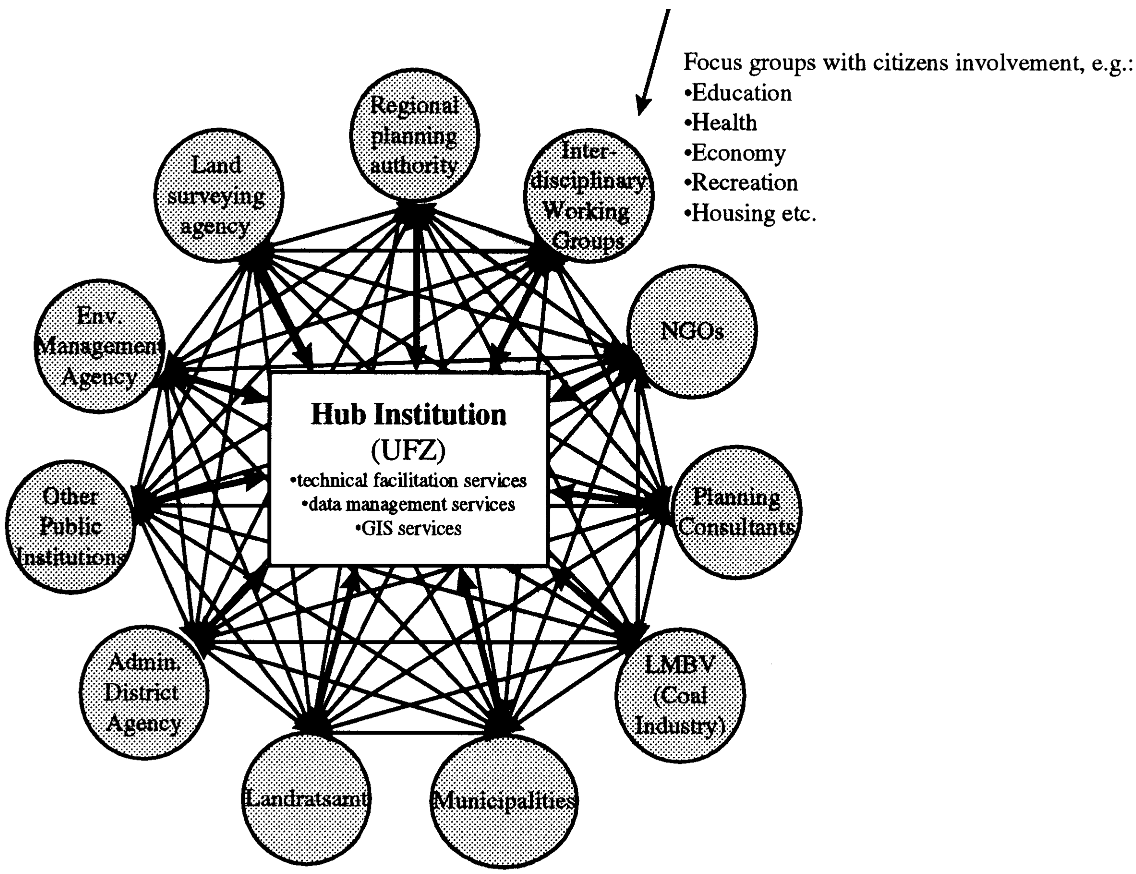


Figure 22: Incorporation of focus groups into online planning model

- For example, focus groups could investigate different aspects of the disputed land use surrounding the lake. One group might represent recreational interests, another might investigate potentially negative environmental impacts, etc.

Build expert network

- An online planning model should take advantage of its global reach and independence of time and location to incrementally build a network of subject experts. These experts could be contacted in case of scientific uncertainty and controversy. For example, focus groups investigating environmental impacts of land use alternatives could contact experts on sustainable land use theory and find sites that have experience with similar issues.

- At appropriate times, the technical mediator could arrange online mediated question and answer sessions with experts.

Set up consensus fund

- The operation of the PIC would require initial setup investment, as well as ongoing support. It would be difficult to solicit stakeholder support based on the model's conceptual blue print. Therefore, I would write proposals to secure state, federal, or private financial support to establish an online planning model. I would propose a budget of about $500,000 - $1,000,000 for the first two years. The decision in favor of or against investing resources in IT largely depends on the importance of the costs and benefits associated with a plan as well as the expected value added to supporting decision-making by an online planning model.
- Once some stakeholders have accepted the model, I would promote the idea of a consensus fund instead of charging for the delivery of PIC services. If stakeholders believe that such a model adds value, they could, for example, contribute a small percentage of their budget on a monthly basis. The fund could also be used to help stakeholder groups gain access to the system.
- Alternatively, the PIC might start out as an independent consulting firm offering EIA services to local agencies. The firm could then try to expand its services by including increasingly sophisticated collaboration and GIS services on a fee-basis.

Promote regional/national information infrastructure

- Public access to government information is essential to ensure government accountability and democratic decision-making. The German environmental information law has laid the legal foundation, and emerging technologies offer opportunities to implement its stipulations.
- I would promote the building of baseline data and an information infrastructure that makes it possible for increasing numbers of stakeholders to connect to the

online planning model. The government sector should play an important role in developing the fundamental spatial information infrastructure due to its activities in the systematic collection, maintenance, and dissemination of geographic data.

- The information infrastructure initiative should build on the MERKIS initiative (discussed in chapter two). The central objective of MERKIS is the integration of local government databases and the avoidance of inefficient duplication of data capture and maintenance.[33] Yet MERKIS has a strong government focus. I would promote to broaden its scope to include other sectors' representatives similar to the National Spatial Data Infrastructure (NSDI) in the US. Any national initiative should also be closely integrated into a broader European framework.

Research impact of public participation

- This paper has excluded considerations for widespread public involvement. This exclusion was deliberate, because public participation raises complex issues that deserve a separate thesis. These issues could question traditional planning processes and power distribution. For example, the major source of citizens' disappointment with public participation in Germany has been the lack of real citizen influence on decision-making. However, as evidenced by the 1994 environmental information law, public involvement has become increasingly important in planning. As citizens demand more efficient and transparent government services, public institutions are confronted with the task of better communicating their services to the constituents.
- Another issue is how much value the dissemination of planning information via the Web adds. While the Web can make information more easily accessible, citizens with a vested interest will seek out information anyway, and it is likely that they will regard the information on the Web as insufficient.

[33] The implementation of MERKIS requires changes in existing organizational structures within local government. Taking the local government of Wuppertal as an example, Cummerwie (1993) has studied the impacts of introducing MERKIS on the complex organizational local government system, whose responsibilities, interdependencies, and procedures have evolved over a long time.

- Further research on the role of public participation and how the public can be integrated into an online planning model needs to be conducted. It is not as easy as advocating to connect every citizen to online planning models. Planning requires a certain level of continued commitment, which not all citizens are willing to contribute. The experience of the UFZ researchers suggests that many citizens seem to be interested in advances in information technologies, but they are often unsure about how these technology can affect their personal life (Grossmann et al., 1996). Once they had gained a better understanding of the potential impact of emerging technologies through participation in workshops, they could better imagine how these technologies might change their demands in terms of, for example, land use or infrastructure.

> *A popular government, without popular information or the means of acquiring it, is but a prologue to a farce or to a tragedy; or perhaps both. Knowledge will forever govern ignorance. And a people who mean to be their own governors, must arm themselves with the power knowledge gives.* John Adams, Aug. 4 1822

Interviews

Interview #1, in person: Joan Gardner, Jan 1997, President Applied Geographics, Boston, Massachusetts

Interview #2, in person: Michael Terner, Jan. 1997, Vice President Applied Geographics, Boston, Massachusetts

Interview#3, in person: David Weaver, Jan. 1997, Vice President Applied Geographics, Boston, Massachusetts

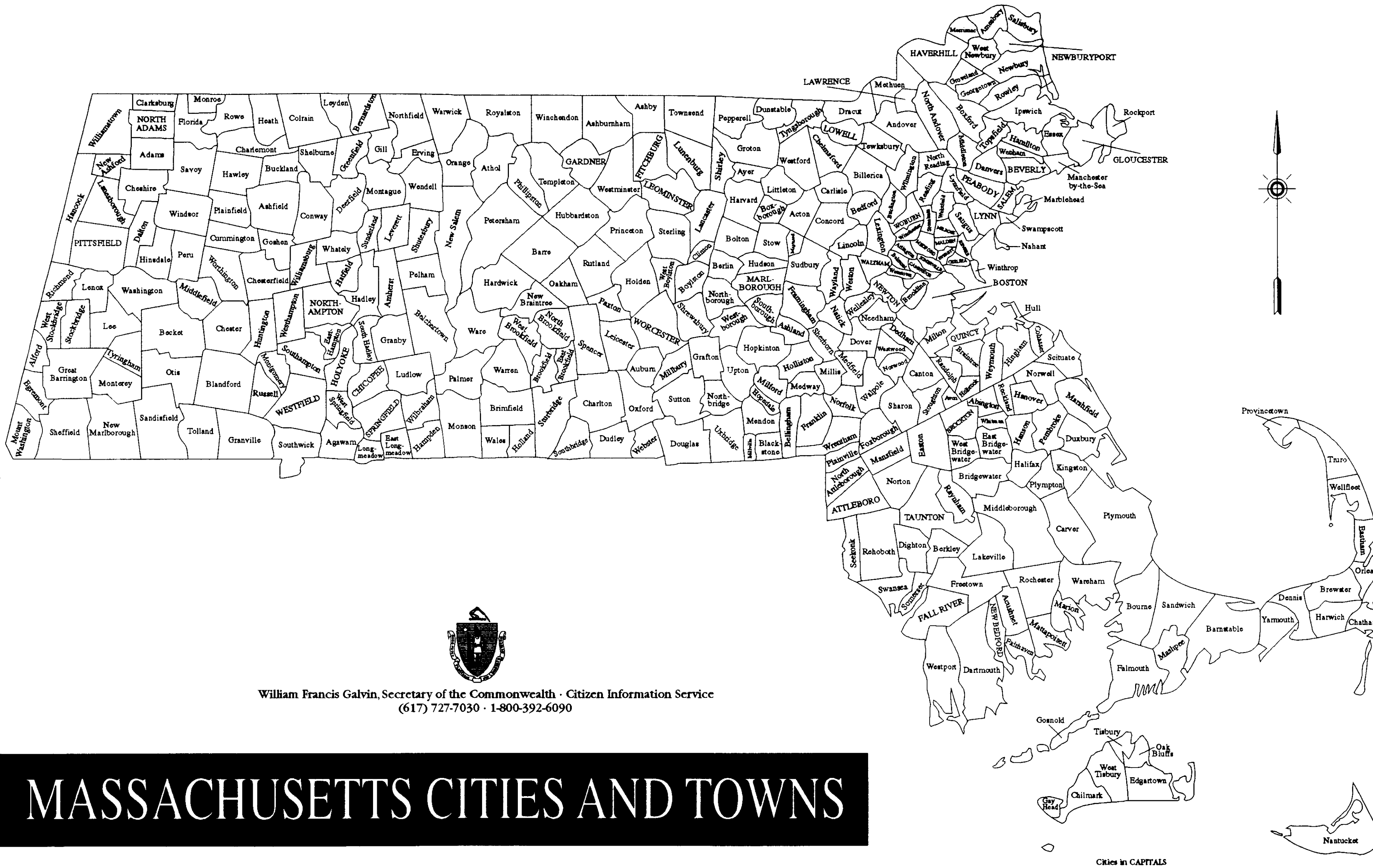
Interview#4, in person: Christian Jacqz, Jan. 1997, Director of MassGIS, Boston, Massachusetts.

Interview #5, telephone: Dr. Meiß, Jan. 1997, Researcher at the Umweltforschungszentrum Leipzig.

Interview #6, telephone: Frau Bellmann, April 1997, Regionaler Planungsverband Westsachsen.

Appendix A

Map of cities and towns in Massachusetts



William Francis Galvin, Secretary of the Commonwealth · Citizen Information Service
(617) 727-7030 · 1-800-392-6090

MASSACHUSETTS CITIES AND TOWNS

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