# Chapter 1. Introduction

The way planners gather and analyze information is archaic and extremely expensive. It has been this way for decades, and unlike other industries, it does not seem to be getting cheaper. Until the planning information systems community addresses this problem in a holistic manner, data-based analysis will never fulfill its potential to inform urban planning.

Few ever dispute the common folklore that 80-percent of any analysis effort is spent gathering data, leaving 20-percent of one's resources for the actual work that needs to get done. This is not a new realization. At least ten years ago we believed that the rapid increase in GIS adoption, and the ubiquity of data in electronic form, would lead to lower data sharing costs (Obermeyer and Perloff 1994). However, there is no evidence that this occurred. In fairness, the quality and quantity of the data brought to bear on a problem has improved dramatically, but the most important factor—the ***relevance*** of analysis in the decision making process, leaves much to be desired. The reason is simple. Analysis is not ***timely***. For example, if it takes years to assemble the data for a large environmental impact study, is it not likely that the analysis will be irrelevant before it is presented? And once this analysis is put in front of decision makers, how extensive is their ability to provide feedback? Can someone propose, for example, an alternative economic strategy based on tourism instead of riverboat gambling and generate a new, 1,000-page report? Or is stakeholder feedback relegated to meetings and minutes, never being explicitly linked to the numbers it discusses?

This thesis argues that our data gathering practices are broken, and are not likely to improve until significant structural changes are made to urban information management systems. The traditional areas in which we focus our research—data modeling, analysis, and visualization—are developed far beyond the capacity of practitioners to use them. The software that does such a good job with those tasks does little to facilitate basic data acquisition and processing. We have for too long overlooked the medieval data gathering practices common at all levels of government. Corporations have moved into the 21st century with integrated information systems that connect businesses with upstream and downstream trading partners, so that data is no longer re-processed when it moves from one organization to another. The planning community, on the other hand, still operates like traders at a bazaar, making deals, bartering, mixing and matching the data sources that form the foundation of our analytic systems.

Improving the flow of data between and within organizations is the next great challenge for planning support systems (PSS). With the sheer quantity of information sources available to planners increasing every year, and the dramatic technology investments made in the late 1990s, this is an especially important time to re-examine the ability of information technology to inform decision making in planning. What we really must do is re-evaluate what it means to be in the practice of creating planning support systems. It does not mean to combine theory, data and a methodology into ***a plan*** of action for a specific place and time. It means to create systems that provide stakeholders with the ability to ***continuously make plans*** (Hopkins 1999), have them pre-empted by others' actions, and re-plan based on the new conditions. A system that did this would truly aid the decision making process and completely change the debate around how information and specialists are used in the planning process.

## Motivation and Background

Over the last ten years, few technologies have captured the interest and energy of information technology professionals like XML[1] and Web services. Recently the fruits of this investment have been seen in public-facing applications like new interfaces to the databases of Google and Amazon. But perhaps more important are the XML and Web service-driven applications buried in the corporate back-office IT infrastructure, seamlessly connecting them with their business partners, and allowing them to achieve operational efficiencies that were barely imaginable in the 1980s. This is how Amazon can sell you a used book from a small, independent bookstore in Allentown, PA for two dollars and still make a profit. This is how Wal-Mart can continuously adjust their prices and inventories to meet changing supply and demand and respond to the vagaries of consumer preference. What can planners learn from Amazon? That question is central to this thesis.

[1] All acronyms are defined in Appendix B.

## ***Leveraging important technology trends***

The research agenda of this paper is inextricably linked to a number of fundamental changes happening in how government collects, stores and distributes data, and how Internet-aware software is built. While planning cannot adopt corporate technology wholesale, we do not have the financial resources to develop our own basic technologies from scratch, like the military industry. This puts us in the precarious position of strategically choosing which technologies to adopt from other fields, and which ones we should develop ourselves. I list here some of the trends I believe PSS must follow and adopt to be successful in the next few decades.

**An urban information explosion.** There is more to solving planning issues than simply obtaining the right data, but it is certainly fair to say that information plays a key role in an effective planning support system. What exactly is this role? How do we conceptualize our information processing requirements? These issues are more important than ever as we enter an era where almost every device will have the capacity to contribute to the city's information undercurrent. The new standard for Internet addressing, IPv6, was created to greatly increase the number of IP addresses available in response to industry's desire to give unique Internet IDs to devices other than full-fledged computers. This standard is already in place and in use. Wireless Internet access is becoming increasingly common and is beginning to play a role in public sector computing (***Muniwireless*** 2004). Hardware for wireless Internet access is less than $10 as of June, 2004. These three trends taken together make it probable that even low-cost devices such as phones, cameras, buses, watches, traffic sensors, air quality monitors, etc.

will be Internet-aware and addressable in the near future, leading to an exponential increase the quantity of information available about the urban landscape.

**Geographic data sharing and systems interoperability.** Efforts to standardize the way in which we describe geographic features are critical to our ability to share government data between different departments, levels of government, and commercial and educational institutions. For example, if all municipalities called parcels by the same name and used the same terminology—and meaning—for a parcel's attributes, the cost of regional planning and administrative operations would be greatly reduced. In Europe, the problem has been less acute as most data collection occurs at the federal level. Therefore, work in this area is mainly happening in North America, where there is a strong tradition of local independence from federal control. The U.S Federal Geographic Data Committee and ESRI have strong programs in place to promote a common description of the most basic data sets used in government.

Of equal importance is the ability to locate and ingest another party's data with little or no human intervention in the conversion process. This is ***systems interoperability***. The OpenGIS Consortium's standards for geographic data encoding (GML/Geography Markup Language), geographic data publishing (WFS/Web Feature Service), and map publishing (WMS/Web Mapping Service) are being well received in the industry and provide one of the foundations upon which this work depends.

**XML.** Arguably the most disruptive technology since the advent of the World Wide Web is Extensible Markup Language, or XML. XML is really nothing by itself. It is simply a framework in which to write highly structured languages for describing things and passing messages between computers. It is also very important that XML languages are plain text, so that their content is transparent to humans, even in the absence of computer programs that can read and manipulate the XML. This has a profound effect on people's trust in the content and in the ability of the content to be used in almost all current and future computing environments.

**Web services.** "Web services" is an umbrella term to describe systems that allow applications to communicate between computers using XML as a messaging language. The different communication implementation strategies go by many names (the most well known being SOAP, or Simple Object Access Protocol). However, the implementation strategies are not important in this context. What is most important is that all Web services strategies use a well-known and widely implemented Internet protocol for communication—HTTP—the foundation upon which all Web sites operate. While some technologists decry the drawbacks of the Web protocol, the advantages are numerous. The most obvious is that most organizations already have a Web infrastructure in place, so implementing Web services can be handled in a familiar way, and the wealth of Web software can be used to develop and run new Web service-based applications. The other important aspect of Web services is that they use XML for passing messages between computers, preserving the transparency that has made XML so popular and useful (although some implementations, most notably those promoted by Microsoft in their .NET framework, often still hide the actual message content (data) in a non-human readable format).

Whether or not XML is better than other technologies, the software industry has quickly supported it, building powerful, reliable tools to read XML and develop Web Services on every operating system and application in common use. Perhaps the strongest sign of XML's importance is that Microsoft, which does not have a strong reputation for encouraging interoperability with others' applications, has decided to base their enterprise development software on Web Services, and has changed the native file formats of Office documents to XML.

### *Reflecting on the science of GIS*

> ***How do we explain geographical phenomena through the application of appropriate methods of analysis, and models of physical and human processes? Under what circumstances is the scientist willing to trust data that he or she did not collect, and will the increased technological ability to share scientific data over the Internet…change them? Such questions about tools often have their roots in theoretical questions about appropriate representations, operations, and concepts.***
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> —Goodchild, et al., IJGIS 1999

These fundamental questions are posed in a 1999 article co-authored by many of the elder states-people of the field, including Mike Goodchild, Max Egenhofer and Karen Kemp. One might suppose that thirty years into the evolution of GIS these issues would have been discussed in great depth. Yet the article introduces an initiative funded by the National Science Foundation, Project Varenius, which seeks to build the theoretical foundation of geographic information sciences that was neglected during decades of practice-oriented work.

This project, while concretely grounded in a prototype implementation, fits well into the research agenda expressed by Project Varenius. It provides a set of circumstances under which scientists (and engineers and planners) can share data and collaborate on analysis. We do not hope to provide the definitive solution—that will take years of work by our community of researchers. The main goal is to encourage the field to step back and address fundamental, broad-based data management problems that must not be left to the fields of management information and computer sciences.

## An Organizational Theory of Planning Support Systems

The field of planning support systems is defined as, "a conception of integrated systems of information and software which bring the three components of traditional decision support systems—information, models, and visualization—into the public realm" (Klosterman 1999). While Klosterman's three components have been well researched over the last two decades, work on ***integration*** has not received proper attention, especially in regard to the organizational setting through which information flows. This section discusses the dominant information management paradigms planners currently use, and the primary ways researchers have attempted to address shortcomings in the effectiveness of collaborative information systems. We see a mismatch between the problems we would like to solve, and the strategies employed to solve them, and we posit that this is why truly effective solutions have proven elusive. To address these systemic problems, it may be necessary to develop a technology strategy based upon a different theory of information sharing across organizations. This section develops such a theory, which informs the technology framework that is the topic of this work.

### *Dominant information management paradigms*

The most basic information management paradigm is the ***single user*** system, where everyone manages their own copy of information for their own purposes. This strategy quickly falls apart in organizational settings, where productivity gains can be had by centralizing data collection and management activities. This leads to a situation where data are in one place, and users are in many other places. This problem has been addressed using ***client-server*** information architectures. The central principle here is that data resides on a server, and multiple, heterogeneous clients all access a particular data set from that server. Over the past few decades this strategy has worked well. It fits (and perhaps has even influenced) the structure of many organizations, who try to centralize specialized activities like information technology in one department. Data producers are able to write, or publish, data into the centralized database server (data entry or publishing clients), and data users are able to read data out of the centralized system. There is no direct connection between data producers and users in this type of setup.

The client-server strategy is usually only employed within a single organization, because allowing users direct access to one's database is a potential security problem, and the system often requires some training and knowledge on the part of the user. In the 1990s, ***Web-based clients*** came into vogue. Data was more secure—database connection information was hidden from the user and buried in the Web server, and the database accessed through the Web was usually a duplicate, expendable version. Data usage and interpretation was also made simpler by using the increasingly familiar metaphor of the Web page for information presentation and manipulation. The security advantages of Web-based systems are clear, but the benefits of Web-based client software is less so. In the 1990s, when these technologies were being developed, users often had little experience with computing, so the Web strategy made sense. But in the near future, if not today, information users will have a sophisticated understanding of software user interfaces, and feel limited by the simplicity of Web-based clients. So while

Web-based clients have taught us a lot about addressing security concerns, Web pages may be reaching the limits of their usefulness as client software. Also, the Web has little to tell us about collaboration. The client-server paradigm has not changed, so there is no reason to expect the traditional Web server-Web page architecture to lead to revolutionary advances in information management and collaboration.

### *Geographic information sharing research*

There already exists a strong body of literature in the area of geographic information sharing. The traditional line of inquiry researchers often take is to examine existing organizations and their efforts at collaboration (Evans, 1997) in an attempt to understand why goals are not better met. The most general problem is that organizational settings are highly complex. When embarking on an information sharing project, many issues may arise, such as reluctance to share GIS files due to a fear of losing autonomy, control over information sources, independence, organizational power, cost, complex inter-organizational interdependencies, and politics (Nedovic-Budic and Pinto, 1999-2, 54). Solutions to these problems usually address the social, political and organizational problems using an existing technology, or at best a new technology within an existing paradigm. On the other hand, research in planning support systems is usually geared towards technology that advances the state of the art in one of Klosterman's three pillars, with no formal attention devoted to how the technology addresses organizational issues. By considering technology fixed, information sharing researchers are led to false conclusions. For example, it has been found that the information sharing success is found when the parties have aligned interests and work well together. What about those organizations who do not have well-aligned goals; do we expect them to never collaborate successfully? Is this an acceptable situation in planning? If we can only expect to build successful information sharing systems in that type of environment, we can never expect to change the balance of the 80-20 data management-analysis split.

### *Positioning PSS in the Theory of the Firm*

We believe that technology research can do more to aid information sharing than the current dominant information management paradigms allow. Above all other problems, the geographic information sharing research community identifies cost as the main barrier to successful projects. While some people express a desire to collaborate motivated by altruism and efficient government, the cost in time, resources, and money to one's own organization, in conjunction with the value derived, most often determines participation and long-term success (Nedovic-Budic and Pinto 1999-1). So then if economic concerns drive behavior, then traditional economic theory should have much to offer the urban planning field. From this perspective, we can restate the information sharing problem as one in which the costs of the system must be less than the benefits. We know that the costs of data management and sharing are high enough so that the literature advises us that the benefits must be very high to achieve successful outcomes. The goal of technology work in this area is therefore distilled to a simple principle. The lower the cost of participation in a system, the less an organization must benefit from participation. And as benefits increase, so can cost. A large state organization whose mandate is information delivery can spend a great deal of money to accomplish this goal. However, a small non-profit whose primary mission is economic development and housing has limited time, resources and interest to devote to the issue. Yet both these groups, and many in between, must be accommodated within the same framework if the technology of information sharing is to address the entire community that planners must serve.

Many in our field are uncomfortable with comparing government to corporate operations because of their different goals and motivations. However, they are more similar than different, as private sector firms have information management demands (and standards) at least as high as state and local government. We can learn a great deal from the business literature if we simply agree that both private and public agencies are groups of people organized to accomplish certain tasks in a cost-effective manner. Such is the case whether the tasks performed are part of a beer advertising campaign or a journey-to-work study. This viewpoint is not novel. Our term of art, planning support systems (PSS), is a direct descendant of the corporate term, decision support systems (DSS), that came into vogue in the 1980s (Klosterman 1999), and most researchers have believed for a long time that GIS should ultimately be part of MIS (Obermeyer and Pinto 1994). So we have always looked to our larger corporate brethren for guidance on how to use information to our advantage. In upcoming chapters we update that strategy and seek to assimilate PSS into the mainstream of distributed information technology, but here we provide the theoretical foundation needed to choose the right technology.

The theory presented here is built up by first specifying a strict definition of the types of roles information plays in planning support systems. Then, we propose a way to approach the problems conceptually. The only assumption made is that organizational behavior is the lens through which these problems should be viewed. Other issues, such as technology, are secondary to this. By developing an understanding of the nature of planning-related information and the organizational behaviors we must encourage to improve our systems, a framework for PSS information management can then be developed.

## PSS from an information processing perspective

Most planning support systems are reticent to admit that their purpose is to quantify planning problems. Instead their proponents hedge, stating that they are no more than a platform for public debate. If the creators of these systems really felt that way, would they put so much thought into their methodology, and effort into data processing? Or is it rather the case that most analyses have such a short shelf life that their cost must be justified in some other way than their ability to provide answers? I would argue that it is the latter, and whether it is called an ***answer***, or a ***model***, or a simplification of a complex system, anyone working in the field of PSS must operate under the assumption that they are creating systems that process data into more easily comprehensible information to help people interpret a complex reality that is beyond the ability of any single individual, corporation or special interest group to understand.

Planning support systems do provide answers through a process that quantifies most inputs, but they are always going to be at an intermediate level. They are no substitute for ***decisions***. Therefore the PSS primarily exists to process information in ways that make it easier for people to make decisions—to understand issues and engage in highly informed debate, ideally in a collaborative environment. This is not to say that the analysis and presentation of information is not important, just that those functions are well studied, and advanced far beyond our ability to populate them with useful data (in fact, if this work is successful, someone might be writing ten years from now that PSS should be seen as an information presentation tool, because they will take for granted the richness of information available for presentation). But no analysis or presentation or public participation can happen without a rich warehouse of information upon which to work.

The complexity of modern cities contributed to the need for the profession of planning, so it should be apparent that the information systems planners use should help cope with this complexity. Although we are in an, "information rich era in which high volumes of data flow through ubiquitous communication networks (Evans and Ferreira 1995), current practices are not able to make use of it, at least not in a cost-effective manner. In fact, organizations usually ***resist*** distributed processing efforts (Meredith 1995), leading to high project costs with little return. This problem will likely become even more noticeable as we try to take advantage of all the environmental sensing equipment embedded in the urban landscape, from security cameras to camera phones and location-tracked transit vehicles, the data sources we can and should incorporate into PSS will increase exponentially in the near future.

It is difficult to argue against the current systems, because the lack of any universal practice or system is more notable than anything else. How do planners manage data? Basically they acquire it, process it in some idiosyncratic way to get it into their database. While there are some standard software packages in use, and plenty of "best practices" available to cite, there are precious few ***ubiquitous practices***. When practices become ubiquitous and generic enough that unrelated organizations can develop connections between their information systems, we have achieved ***interoperability***. And that is the point of this work, to define the general, interoperable, practices that software packages must implement if we are to have any hope of making better use of the information available today, and the immense increase in quantity and disparity of information that will be available tomorrow.

The primary raw material needed to create an analysis product is information. This information could be obtained by developing in-house data gathering capabilities, but the cost of that effort is beyond most organizations. Imagine sending teams of city planners (even if they ***were*** graduate students) out into the field to count traffic, go door to door asking people how much money they make, or how much they paid for their house. Why do this when organizations like the assessing department, the US Census Bureau, the Bureau of Labor Statistics, the realtor's Multiple Listing Service, and the actuarial databases of all kinds of insurance companies already have the information? It makes much more sense to form partnerships with these groups, and only develop custom data sets when absolutely necessary. For this reason, ***the production of planning analysis depends upon inputs from multiple, disparate suppliers***.

So ultimately, to make use of a large body of data, it will be necessary to work with multiple, disparate suppliers. But it may be easier to start by looking only at the case of a municipal planning effort using solely municipal data sources. What is the private sector analog to a town? Is a town a firm or a conglomerate? This is where things get slightly complicated. Most of a town planner's information providers are other municipal agencies, such as property assessing, building permitting or zoning, so it is tempting to look at municipal government as one firm with different departments that support the development of different products, like tax bills, parking tickets, police officers, drinking water, etc. However, in practice a government bureaucracy operates more like a ***multidivisional firm*** than a company in the normal sense.

Multidivisional, or M-form, firms have many unique characteristics, but for our purposes the critical one is that the reward and decision making systems are constrained within a division, so that there is little incentive for one division to act in the best interests of another (Carlton and Perloff 1990). Some opportunities are lost this way, but at least the organization does not collapse under its own weight (Ba and Stallaert 2002). At the state and federal level, this probably makes a lot of sense because the information and coordination required to operate such large organizations is overwhelming, but municipalities may be emulating their larger relatives, without much thought paid to the reason. This theory suggests that one solution to this problem (and perhaps to many other problems) could be to institute more hierarchical forms of local and county government so that all divisions operate under a unified risk and reward structure. However, the task at hand is to redesign information systems, not government. So we will work within the given institutional parameters, which suggest that it is best to consider a local government as a multidivisional firm, and that it will stay that way in the future.

So town planners cannot count on other departments to act as partners in the creation of their product. In other words, the assessing department has little to gain from reducing costs in the planning department. We are left with a situation where, from an ownership perspective (either as a stockholder or taxpayer), we would like to see our government maximize production across all divisions (e.g. assess property values ***and*** undertake planning analysis). However, the organizational structure cannot change, and by the definition of a multidivisional firm, the highest levels of the firm are not provided with enough information to tell the divisions ***exactly*** what to do. This is a vexing problem, and I believe it provides a good model of reality. In fact, this may be why we have so much trouble developing effective planning support systems—because we believe the government to operate like a single, unified firm.

When faced with the question of how to incorporate property value information into a planning support system, the PSS community has generally addressed the technical issues and assumed away the organizational ones. This would be fine if the organizational issues could be treated in isolation, but they are intertwined with technology. For example, since the 1990s, the trend in GIS has been to put data into an "enterprise" warehouse. "Enterprise" means that the data maintained by an organization (enterprise) resides in a centrally maintained database, with clients connecting over a network, and accessing those data sets a database administrator has granted them permission to use. This is fine as an intra-divisional solution, but the M-form theory suggests that enterprise databases find it difficult to cross divisions, and therefore enterprise solutions do little to address information management issues that cross divisional boundaries (Carlton and Perloff 1990). The theory is borne out by recent empirical data such as the following example. In a recent survey of 110 companies with revenue of at least $500 million, only 23% had their entire firm using one instance of ERP (enterprise resource planning) software.[2] And in one extreme example, as many as 400 different versions of a single vendor's ERP software were in use at a single, large company (Kock 2004).

[2] ERP is a term used to describe the process of managing an organization. The software usually keeps track of company-wide information regarding employees, facilities, etc. Unlike software used to achieve business objectives (like customer relationship management software), which might naturally be specialized for certain divisions or functions, one would expect enterprise resource planning operations to be easily centralized.

Examining local government from the perspective of an M-form, or multidivisional firm, provides some insight into past information management failings, but remember that a discussion of a municipality's relationship to other organizations was postponed. It is now quite easy to return to that issue, because our theory already considers different divisions as basically acting like different firms. Conceptualizing government as a multidivisional firm makes it easy to incorporate other levels of government, non-governmental entities, and even private firms. And later it will be shown that the theory suits not only the case when the analyst is a government entity, but the more realistic case when the analyst is a private entity working in loose collaboration with government, their own firm, and the public. There is no change required at the broadest theoretical level, although in practice minor differences will emerge—most likely around tighter data privacy requirements and perhaps higher costs and information licensing restrictions. While the differences between separate firms and different divisions within the same firm might be important in some ways, for the purposes of looking at how they share and process information, it is most useful to consider their relationship to be that of ***trading partners***.

***The way trading partners exchange information is by executing a contract***. This is a tremendously important point. A contract is a specification of all the rules governing a business transaction between parties. A contract is needed when the parties doing business cannot count on each other to maximize performance without one (this is basically any time when the two parties have different bosses). The contract must anticipate and specify what happens in all possible scenarios, because if you could count on the parties to behave properly in a situation not covered by the contract, the contract would not have been needed in the first place. While subcontracting and outsourcing continue to be cost-effective ways of doing business, this description of contracts begins to suggest how they can become quite expensive.

The cost of doing business with outside parties is addressed in a number of organizational behavior theories, most notably “Agency Theory” and “Transaction Cost Theory” (Vibert 2004). These theories help us decide when to outsource and when to keep a function in-house. Transaction costs have been identified as a key factor in geographic information sharing (Nedovic-Budic 1999), and being able to accurately predict these costs, and develop contractual agreements that govern the process, help ensure project success. Overall, cross-organization information sharing can achieve economies of scale, so planners should continue to outsource their data development needs, but these theories tell us that we still must put contracts in place. Even when cross-agency cooperation seems strong, tools like Memorandums of Understanding (MOUs) should be employed to ensure good results. What should these MOUs contain? This is where PSS research can inform policy. ***No treatment of planning support systems is complete without attention paid to the rules by which information is transacted across agencies***. Either this policy work must be done for every PSS proposed, or the PSS must leverage a broader technology framework that has already accounted for these issues. This subtle interplay between technology and policy is a large part of the motivation for this work.

### Framing the Issues from a Firm’s Perspective

With a basic theory in place about PSS and its place in local government, we can begin to address the problems raised in the introduction. Planning analysis still has relatively little influence on development when compared to highly deterministic tools like zoning and the transportation manual, which seem to single-handedly (along with developers' interpretation/manipulation of them) shape urban form. But we cannot seek to emulate zoning or engineering manuals. They are different kinds of tools. They are one generation downstream, offering patterns or heuristics to follow. We must operate upstream, providing the guidance by which these heuristics are created, or by which they are accepted or rejected at the time of decision making.

### Data, data, data

In real estate, the three most important characteristics of a property are location, location and location. Planning analysts have a similar love affair, but with data. Urban environments have become such incredibly complex organisms that no single person or agency has enough knowledge to make responsible decisions. Instead we rely on a web of specialized disciplines to build and maintain the databases and analytic tools we bring to bear on planning problems. The cost of gathering and processing this data is arguably the most significant cost for planning analysis. In rare cases, one might undertake one's own data collection effort, such as a survey. But this only happens in research environments. The general case is one where practicing planners build their analysis around data that is readily available, and unless society develops the willingness to fund planning research (like we do in defense), this will continue to be the case. The point here is that planners are not data producers. We operate like traders at a bazaar, making deals, bartering, mixing and matching the data sources that build our analytic systems. I hope I have evoked a mental image of planners shuttling between medieval tents on muddy roads, because that is the state of civic information systems.

Information technology has certainly brought significant improvements to the speed and cost of creating and maintaining data, but we are still far from being good at bringing information to bear on a problem at the precise time when decisions are being made. In most urban information systems data comes from a variety of public and private sources, and can quickly became outdated. In the case of government agencies, whether at the federal, state, or local level, data is usually easy to acquire at any particular point in time, but difficult to keep current at all times. We often try to supplement government data with more current data from the private sector. For example, in urban growth studies, the most up to date source for new construction and land use is the developers building them. But there are no generally accepted best practices for integrating public and private data sources in a PSS, and without policy in place, we cannot expect anything more than ***ad hoc*** participation from the private sector.

Agency theory suggests that the data provision issues can be improved by having the concerned parties execute a contract specifying exactly the rules of engagement. This may sound simple, but this type of contract is rare. Most data sharing agreements do a good job of detailing what will be shared, but not how. This is probably because it is seen as going beyond the boundaries of politeness to tell another agency how to do their job. Yet who will tell them how to do it? In a multidivisional firm, we have learned that the "bosses" are prevented from having enough information to do this, so the appropriate rules must come out of a negotiation process between the interested parties; in other words, a contract.

So what should the contract say? One could image, for example, a program that could compare an old data set to a new one and make suitable updates. In this case, the contract might say that a new data set will be provided whenever a change is made. If the data are large, however, this could be a very wasteful way of doing things. It would make more sense to write a piece of software that could receive messages telling it to update a particular data set in a particular way. In this case, the contract could specify that the data provider's software send messages to this new, smart piece of software. This puts a burden on the data provider, but the user could compensate them with the money saved from not having to do data updates any more. And the provider would be much more likely to agree if they could re-use the updating system (and the contract) with other users. Now the interplay between technology and policy should be becoming clear. In order for data users to solve their information management problems, they need to develop detailed, clear relationships with data providers. This clarity must be evident in contractual terms, public policy, and technological execution.

### The timing of decision making

Planning support systems, like decision support systems, are tools. Their intent is not to produce maps and figures for annual reports, but to be ready partners in the process of decision making. Fulfilling this role requires that ***PSS must be operated by stakeholders at the time when decisions are being made***. Current practice is for technicians to operate the system, and the usefulness of its results is usually tied closely to the time at which the data were acquired, or the analyses were run. In the Buildout analysis, we will see that MassGIS valiantly attempts to address this issue by providing online access to the analysis. This shows that they recognize the problem, but without up-to-date data, the fact that the analysis is available to a larger population does little to inform public debate.

At this point in the discussion, many studies of planning information systems tend to dive into the contentious arena of public participation and get diverted by issues of politics, power and class. “Rational,” information-based decision making processes might be mentioned as a marginalized form of discourse, or even as a tool of the wealthy to erect a façade of objectivity around questionable decisions. This paper takes a slightly different position, and suggests that people’s main motivation to use rational scientific analysis is honest; they genuinely believe in its power to inform good decisions. It is more productive to take the position that our community of information scientists provides the public realm with poor decision making tools. Our ***analytic methodologies*** are usually sound, but we have done little to adapt them to realistic decision making scenarios. Maybe the academic, prototyping environment in which our technologies are developed are to blame, or maybe there is some other cause, but systems that depend upon pre-prepared, static data sets have extremely limited value. And there seems to be a tacit understanding of this, leading to a general dissatisfaction with most urban information systems. Doing nothing but improving the timing of analysis would revolutionize the field, but achieving that goal requires the other changes discussed here as well.

## The timing of expenditures

A finance expert will tell you that the predictability and non-volatility of an expense is just as important as its actual amount. “Lumpy” expenses are bad, because it is difficult to budget for them. The preference for stable receipts and payments can be seen in many facets of the economy. This is why companies are willing to pay more to lease equipment, and people can be driven bankrupt by an ill-timed job loss. Planners also can ill afford ***lumpy expenses***. We may go to our city council or governor and ask for a fourfold budget increase, just for the next couple of years to develop a twenty year master plan, but if conditions change, and in five years that plan is no longer valid, the money will not be there to re-do the work. A world that changes in complex ways at unpredictable times requires continuous planning and analysis. Yet the nature of public expenditures demands constancy and predictability. So the cost of performing planning analysis must reconcile these conflicting forces. The Buildout analysis suffers greatly from this problem. A great deal of good work is obsolete soon after it is complete. While policy may take the lead on this issue, any technology work in the field should also be aware of the importance of timing.

## Research Question & Methods

How can planning take advantage of these cutting-edge technologies that are changing the corporate IT landscape? This question motivates the research presented here. Surely there are benefits to be had from the Web services paradigm of information flow, but do the benefits outweigh the costs of adoption? And as mentioned earlier, we must be smart about how much we adopt, and how we adapt technology to fit the needs of government and urban planning.

***Proving*** that the future of urban information systems lies within an XML/Web Services information paradigm is a difficult task at best—there are few tools or precedents for proving the value of paradigm shift. Falling short of this, the best strategy is to position the field within a theoretical framework that helps explain why some issues are successfully handled, and others remain intractable problems. Starting from the theoretical position put forth above, we make a strong case for Web services through hypothetical syllogism (Weston 1992, 51). We do this by showing that government organizational behavior is similar to corporate structures, and therefore that the solutions corporations employed to successfully address information management and collaboration issues can be employed in planning, which includes both governmental and private sector organizations.

## Thesis Organization

This chapter introduced a vexing problem. We seem to be constantly progressing in our ability to capture, store and disseminate data, but our ability to manage and make efficient use of this information leaves much to be desired. The PSS literature focuses too heavily on the traditional specialties of data management, modeling and visualization, paying too little attention to their integration, or issues regarding implementation within an organization. On the other hand, the information sharing literature often takes technology as a given, and seeks to address information sharing and collaborative planning issues from an organizational behavior perspective. We propose a blended approach. The major points made here about how organizations collaborate are that ***transaction costs*** and the ***chain of command*** are important factors in the ability of organizations to function effectively. Executive managers must have very good information about the costs and benefits of different actions and outcomes if they hope to run their agency effectively. If an organization is too large (or inefficient) for executives to get the information needed to make these decisions, they must cede decision making authority to lower levels. This makes small ***divisions*** effective, but magnifies cross-divisional problems—exactly the situation we observe in government today.

In Chapter 2, modern, Internet-centric, distributed information technologies are reviewed with a focus on how they address information management problems. Chapter 3 presents the Massachusetts buildout analysis, an urban growth model developed as part of the Community Preservation Initiative (CPI), an effort to better engage towns in planning for growth management and open space preservation. The CPI is interesting in itself, and is discussed in more detail elsewhere (Hodges 2004), but here we look only at the buildout analysis in its role as a practical tool with great potential, but limited usefulness, because it suffers from the problems predicted by the theories put forth in Chapters 1 and 2.

With this background, we are able to design a new framework for urban information management. Chapters 4 and 5 present solutions to common PSS requirements such as data sharing, participatory decision making, and expert collaboration. These solutions are expressed within a Web services framework, which uses a shared, formal, XML-based vocabulary called PAMML (Planning Analysis and Modeling Markup Language). The PAMML framework consists of a language in which abstract ***data sharing***, ***transformations*** (arithmetic operations, format translations) and ***public feedback loops*** can be expressed, and a suite of Web ***services*** that allow organizations to advertise their ability to perform specific tasks, such as the transfer of a particular data set, or the execution of a particular spatial operation. The entire PAMML vocabulary is expressed in the XML Schema language, and is listed in Appendix A.

The theoretical argument is strengthened by reference to an example of a real planning support system being used in Massachusetts. Armed with a theory and an actual system that exhibits shortcomings common to its kind, the thesis presents a solution based on XML and Web Services. As stated, there is no definitive way to unequivocally ***prove*** the system's value, but it is hoped that the preponderance of evidence presented here should ***convince*** the reader that paradigm shift is worthwhile.