

2. The new web - technology, policies, people, and organizations

Advanced applications of information technology in government are well-integrated combinations of policy goals, organizational processes, information content, and technology tools that work together to achieve public goals.

One of the specific goals of the Digital Government Program is to speed innovation, development, deployment, and application of advanced technologies into useable systems. Two existing examples help illustrate how this goal might be achieved.

At nearly \$100 billion a year, Medicaid may be the highest cost domestic program offered by American government. Because of its size and cost, even small amounts of error or fraud cost taxpayers millions of dollars. In Texas, a new fraud detection program is fueled by one of today's most advanced applications of information technology — neural networks that identify patterns in data that suggest areas ripe for investigation and corrective action.

Safe streets, schools, and downtowns are prerequisites for economic growth and civic engagement. Public safety is therefore often the number one concern of local governments. To help fight crime, the New York City Police Department has infused local policing with precinct-by-precinct incidence and performance information, backed up by management processes and political commitment to use that information to direct police operations throughout the City. This consistent and sophisticated marriage of information, management, and policy direction is an equally advanced use of information technology — even though the technology itself has been commercially available for years.

The Texas system uses a "leading edge technology" to support an important programmatic goal, where the New York City example incorporates commonly- available technology into a "leading edge application" that is part of a broad programmatic strategy. What, then, is an "advanced application of information technology" in government? The results of the October 1998 Workshop suggest this definition: ***Advanced applications of information technology in government are well-integrated combinations of policy goals, organizational processes, information content, and technology tools that work together to achieve public goals.***

Given that definition, what might 21st Century Digital Government look like? Fully developed, these now- unusual situations will be commonplace:

- A couple expecting twins and planning to renovate their home will use their television to submit and receive all the necessary plans and permits electronically via e-mail and the Internet. There will be no need to take time off from work or to devote precious Saturday mornings or family evenings to visit their town hall, planning board, building inspector, or zoning commission.
- An enterprising young man who wants to open a lakeside restaurant catering to boaters will use his home PC to apply for all the business permits he needs in one sitting through one World Wide Web site — despite the fact that his business is of concern to the state and local health departments, Federal and state tax agencies, the state environmental protection commission, the labor department, and local zoning and economic development officials.
- A government disaster response coordinator will use wireless communications, multi-media analytical tools, and dynamic and static geographic data from Federal, state, local, and private sources to direct a massive recovery effort following a devastating ice storm. These integrated and constantly updated information sources will help restore bridges, roads, power grids, telecommunications services, water supplies, health care facilities, homes, farms, schools, and businesses.
- A state legislator considering a proposed tax package will apply easy-to-use advanced data analysis tools to assess the impact of the proposed legislation on citizens in her district, post this analysis on the Internet for the voters to read, and poll voters for their opinions. The legislator will hold a virtual "town meeting" through the Internet where she can present her analysis of the bill and gather feedback from her constituents.

Technology and digital government

The technologies involved in these transformations — networking and the Internet, decision support systems, electronic commerce, knowledge discovery tools, geographic information systems — are not necessarily the most advanced tools available. Public sector innovations tend to result more often from the infusion of well-developed technologies into the complexities of governmental programs and processes, in an environment with many stakeholders and competing values. In this section, we highlight some of the technologies that support this transformation. We also point out special issues that affect how government takes advantage of these

2. The new web - technology, policies, people, and organizations

technologies and identify areas where additional research is needed.

Networking and the Internet

In a relatively brief span of time, the Internet has led to significant changes in how public agencies disseminate information, how government staff interact with each other and with people outside government, and how government delivers services. The most obvious examples are government WWW sites. Agencies ranging in size from large Federal departments to small towns and villages have public Web sites, designed to meet their high-priority objectives — economic development, tourism, information about government services, purchasing, statistical data, or selected service transactions. An electronic mail address on the Web site makes elected officials accessible to their constituents and allows citizens to communicate directly with public employees.

In addition to person-to-person communication, the Internet is increasingly being used to exchange data between organizations. This includes record-oriented transactions, real-time querying of remote databases, as well as larger exchanges of complete GIS data sets or other databases integrated into data warehouses. Processing of workers compensation claims, for example, may involve real-time transactions against databases from a half-dozen organizations to verify eligibility.

The use of the Internet for public purposes inevitably raises the issue of equal access. In 1997, about 17 percent of private households in the U.S. had direct access to the Internet and these were concentrated in middle- and upper-income areas of cities and suburbs. Often those most in need of government services are those least likely to have access to the Web. Rural areas, with less likelihood of having high-performance technologies such as ISDN or cable modems, are at a disadvantage, as are lower-income households, grass-roots community organizations, and small businesses that often lack direct access. While Internet access through schools, libraries, or other public places is increasingly available, people without direct access remain at a disadvantage compared to the connected minority. Given this uneven distribution of access to the Web, traditional service delivery through telephone, mail, and face-to-face interactions will be needed for many years to come.

Collaboration tools

Communication tools support and nurture linkages and relationships that were not possible through more formal means of communication. More and more often, we expect people, including government staff, to have and use electronic mail. Discussion listservs and shared Web sites routinely connect distributed organizations and virtual communities, fostering increased discussion and cooperation among those who share a common interest. Easy public availability of such information as government contracts or grant programs fosters greater equity and efficiency of government purchasing and the distribution of public resources.

Videoconferencing is another technology that is making its way into standard government practice. For example, video technology is used today to interview crime victims who would otherwise have to travel long distances to a police precinct or court house. At present, however, the use of videoconferencing typically consists of dedicated facilities linked by telephone lines. As a result, the technology tends to be used in a localized and specialized fashion. As Internet videoconferencing technology matures, it is likely that many more such interactions will take place.

Advanced IT applications in government must integrate policies, processes, information, and technology

These relatively ubiquitous capabilities are being augmented by more advanced collaborative tools in such areas as distance learning, just-in-time training, and anytime-anyplace meetingware. Use of the Internet and video conferencing techniques to deliver entire curricula from remote sites extend higher education and lifelong learning to many who would otherwise not be able to attend classes. Distance courses in specialized topics enable elementary and high school students to pursue studies unavailable to them in their home districts. Thanks to networked collaboration, these students can even conduct joint science experiments with their counterparts around the world. Although the pedagogic effectiveness of alternate modes of study and instruction are still being evaluated, it is clear that network-supported learning will play an increasingly important role in the future of American education.

The Internet also has the capability to extend expertise across physical distances. In medicine, for example, a specialist can expand his sphere of effectiveness, without traveling, by remotely reviewing diagnostic tests. This technological capability has not yet been extensively used in the U.S., though, in part because it requires changes in insurance rules as well as changes in the culture and traditions of medical practice.

Knowledge management and analysis

Data visualization, knowledge extraction, data integration, and digital library technologies have put the power of distributed information to useful social, scientific, and individual purposes. Data mining tools aid in identifying fraud and abuse in government programs. Data warehouses gather and integrate data from disparate sources, and data management and knowledge discovery tools are used to conduct planning and program evaluation in areas ranging from capital construction, to economic forecasting, to the performance of schools. Technologies such as data intensive computing environments facilitate the use of information from disparate heterogeneous databases. Digital library technologies are emerging to help users find and use information and records regardless of physical format or location.

Today use of these advanced analysis tools varies considerably across agencies and levels of government, and it is too early to tell which applications will be most useful and adaptable. Applications of these technologies are limited today by at least three important considerations: poor or variable data quality, the willingness and ability of organizations to share information across their boundaries, and, when applications involve information about people, threats to personal privacy.

Government, particularly at the Federal level, is already an active partner in the research needed to develop and employ this next generation of data management applications through such projects as the Next Generation Internet, the Partnership for Advanced Computational Infrastructure, and the Digital Libraries initiative.

Security mechanisms

The exchange of information through a network is not a new phenomenon in government. In the past, telecommunication was accomplished using dedicated point-to-point connections between pairs of agencies, or through secure value-added networks. TCP/IP networks are now replacing these facilities. The use of these Internet protocols facilitates communication between partners because only a single connection need be maintained to communicate with all partners on the network. However, the communication channel must retain properties that duplicate those found in earlier modes of communication: secure and private communication, authentication of messengers, integrity of messages, and stability of the network.

One way to achieve this goal is to create a separate network, closed to all but trusted communicators. This model works for certain types of transactions, but since government agencies often work closely with many other organizations, a more affordable and open solution is needed. At present, there are no commonly implemented models of security architecture that provide a trusted basis for electronic interactions. The array of issues, and the limited choices of technologies and strategies has led to very slow progress in deploying these architectures. In such an environment, it is not surprising that issues of security dominate much of the discussion in government about networking.

Document management and preservation

An increasing number of important government records are now stored exclusively in electronic media. Many of these records contain multi-media formats, and they are often associated with automated workflow and electronic document repositories. Depending on the circumstances, informal information such as electronic mail messages may be part of an official government record. Few guidelines exist for effectively managing digital public records, yet their numbers grow dramatically every month.

Preservation of electronic records is a particular challenge, as the media, software, and hardware used to create records and maintain them for active use are replaced with new generations every few years. Ironically, while the records of the 17th and 18th centuries remain readable today, our own generation of records is rapidly disappearing due to technological advances. At the same time, government archives are increasingly trying to accommodate the digitization of historical records in order to make these holdings more widely accessible to more users.

Finally, with the increasing availability of information in electronic form, it is becoming easier to use information for purposes beyond the original reason for its collection. Yet most government records systems are created without regard to the needs or preferences of secondary users, whether they are in different units of the same agency, in other organizations, or are future users whose interests come into play long after the records have served their primary purpose. More extensive research into archives and records management theory and practice are needed to resolve these issues.

User interfaces

The standard user interface and the World Wide Web browser, itself a product of NSF-sponsored research, have done much to extend useful computing to every area of our society. The standard interface, commonly based on Microsoft Windows, flattens the learning curve needed for each new application. The Web browser's ease of use and widespread public acceptance have led many agencies to use this technology in direct public contact.

One attractive feature of the WWW is its ability to integrate information and services from separate organizations into a single user presentation. This technique has been used to develop Web sites that serve as a portal to all that a government unit has to offer. Today, most of these sites are limited to a single level of government, and do not represent true integration of services. Instead, they typically provide an extensive table of contents of many agency programs and services. However, many government agencies have begun re-orienting their Web services around the needs of users rather than around their organizational structures.

Further advances in user interfaces are likely to focus both on simplicity and increased power. Digital library technologies, for example, will put the power of multiple databases to more effective uses. Data visualization technologies allow users to manipulate large data sets to get a better understanding of the information they contain. Research into the interaction between people and machines, including speech recognition and 3D modeling, will likely lead to innovations in the way people perceive and use the information environment.

Large systems

The models and processes for designing and developing large, complex systems have advanced much less than the specific technologies they might employ. While all organizations face this issue, the development of large government information systems face special challenges that lead to an especially risk-prone environment. Typically, a significant number of participants and organizations have a stake in the system. This may be due to the innate complexity of the underlying program or existing systems, to legislative mandates, or because a large number of organizations play a role in the system development process. In addition, because of government funding rules, multi-year projects must usually be developed with a series of single-year budgets. Because they are developed with taxpayer dollars in a public setting, these projects are subject to a high level of external criticism and public scrutiny. In such an environment, it is very difficult to maintain consistent approaches to architecture, data definitions, data collection, information quality, data integration, and overall system functionality.

These complications add time, cost, and complexity to the development life cycle. As a consequence, design and implementation may take years, conflicting directly with the rapidity of technological change. By the time they are completed, the best technologies for the job may well have changed. For example, the recent redesign of the air traffic control system by the Federal Aviation Administration was begun before the widespread commercialization of global positioning systems. Such major technology shifts can cause wholesale changes to system design in the middle of the development process.

Existing software development models such as the waterfall and spiral models do not deal explicitly with these kinds of changes. Prototyping, while very useful in some projects, seems to have less utility in dealing with the complexities of these large systems with their enormous interoperability issues, and long development times.

Human and organizational factors

Most of the research currently conducted to support government's transition to the digital age is focused on technology itself. However, given the complexity of the environment, the need for government applications to work well in a variety of settings, and the interdependence of so many players, technology research alone is insufficient. Other powerful factors, discussed briefly below, shape the ability of government to adopt and deploy IT effectively.

Human factors

The degree to which individuals accept new technologies and the manner in which they learn and adapt to them are all factors to be considered in the deployment of new tools. Recent studies about the success of information systems in organizations suggest that more than 80 percent fail to achieve their objectives or to be implemented at all. The foremost reason for failure is the lack of involvement by system users in design and deployment. Lack of attention to user needs and preferences is a common weakness in the design and deployment of advanced

2. The new web - technology, policies, people, and organizations

technology.

In government information systems, with their tendency to be used in a wide variety of physical settings by users who may have markedly different levels of interest and skill, this is a particular problem. How can we design technologies or systems that work in both a large urban setting and a small rural one, or in an affluent organization and a shoe-string operation, where the technology tools likely to be available to users are not the same? Beyond questions of design are considerations of user training and support. Too often, new systems are accompanied by one-shot training programs, often out of synch with the actual implementation schedule, that do not provide for ongoing updates or active user support.

Universal design principles have been developed to guide us toward systems that are more useable, more in tune with the way people think and act, and more adaptable to the different ways that people work and learn. These principles, such as the ones developed at the TRACE Center at the University of Wisconsin, focus on such topics as accommodation of a wide range of individual preferences and abilities, ease of understanding regardless of a user's experience or knowledge, and tolerance for errors. Any system could be made more usable by incorporating these principles in design. Moreover, as government moves toward more systems that offer self-services to the public, these design principles will increase in importance.

Organizational learning and adaptation

Just as human factors circumscribe the use of new technology, organizational design and behavior also figure prominently in the adoption and use of new technology. In turn, successful adoption of new technology has a significant effect on organizational viability and performance. While Industrial Age organizational forms are well suited to the technologies of efficiency and specialization, Information Age technologies presuppose organizations that thrive on information flow and sharing, asynchronous communication, and analytical thinking.

The organizations of the Industrial Age had structures and cultures which facilitated hierarchical decision making, specialized and narrowly defined jobs, and efficiency in production. In the Information Age, the structure and culture have evolved to create organizations where decisions and communications can occur anywhere in the organization, jobs are fluid, and flexibility and attention to customers are highly valued. Here, technology is viewed as an enabler to meeting the mission and goals of organizations, rather than as a control mechanism. Automation is no longer an alternative process in organizations; it is a basic process. Indeed, IT is now often considered a strategic asset that adds value to the routine transactions and processes of organizations.

What is technically possible may not be organizationally feasible or socially or politically desirable

Successful organizations today are characterized by insistence on knowledge, productivity, and innovation. In order to capture the value of these key variables, organizations must engage in constant change. The new models for change reflect the idea that change is discontinuous, that is, it cannot be controlled or anticipated. These models call for organizations to "think outside the box," to improvise, to unlearn the past, and to stretch beyond their current capabilities. Information technology is a necessary ingredient in this discontinuous change environment. Recent history shows that IT can both drive and enable change. The critical factor in these changes is the ability of organizations to select appropriate technologies, implement and diffuse them, and adapt to new ways of working, even when there is little experience and no clear-cut rules or procedures to guide them.

As organizations experiment with new technologies, they change business processes, communications methods, work flows, decision making, and even the basic structure and boundaries of the organization itself. With technology embedded in organizational functions, geography and time are no longer restrictive, nor are traditional hierarchical and departmental barriers. By incorporating information technology into an organization's infrastructure, new options of structure, culture, decision making, teamwork, leadership, and communication become available. Inevitably, organizational norms are reshaped.

Emerging organizational forms and new models of collaboration

People sometimes associate a government program or service with a single public agency. Most everyone expects that the local Social Security Office is the place to file for Social Security retirement benefits; if you need to renew your driver's license, you contact the Department of Motor Vehicles. But what if you want a fishing license or need to find a nursing home for your elderly mother? When you drive to work on a snowy day, who plows the roads you travel or operates the bus that takes you from the county you live in to the one where you work? Who really pays your Medicare claims? All of these public services are offered through a complicated set of

2. The new web - technology, policies, people, and organizations

public-public and public-private linkages. Some are formal and well-defined, others are more dynamic and ad hoc.

Interorganizational networks are emerging in nearly every dimension of work and society. Traditional theories of exchange and resource dependence, based mostly on private sector research, are inadequate to explain either the partnerships and collaborative models or the mixed models of cooperation and regulation that are becoming prevalent in the operation of government programs. These networked forms of organization are emerging in every domain from health care, to social insurance, to infrastructure. Networked information systems are just one feature of their structure and operation. These organizational entities also encompass new forms of communication, decision-making, financing, and accountability.

Consider the National Spatial Data Infrastructure (NSDI) in which Federal, state, local and tribal governments, along with the private sector and academia, are working to develop and promote better access to geospatial data. Geospatial data plays a key role in helping communities synthesize information relevant to complex economic, social and environmental issues, but these data are often difficult and expensive to locate, obtain, and integrate. The NSDI features a national data clearinghouse and other activities to help organizations and individuals know the characteristics of data, find and access data owned by others, obtain common sets of data to use as building blocks, and transfer and integrate data among users and providers through the use of data models and standards for common classification systems and content.

In the State of Washington, a high speed Information Network for Public Health Officials (INPHO), allows local health professionals to share information about prevention services, emergency notices, training, and health reports, and gives them the ability to act quickly to solve public health problems. A joint project of the Washington State Departments of Health and Information Services, local health jurisdictions, and the Federal Centers for Disease Control and Prevention, INPHO offers access to timely, relevant, accurate and authoritative information to support local decisions and actions. As an example, local officials were recently able to compare DNA samples with others in a national database allowing them to quickly identify and respond to outbreaks of E-Coli.

Policy, management, and technology march to different drummers

Throughout our history, developments in technology have emerged much faster than the evolution of organizational forms. Global communications have eliminated the barriers of time and place, and digital information has broken the bond between information and its physical format. Yet, most agencies and businesses are still organized for the physical limitations of the Industrial Age. They continue to rely on specialization of tasks and command and control management structures. Public policies lag farther still behind technological evolution. Only in the past few years have policy makers begun to tackle the policy implications of global telecommunications and to move beyond the policies developed when information was a matter of printed media and limited broadcasting.

The pace of technology responds to the forces of scientific inquiry and innovation. Organizational change more reflects the ability of humans to recognize and adapt to changes in their environment. This slower process is especially difficult in the public sector as it is bound by civil service systems, one-year budget cycles, and rules and procedures cast in both statute and regulation. Finally, by design, public policies change only when there is a broad consensus that change is needed and will move our nation, community, or society in a desirable direction.

The interaction of these three domains generates a very important societal debate because what is technically possible may not be organizationally feasible or socially or politically desirable. Recent court decisions about the transmission of objectionable material over the Internet are an excellent case in point. The technology has made it possible for anyone, anywhere to post adult-oriented information on the World Wide Web. Much of this material would not be readily accessible by children in most other media, but on the WWW very few limitations can be imposed that protect children but do not also infringe the rights of adults. Elected officials, interest groups, information professionals, states, and courts are all struggling with the issues this generates around free speech, protection of children, the role of the market, the applicability of existing laws, and the meaning of community standards.

Meeting the goals of the Digital Government Program requires research that spans policy, management, and technology domains. Valuable as focused investigations are, they are insufficient if they remain locked in disciplinary niches. We also need interdisciplinary approaches designed to understand the interrelationships among policy, management, and technology factors. To do this will require change in the way research is conceived, funded, and conducted, as well as changes in the way research results are disseminated and used.

2. The new web - technology, policies, people, and organizations

The following sections discuss the workshop results in terms of specific research needs, broad research challenges, and recommendations for dealing with them.