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The Diffusion of Internet Technology in the Workplace

James W. Pearce
August 1998

Abstract

The twentieth century has been shaped by sweeping changes in communication technology. The latest development to radically transform the communication landscape has been the widespread adoption of internet technology and its integration into the international communication infrastructure. Despite the changes it has brought about, as well as those it portends, relatively few studies have sought to identify the factors that influence the diffusion of internet technology either in society in general or in an organizational setting.

This study begins to consider two sets of factors that may influence the diffusion of internet technology. First, it examines the importance of organizational heterogeneity, a key concept of critical mass theory, to the diffusion of internet technology within organizations. It then probes the nature of the relationship between interpersonal and organizational factors in terms of how they affect the diffusion of internet technology through organizations.

Data for the study was generated by a survey which was administered to employees at six Department of Energy facilities operated by Lockheed Martin Corporation's Energy and Environment Sector. The survey was

made available in three formats: on the Worldwide Web, as an e-mail message, and in a traditional paper format. Overall, 9040 survey solicitations were distributed, and 2711 usable responses were received, yielding a 30% response rate. The data gathered in this study was analyzed using descriptive analyses, as well as t-tests and multiple regression analyses of the study's hypotheses.

This study is a small step in the direction of understanding the processes and identifying factors that influence the diffusion of internet technology in the workplace. Its findings include support for the following assertions:

1) Higher levels of organizational heterogeneity catalyze the diffusion process by positively influencing factors associated with internet technology in the following areas: level of use, attitudes, organizational support, and perceived managerial support.

2) Critical mass theory provides a set of organizational environment variables within which traditional, individual/interpersonal diffusion of innovation variables operate under greater or lesser constraints. This relationship can be described by two generalizations:

- High-heterogeneity organizations tend to create an environment within which organizational factors enable the diffusion reaction to proceed unimpeded—possibly reaching critical mass.
- Low-heterogeneity organizations tend to create an environment within which organizational factors moderate the diffusion reaction, either slowing or stopping its progress toward critical mass.

3) Rather than defining divergent views of the diffusion process, critical mass theory and traditional diffusion of innovation theory seem to provide complementary explanations of different aspects of the process by which interactive innovations diffuse through organizations.

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Chapter I

Introduction

Overview of Internet Technology

The twentieth century has been shaped by sweeping changes in communication technology. Successive waves of innovation—telephone, radio, television, satellite communication, digital networks, and others—have radically altered the way we communicate with each other. The latest development to radically transform the communication landscape has been the widespread adoption of internet technology and its integration into the international communication infrastructure.

Although nationwide digital communication networks have existed in the United States since the establishment of ARPANET by the Department of Defense in 1969 (Zakon, 1998), the frenetic growth that characterizes the internet as it is known today was catalyzed by two relatively recent events. The first was the release in 1991 of Worldwide Web (web) server software by CERN (The European Laboratory for Particle Physics). This software was developed to mediate among a number of information formats, thereby enabling computers to easily share information over digital networks. The second critical event was the 1993 release of

Mosaic internet browser software by the National Center for Supercomputing Applications (NCSA) at the University of Illinois, which provided a simple means for computer users to access information on the web. Adding to the popularity of this software was the fact that it was distributed free of charge and was made available for most popular personal computing platforms. The effect of these two events was to (a) provide a single means (a browser) of accessing a number of existing information transfer protocols (such as Telnet, FTP, Gopher), as well as the newly established HTTP, or Hypertext Transfer Protocol), (b) establish a common language (Hypertext Markup Language, or HTML) to be used for sharing information on the web, and (c) enable almost anyone using a networked personal computer to access the web.

By simplifying access to the internet, these developments triggered the rapid adoption of internet technology in general and web and e-mail technologies in particular. This trend of adoption began in the "networked" community (primarily in government-related and educational institutions that already possessed the communications infrastructure to support internet technology) and rapidly spread to other segments of society as access to internet connections over standard telephone lines became more widely available. The number of people

currently using internet technology in some form is the subject of some debate; however a credible estimate is provided by a December 1997 CommerceNet/Nielsen Media Research Survey, which suggests that more than 58 million people in the United States and Canada currently use the internet for purposes ranging from e-mail to electronic commerce (CommerceNet/Nielsen Media Research, 1997).

Regardless of the precise number of internet users, it is clear that the impact of this new communication technology on society is potentially quite large. In fact, in a number of business organizations, it is already being felt. This is evident in the preface to the CommerceNet/Nielsen Media Research Surveys, which states that "The Internet revolution is sweeping the globe with such swiftness that companies are desperately trying to understand what is occurring.... Countless organizations are exploring how they can best use the Internet, in particular the World-Wide Web (WWW), for business applications, such as marketing, supply chain management, public relations, customer support, product sales, and electronic data interchange" (CommerceNet/Nielsen Media Research, 1997).

Because of their more robust communication infrastructure, many businesses and academic institutions have been able to take greater advantage of the capabilities of internet technology than the general public. As a result, not only are these organizations making extensive use of publicly available internet information resources, but rather than relying on traditional internal digital communication systems, which are often composed of disparate computer systems, they are increasingly looking to internet technology to provide a common interface with the information systems that make up their "intranets" (internal communication systems based on internet technology). The extent to which internet technology has permeated internal business communication is reflected in the results of a March 1998 survey by RHI Consulting, which reported that 66% of corporate chief information officers either have an "intranet" in place or plan to have one in place within the next three years (RHI Consulting, 1998).

Objectives of the Study

Traditional diffusion of innovation research, at least as it is articulated by Rogers and his supporters, have placed much of the responsibility for accepting or rejecting innovations in the hands of the individual or the individual in the context of interpersonal channels (Rogers, 1995).

Clearly, Rogers and others do not discount the role played by the organizations within which individual adoption decisions are made, but the primary focus of traditional diffusion research has been on the individual in the context of individual/interpersonal relationships. Critical mass theorists, such as Markus, on the other hand, place more responsibility for the acceptance or rejection of new media innovations on the group or organization with which the individual is associated (Markus, 1987). This is due, at least in part, to the interactive nature of the innovations critical mass theorists concern themselves with. The concept of critical mass was originally developed to integrate theories of collective action, such as the "bandwagon effect" and the "tragedy of the commons." The concept helps to define the conditions under which certain reciprocal behaviors (the use of an interactive medium such as internet technology, for example) become self-sustaining. In other words, critical mass is the number, or proportion, of adoptees necessary to sustain the adoption process until universal access to the interactive medium is ensured. While the concept of critical mass is applicable to a wide range of social phenomena, it has been applied to the fields of communication and organization science primarily to explain the diffusion of interactive communication innovations through organizations and communities.

One of the objectives of this study is to begin to determine the nature of the relationship between individual/interpersonal and organizational factors in terms of how they affect the diffusion of internet technology through organizations. The results of this analysis should help to clarify the applicability of both traditional diffusion of innovation ideas and critical mass theory to internet technology in particular and, perhaps, to interactive media in general.

Another aim of this study is to consider the effect of organizational heterogeneity on the diffusion of internet technology within organizations. Several of the propositions Markus offers regarding critical mass theory depend heavily on assumptions about the role of heterogeneity in the diffusion process. Markus' initial contention that heterogeneity of resources and interests among the members of the community will increase the likelihood of universal access to interactive media, such as the internet, addresses the issue of heterogeneity directly. However, Markus also suggests that conditions favorable to other propositions—i.e., that having high-interest and high-resource individuals among the early users of an interactive medium is highly favorable to the achievement of universal access in the community, and that interventions that increase the overall level of interests and

resources within the community will increase the likelihood of universal access—are more likely to occur in a heterogeneous environment.

It is also important to note that, because internet technology is evolving at such a rapid pace, the importance of early adopters, and hence heterogeneity, may be magnified by the fact that the adoption process is, for practical purposes, ongoing. The resulting progression of new applications of internet technology, if they are to be generally accepted, must each first be adopted by individuals with the requisite resources and interest—circumstances Markus contends would be most likely to occur in a heterogeneous environment.

Theoretic Perspective

Diffusion of Innovation

In Rogers' definitive work on the subjec*t, Diffusion of Innovations,* he distills hundreds of diffusion studies scattered across over a dozens of disciplines, settling finally on what he calls "middle-range analysis," a compromise level of theoretical complexity somewhere between "empirical data and grand theory" (Rogers, 1995).

The importance of diffusion research, apart from the obvious importance of theory building to understanding how things happen, is that

understanding the process of innovation promises to give practitioners of innovation—"change agents" in Rogers' lexicon—the tools they need to bring about social change in a more efficient manner, or to evaluate the possible consequences of change before the process of innovation has begun.

Rogers goes to great pains to demonstrate that diffusion of innovation research is a stream bearing the mingled waters of many springs, including communication, sociology, education, and marketing. Anthropology is the oldest of these merged diffusion traditions, and possesses a relatively long tradition of emphasizing the social consequences of the adoption of innovations, dating back at least to the 1930s. Communications and marketing are the two most recent additions, both tracing their diffusion roots back only to the early 1960s in agricultural and consumer studies, respectively (Rogers, 1995).

Diffusion of innovation is characterized by three stages: (1) invention, the development of a new idea, (2) diffusion, the communication of the idea through the social system, and (3) consequences, the changes that go along with the adoption or rejection of the new ideas. The recognition of the need for innovation can arise from within a social system or from

without, as can the impetus for pursuing or enacting change. The source of the innovation, as well as the impetus for its adoption or rejection, plays a major role in the success of the innovation, the channels it is communicated through, and its rate of adoption. Borrowing liberally from several other general communication models, Rogers' diffusion model considers the "innovation, which is communicated through certain channels, over time, among the members of a social system." These elements are described briefly below.

Innovation - Diffusion theory suggests an innovation, is an idea, object, or way of doing things that is perceived to be new. Innovations, such as internet technology, it is further suggested, are accepted or rejected on the basis of the following characteristics (Rogers, 1995):

- Relative advantage - the degree to which an innovation is perceived as better than the idea it supercedes
- Compatibility - the degree to which an innovation is perceived as being consistent with existing values, past experiences and needs of potential adopters
- Complexity - the degree to which an innovation is perceived as difficult to understand and use

- Trialability - the degree to which an innovation may be experimented with on a limited basis
- Observability - the degree to which an innovation or the results of an innovation are visible to others

Communication Through Channels - A channel is simply a means of communicating with another individual. Rogers suggests that certain types of channels are better than others for certain purposes. For example, media channels are effective in communicating knowledge of an innovation, while interpersonal channels are effective in influencing decisions to adopt or reject innovations. Rogers also notes that, when they have a choice, people prefer to communicate through familiar channels, that is, with people like themselves. This sameness may include similarities in location, work, interests, values, and beliefs, which result in more efficient communication. In the case of internet technology in an organizational setting, this propensity suggests that technology would be more likely to diffuse throughout the organization if it were adopted by a wide, representative range of individuals and disseminated through their peers, rather than being introduced at a single point or a set of homogeneous points.

Time - Based on studies of diffusion processes conducted across a wide range of disciplines, Rogers breaks the diffusion process into five main steps: knowledge, persuasion, adoption, implementation, and confirmation. These steps suggest that merely introducing an innovation into an organization—or even ensuring that it is adopted and applied—isn't enough to guarantee that the innovation will be adopted over the long term. Only a positive decision for the adopted technology in the "confirmation" stage ensures that the technology will become integral to the adopting group or organization.

Social System - The structure of a social system can speed or impede the diffusion of innovations in the system. Rogers identifies five key characteristics of social systems with respect to diffusion research: social structure, system norms, opinion leaders and change agents, types of innovation decisions, and the consequences of innovation. In an organizational setting, these characteristics suggest that people, power, infrastructure, intra-organizational relationships, and politics can all influence the decision to adopt a new technology.

While Rogers' traditional approach to diffusion of innovation research is the dominant approach in the field of communications, there are

derivative concepts that not only augment traditional diffusion theory, but provide the opportunity for additional insights into the factors that affect the diffusion of innovations through organizations.

Technology Clusters

Rogers and others suggest that technologies are sometimes adopted as part of a cluster or package consisting of several technologies, rather than individually. The most frequently cited example of this behavior is Silverman and Bailey's 1961 study of a cluster of innovations adopted by Mississippi corn farmers to increase crop yields: the use of fertilizer, hybrid seed, and thicker planting (Silverman and Bailey, 1961). According to Rogers, this concept arises from the way in which innovations are viewed by their users. "Innovations," says Rogers, "are not viewed singularly by individuals. They may be perceived as an interrelated bundle of new ideas. The adoption of one new idea may trigger the adoption of several others. A technology cluster consists of one or more distinguishable elements of technology that are perceived as being related" (Rogers, 1995).

Internet technology can be viewed as a cluster of technologies on at least two levels. First, internet browser software is, in a sense, a bundle of

information interfaces. A contemporary browser enables the internet user to access information developed specifically for the web, as well as that developed for web precursors, such as Gopher, FTP, Telnet, and others. In addition, the use of an internet browser is very often accompanied by the use of electronic mail. This is reflected in the results of the previously cited December 1997 CommerceNet/Nielsen Media Research Survey, which estimated that there were 59 million electronic mail users in the United States and Canada—80% of whom used the web as well (CommerceNet/Nielsen Media Research, 1997).

The magnitude of the of the technology cluster associated with adopting internet technology will vary from organization to organization, depending on the technology in place at the time of its adoption. As Nord and Tucker note in *Implementing Routine and Radical Innovation,* "Routine innovation is the introduction of something that while new to the organization is very similar to something the organization has done before. A radical innovation, in addition to being new to the organization, is very different from what the organization has done previously, and is therefore apt to require significant changes in the behavior of employees and often the structure of the organization itself" (Nord and Tucker, 1987). In the case of internet technology, an organization accustomed to

using networked information systems and personal computers might consider the transition to using internet technology fairly routine, requiring the adoption of a fairly small cluster of new technologies. On the other hand an organization unaccustomed to any computer use would consider the same transition to be a radical departure from business as usual, requiring the adoption of an entire digital information infrastructure, as well as internet-related software tools.

Another impact of internet technology being a cluster of technologies, rather than a single innovation is that, while a single innovation may be implemented or not, a cluster of technologies provides considerably more latitude in terms of implementation. For example, an individual could adopt the use of internet technology, but choose only to use it's e-mail capabilities. One effect of users having the option of partially implementing a cluster of technologies is that measurements of internet use should take into account both quantitative factors, such as hours of use per week, as well as qualitative factors, such as the sophistication of the tasks the technology is used for.

Assimilation Gaps

Another concept closely related to traditional diffusion of innovation research is the "assimilation gap." The term, "assimilation gap" refers to the time differential, or lag, between the acquisition of a technology and its actual use or deployment. This gap may be visualized by thinking of the S-shaped (or sigmoid) curve that is often used to illustrate the diffusion of an innovation over time. Fichman and Kemerer note that similar S-shaped curves may be constructed to illustrate both the acquisition of an innovation over time and the deployment of an innovation over time (see Figure 1.1) (Fichman and Kemerer, 1995). Near the origin of the time (horizontal) axis, these curves may be fairly close together because some early acquirers are likely to be early deployers. Rogers provides support for this supposition by asserting that the "salient value for innovators [individuals who first adopt a technology] is venturesomeness, due to a desire for the rash, the daring, and the risky" (Rogers, 1995). Late adopters, or "laggards," as Rogers refers to them, have a relatively long decision process with "adoption and use lagging far being awareness/knowledge of a new idea" (Rogers, 1995). If all acquirers deployed the innovation in about the same time frame, the two curves would be separated by a constant distance. However, if deployment is

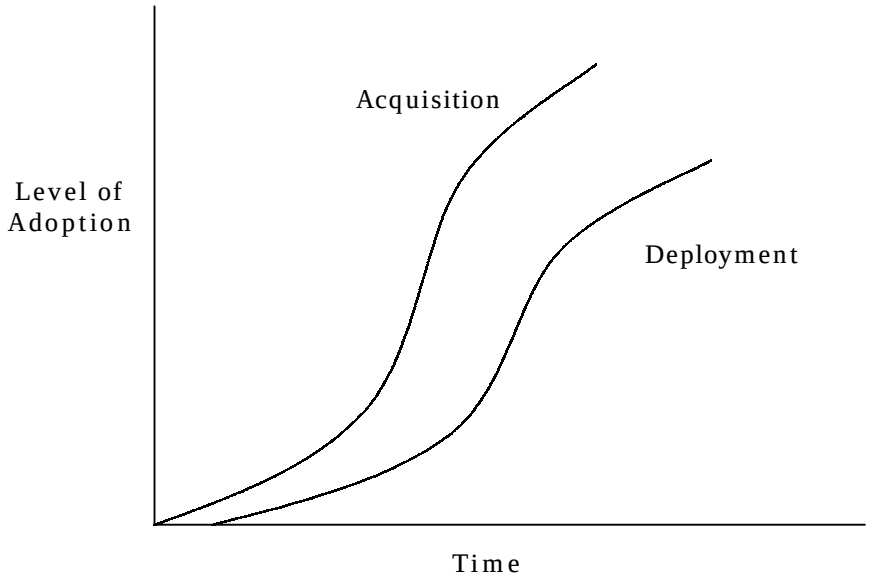

Figure 1.1 The assimilation gap between technology acquisition and deployment (adapted from Fichman and Kemerer, 1995)

delayed or non-existent among some significant fraction of later acquirers, the curves become more widely separated over time. This increased distance is the assimilation gap.

An illustration of this effect is provided in Liker, Fleischer, and Arnsdorf's 1992 study of the acquisition and deployment of computer-aided design, or CAD, software. The authors interviewed CAD users and managers from six companies known to be heavy CAD users regarding the extent to which they took advantage of the capabilities of their CAD systems (Liker, Fleischer, and Arnsdorf, 1992). In general they found that organizations tended to "simply replaced old tools with new ones—'move

out the drawing boards and give the drafters a CAD system'," rather than taking advantage of the "high-level" features of the software. High-level features included capabilities, such as using three-dimensional modeling techniques to help to ensure that parts fit well with one another later on in the design process. The authors concluded that individuals in charge of deploying CAD in these organizations were unable to "see the big picture" of how CAD could fit into their design processes. Instead they took "the path of least resistance" by replacing traditional tasks with their CAD equivalents and failing to take advantage of CAD's higher-level features.

In light of these findings, Fichman and Kemerer emphasize that simply looking at the acquisitions curve (or, presumably, any other nominal measure of adoption) can present "an illusory picture of the diffusion process—leading to potentially erroneous judgments...about the robustness of the diffusion process already observed, and the technology's future prospects" (Fichman and Kemerer, 1995). This caution may be particularly appropriate for studies of the diffusion of clustered technologies, such as internet technology. When a cluster of technologies is adopted, it is possible to gain a marginal benefit, at least in the short term, by implementing those components of the cluster

requiring the smallest investment of time, training, and money. For example, a user of internet technology may find that receiving e-mail is useful and requires little effort, but is unwilling, or is not afforded the necessary resources, to apply to use some of the higher-level capabilities of internet technology, such as using the browser interface to query on-line databases, conducting internet or intranet searches, etc. The possibility of partial implementation suggests that nominal measures of internet technology use, such as the amount of time spent using internet technology, can mask the actual extent to which the technology is deployed in an organization—five hours a week reading e-mail does not represent the same level of technology deployment as five hours a week querying on-line databases.

In the case of rapidly evolving innovations, such as internet technology, which have nearly constant implementation cycles, the gap between early, complete implementers and late, partial implementers has the potential to widen over time, making the technologically rich progressively richer and the poor poorer.

The New Media

Internet technology is a vehicle for several examples of the so-called "new media," such as the web and e-mail, among others. Rogers identifies the following three qualities of the new media that distinguish them from their predecessors: interactivity, de-massification, and asynchroneity (Rogers, 1986). De-massification refers to the opportunity for users of a medium play a larger role in determining the content they receive. For example, rather than viewing all of the material on a particular web site, web users can use a search engine to locate resources related to a particular subject at that site or at hundreds or even thousands of different sites. This enables them to bypass the constraints of content providers and interact directly with the information they're interested in. Rogers notes that there are parallels to this phenomenon in traditional media: "a certain degree of the control of mass communication systems moves from the message producer to the media consumer. The reader of *The Sunday New York Times* also has a type of control in choosing to read certain news items and ignore the rest." (Rogers, 1986). However, the practical extent of the control exercised by the internet user is far greater, enabling the user to read not only the news items of interest in the Sunday *Times,* but also related items in on-line publications around the world.

Asynchroneity refers to the ability to send a message and not have to wait for the receiving party to respond. For example, writing a letter and mailing it is a form of asynchronous communication, as is sending e-mail or leaving a message on an answering machine. Since the time of Rogers' characterization of new media as asynchronous; however, the synchronous communication capabilities of internet technology-based new media have become considerably more developed, comprising "internet telephone" services, chat rooms, and interactive video applications, among others.

The quality of the new media that is most important for the purposes of this study is interactivity. Rogers defines interactivity as "the extent to which participants in a communication process have control over, and can exchange roles in, their mutual discourse" (Rogers, 1986). Interactivity allows information to be sought out and exchanged, rather than merely received. As noted by Markus, interactive media also have characteristics that are not shared by many other media, or many other innovations of any sort: "First, widespread usage creates universal access, a public good that individuals cannot be prevented from enjoying, even if they have not contributed to it. Second, use of interactive media

entails reciprocal interdependence, in which early users are influenced by later users as well as vice versa."

Several of these distinctive characteristics of the new media also play important roles in critical mass theory, which is described below.

Critical Mass Theory

Another perspective on interactive media is provided by proponents of critical mass theory. Rather than challenging the assertions of traditional diffusion researchers, critical mass theorists consider situations in which individual adoption decisions may be less important in determining the probability and extent of diffusion than factors more closely related to in the individual's social system or organization.

Critical mass theory was developed by sociologists Oliver, Marwell, and Teixeira in 1985 to integrate theories of collective action regarding "phenomena variously labeled 'snob and bandwagon effects,' 'the free rider problem,' and 'the tragedy of the commons,' by economists and sociologists" (Markus, 1987). Generally speaking, the concept of critical mass helps to define the conditions under which certain reciprocal behaviors, such as the use of interactive media, become self-sustaining.

Specifically, critical mass theory has also been applied to the field of communications to explain the diffusion of interactive communication technologies through businesses, organizations, and other social groups. A number of these studies have addressed the use of electronic mail and telephone messaging services (for example, Markus, 1987, 1994; Allen, 1988). However, to date few, if any, have focused on the diffusion of internet technology in an organization or a group of organizations. The rarity of such studies may be due, in part, to the relatively recent increase in the use of internet technology and the difficulty of locating and sampling a sufficiently large and well-defined population of internet users for study.

There is a broad consensus among all types of diffusion researchers that an individual most often considers adopting an innovation because it provides the individual with some sort of net benefit. However, the benefit derived from the adoption of an interactive technology, is largely dependent not on the individual's efforts, but on how others respond to those efforts. A single electronic mail user in an organization, to cite an extreme example, will accrue no benefit from his or her adoption of the innovation until others adopt the innovation as well, allowing reciprocal interaction to occur. In addition, electronic mail users will not receive all

of the benefits of the innovation until a very large fraction of the entire organization has also adopted the innovation.

According to Markus, "the individual considering the adoption of an interactive medium is very likely to choose not to use it unless a sizeable number of his or her communication partners are already using it." This "sizeable number" is what sociologists Oliver, Marwell, and Teixeira, as well as Markus and others have referred to as "critical mass." In nuclear physics, critical mass is the amount of nuclear material necessary to sustain a nuclear reaction. In the diffusion of interactive technologies, critical mass is the number, or proportion, of adoptees necessary to sustain the adoption process until universal access to the interactive medium is ensured.

The difference between this type of interaction and Rogers' collective- and authority-type decisions is that there is no formalized conversation, negotiation, or decision-making process among the user, the community, and/or the authorities (Rogers, 1995). The interactions themselves, or rather the extent and frequency of these interactions, are what drive the use of the medium toward either universal access or abandonment.

To reach critical mass, however, a sizeable number of individuals must commit to using the technology with no certainty of obtaining a benefit for themselves. Oliver, et al., note that this is more likely to happen if "A positive correlation between interests and resources" exists because "it increases the probability of there being a few highly interested and highly resourceful people who are willing and able to provide the good for everyone" (Oliver et al., 1985). Markus adds that "heterogeneity [variation] in interests and resources is believed to affect the probability, extent, and likelihood of collective action" because it provides some individuals with a greater likelihood of benefiting, and therefore with more incentive to act, than others.

As noted above, the rapid evolution of internet technology magnifies the importance of early adopters, and hence that of heterogeneity. Morris and Ogan also recognized the dynamic nature of interactive media in their 1996 study of the internet as a mass medium, contending that, in order for participation in an interactive medium like the internet to be maintained, a shared pool of data must be established and *renewed* by individuals with the interest or resources to contribute new information. "If no one contributes, the data base cannot exist. It requires a critical

mass of participants to carry the free riders in the system, thus supplying this public good to all members..." (Morris and Ogan, 1996).

Markus offers five propositions to (a) describe the conditions which may sustain the diffusion reaction until critical mass is reached and (b) guide empirical investigations of the phenomenon:

1) There are only two stable states of interactive medium usage in a community: all or nothing. Either usage will spread to all members of the community or no one will use the medium either because no one started using it or because usage fell off in the absence of reciprocity.

2) Factors that reduce the number of resource units each adopter must contribute to maintain communication discipline for an interactive medium will increase the likelihood of universal access in the community.

3) Heterogeneity of resources and interests among the members of the community will increase the likelihood of universal access.

4) Having high-interest and high-resource individuals among the early users of an interactive medium is highly favorable to the achievement of universal access in the community.

5) Interventions that increase the overall level of interests and resources within the community will increase the likelihood of universal access (Markus, 1987).

These five propositions emphasize the key roles resource availability and organizational heterogeneity play in the adoption of interactive technologies—and how the two factors are related. Markus identifies two types of resources: an individual willingness to reciprocate—to use the technology—and operational resources, such as hardware and software in this instance, and the knowledge or training necessary to use the technology.

In recent years, several studies of computer-related technologies and information technologies have found that the availability of resources, particularly operational resources, is tied to managers' attitudes toward the technology the resources are supporting. For example, in his 1994 study of white-collar computerization, Long writes: "If top management

favours WCC [white-collar computerization], it is more likely to happen than if it does not. There are two main reasons. First, top management is in a position to determine the organizational resources that will be devoted to the innovation. Second, top management serve as opinion leaders, to whom many employees at lower organizational levels will look for guidance when deciding whether to adopt the new innovation" (Long, 1994).

This conclusion is echoed by Rogers, who notes that the composition of the community of adopters of interactive technology can influence the level at which critical mass is attained: "a small number of highly influential individuals who adopt a new idea may represent a stronger critical mass than a very large number of individual adopters who have little influence" (Rogers, 1995). This highly influential group may also be in a position to "provide resources for the adoption of an interactive technology and thus lower individuals' perceived cost of adopting" (Rogers, 1995).

In Babcock, Bush, and Zhiyong's 1995 study of executive use of information technology, the authors note both that "[all executives studied] reported a considerable degree of involvement in decision

making concerning information technology acquisition" and that "organizations that enjoy a higher level of information technology use tend to have managers who have positive attitudes toward information technology" (Babcock, Bush, and Zhiyong, 1995). Similarly, in their 1995 study of technology investment decisions, Abdul-Gader and Kozar found that "if two managers equally think that (1) computers are needed in their departments and (2) computers are within their departments' budgets, the manager who is confident that computers will not challenge his/her control is more likely to purchase than the one who perceives threats from computers" (Abdul-Gader and Kozar, 1995).

Markus also contends that organizational heterogeneity is intimately tied to resource availability, in that having heterogeneity of interests and resources in an organization improves the chances that high-interest and/or high-resource individuals will become interested in a given interactive medium, thus improving the likelihood that others will adopt the new technology and that critical mass will be reached.

Other Studies of the Diffusion of Internet Technology

Over the last twenty years, a number of studies have explored the diffusion of the use of computers, various forms of information

technology, and internet precursors, such as BITNET and electronic messaging systems.

In a study of the evolution of BITNET, an inter-university electronic communication system established in 1981, Gurbaxani found that the rate of adoption closely resembled the S-shaped curved characteristic of critical mass and other diffusion of innovation studies. In Gurbaxani's estimation, critical mass for BITNET was reached shortly after the University of California's Berkeley campus was added to the system, after which the number of connections added to the system doubled every six months (Gurbaxani, 1990). Rogers suggests that the addition of a highly respected institution like the University of California at Berkeley (which presumably had a large number of professional and social relationships with other universities) triggered the cascade of adoption that followed by increasing the reciprocal interdependence of the system (Rogers, 1995).

As the popularity of electronic messaging grew, it spawned enhanced versions of the technology. Among these was computer conferencing—a technology that enabled messages to be exchanged among individuals and/or groups and also provided a record of these exchanges that could be accessed at a later date. In a 1984 study of influences on the adoption

of computer conferencing, Rice found that the factors that influenced people to use computer conferencing included the number of people already on the system, the individual's anticipated level of use, the priority of tasks to be performed on the system, access to the system, a perceived need to communicate, and the existence of an advocate for the group.

With the advent of videotext and similar newsreading services in the early 1980s, electronic messaging began taking on some of the characteristics of a broadcast medium. In their 1984 overview of rival theories of newsreading, Dozier and Rice considered the impact of innovation and user characteristics on the diffusion of videotext and teletext, as well as obstacles to its diffusion. They found that user acceptance of electronic news services depended to a great extent on the user's purpose for reading the news (business or pleasure). They also noted that design of the news service influenced whether it was embraced by purposive or pleasure-seeking reader. Finally, they determined that concern over costs (for access and hardware), uncertainty about infrastructure (the availability of cable connections), and incompatible standards across electronic text systems all had the potential to slow the use of videotext.

By the mid-1990s, momentum in the area of online communication had clearly shifted to the internet—and to the web in particular. One of the earliest and most comprehensive attempts to examine internet use was the series of World Wide Web User Surveys conducted by the Georgia Institute of Technology's Graphics, Visualization, & Usability (GVU) Center. To date, nine GVU studies have been conducted, collecting data on general demographics, technology demographics, web and internet usage, and internet commerce, among other areas. According to GVU, the point of the studies is to "characterize WWW users as well as demonstrate the Web as a powerful surveying medium.... This interface also enables users to complete our survey at their own convenience, and answer questions in a low-overhead fashion" (Graphics, Visualization, & Usability Center, 1998). It should be noted that, while the GVU surveys provide some direction for conducting survey research on the internet, they don't directly address issues related to the diffusion of internet technology. Also, while the GVU studies have done a great deal to promote internet-based survey research, one of the greatest strengths of their surveys, convenience, is also one of their biggest liabilities. Rather than devising a method of conducting a systematic survey of internet users, GVU researchers opted to make the survey widely accessible on the internet (in order to ensure the most representative sample possible

under the circumstances). They then employed a number of correction techniques to ameliorate the effects of this non-probabilistic sampling method. GVU researchers, Pitkow and Kehoe, acknowledge that these methods reduce their ability to generalize from the surveys' results to the entire internet user population. They also suggest that, until a set of validation and correction metrics for this sort of non-probabilistic research is more widely accepted, a conservative interpretation of the data is called for (Pitkow and Kehoe, 1996).

In 1996, LaRose and Hoag reported on one of the few studies to consider internet use from a diffusion of innovation perspective. In their phone survey of 233 businesses on the role of innovation clusters (innovations that are adopted as a package, or cluster) in promoting internet use within organizations, the authors found that internet use was more closely related to the previous adoption of certain infrastructure-related innovation clusters (such as large area networks, wide area networks, microcomputers, and computer workstations) than it was to measures of innovation attributes, and various organizational factors, such as size, the existence of a "champion" for the technology, and management support (LaRose and Hoag, 1996). The LaRose and Hoag study did not consider what factors, beyond those associated with innovation clusters,

influenced the diffusion of internet use within the organizations studied, nor did they consider the effect of management support for internet use on the acquisition of the infrastructure necessary to support this technology.

Summary

Studies of the process of the diffusion of technological innovation over the last 70 years have focused on innovations ranging from steel axes to internet technology and have demonstrated that an innovation's ultimate acceptance or rejection and the extent of its impact on a social group is heavily influenced by the manner in which it is introduced and applied. The study described in the chapters that follow will consider the ongoing diffusion of internet technologies at six U. S. Department of Energy (DOE) facilities operated by Lockheed Martin Corporation's Energy and Environment Sector and will attempt to determine how the individual/interpersonal factors frequently cited by traditional diffusion of innovation researchers and the organizational factors cited by critical mass theorists expedite or inhibit this process.

Chapter II

Design and Methodology

This study consists of a pretest survey and a final survey. The pretest was used primarily as a test bed for the survey instrument and the data-gathering procedures. Both surveys are described in detail below.

Pretest Survey Sample and Administration

A pretest survey was conducted between July 9, 1997 and July 18, 1997 to validate and focus the final survey instrument, as well as to serve as a dry run for the web, e-mail, and paper versions of the survey instrument (particularly the programming that enabled data to be collected from the web and e-mail instruments automatically). Requests to participate in the survey were sent to all 129 members of the Computing, Information and Networking Division at Oak Ridge National Laboratory in Oak Ridge, Tennessee. Using an alphabetical list of division members, and alternating among the three survey formats, (web, e-mail, and paper), 43 potential respondents were sent e-mail messages directing them to a web-based survey; 43 were sent e-mail surveys, and 43 were sent paper surveys. All members of the pretest group had access to e-mail and the

internet. Seven days after the initial solicitation, a reminder message was sent to individuals who had originally received e-mail solicitations for either the web-based or e-mail survey; a reminder survey was sent to those who had initially received paper surveys.

The 129 pretest survey solicitations generated 55 responses (22 web, 17 e-mail, 16 paper)—a response rate of 42.7%. The demographic make-up of the respondents was relatively diverse. Occupations included administrative (7.3%), clerical (3.6%), computer-related (36.4%), managers (3.6%), professionals (21.8%), and other (7.3%). Twenty percent of the respondents chose not to respond to the "occupation" item. Respondents included 24 females, 15 males, five individuals who preferred not to indicate their gender, and 12 who did not provide a response to the "gender" item. Ages of respondents ranged from the 20–29 bracket to the 50–59 bracket, with the largest number being concentrated in the 30–39 bracket. Overall, the pretest survey respondents were somewhat younger and somewhat more likely to be female than final survey respondents.

Pretest Survey Instrument

The pretest survey instrument consists of six sections: five specialized indexes (described below), and a demographic information section. The individual items that make up all of the indexes except the Internet Use Index employ five-point Likert-type scales, ranging from "strongly agree" to "strongly disagree." The Internet Use index employs a multiple-choice format with responses graduated in order of amount or sophistication of use. Respondents' scores for each of the indexes were determined by calculating the mean score for each set of items. The web, e-mail and paper versions of the pretest survey instrument are reproduced in Appendix A.

The first section of the pretest survey is the Individual Adoption Index. It includes two items for each of Rogers' five "characteristics of innovations": relative advantage, compatibility, complexity, trialability, and observability (Rogers, 1995). The Individual Adoption Index is designed to measure the extent to which internet use in the workplace is influenced by the individual/interpersonal factors frequently cited by traditional diffusion of innovation researchers.

The second section of the pretest survey is the Internet Attitude Index. It is made up of 18 items based on Abdul-Gader and Kozar's Computer Alienation Scale (Abdul-Gader and Kozar, 1995); however, it focuses on respondent's attitudes toward internet technology, rather than computers in general. Three items from the Computer Alienation Scale didn't translate particularly well into the "internet attitude" construct, so those items aren't reflected in the Internet Attitude Index.

The third section of the survey pretest is Abdul-Gader and Kozar's 21-item Computer Alienation Scale (Abdul-Gader and Kozar, 1995). Originally designed to examine "decision makers' attitudes and internal beliefs, especially the construct of alienation, with regard to the broader context of information technology investment decisions" (Abdul-Gader and Kozar, 1995), the Computer Alienation Scale was included in the pretest to provide a means of documenting that the constructs of "computer alienation" and "internet attitude" are relatively closely correlated, thereby providing a degree of validation for the Internet Attitude section of the survey.

The fourth section of the pretest survey is the Organizational Support Index. It is made up of 10 items based on the five propositions offered by

Markus with respect to the probability and extent of the diffusion of interactive media usage within communities (see Chapter I) (Markus, 1987). Two index items address each of Markus' propositions. The Organizational Support Index is designed to measure the extent to which internet use in the workplace is influenced by the organizational factors frequently cited by critical mass theorists.

The fifth section of the pretest survey is the Internet Use Index. This index includes six items which measure aspects of individual internet use, including measures of frequency, duration, and the type and sophistication of tasks. These items are fairly generic measures of internet use and are not based on any other instrument in particular. However, they have aspects in common with a number of internet use surveys.

The sixth and final section of the pretest survey is made up of eight demographic items and two short-answer questions. Demographic questions were kept to a minimum in order not to cause respondents undue concern about the anonymity of their responses. The demographic information solicited in this section includes: facility, occupation, field of formal education, gender, age, computer operating system, primary

internet browser, and sources of information about new internet resources. The two short-answer questions are "What would it take to make internet technology more useful in your everyday work?" and "Are there any other comments you'd like to pass along concerning internet technology?" The primary purpose of these short-answer questions is to provide feedback to the organizations participating in the study.

The three versions of the pretest survey instrument (web, e-mail, and paper) are made as similar as is practical, given the limitations of their respective media. All of the survey instruments are reproduced in Appendix A. The wording and order of the questions is identical in all versions, and the instructions are very similar, with the exception of media-specific variations. For example, on the paper version of the survey, participants are asked to "place an 'X' in the circle"; on the web version, they are asked to "click one of the small, round buttons"; and on the e-mail version, they are asked to "enter your answer on the same line as the answer pointer."

An ANOVA was conducted to compare the pretest scores of the five indexes across the three media (web, e-mail, and paper). The results of this comparison are shown in Table 2.1. The results suggest that there

Table 2.1 Analysis of between-groups variance of pretest survey index scores on web, e-mail, and paper survey instruments. (N=55)

Source of Variation	Sum of Squares	Degrees of Freedom	Mean squares	F	Sig.
Individual Adoption Index	1.244	2	.622	1.132	.330
Internet Attitude Index	.427	2	.213	.473	.626
Computer Alienation Index	1.766	2	.883	1.656	.201
Organizational Support Index	1.202	2	.601	.758	.474
Internet Use Index	2.547	2	1.273	1.190	.312

are no significant differences among the index scores that can be attributed to the format of the survey. However, the lack of significant differences may be due to the relatively small sample size. In general, the mean index scores of the three survey groups (Table 2.2) indicate that mean scores are highest for web-based survey responses, second highest for e-mail survey responses, and lowest for paper survey responses. This rough hierarchy is not unexpected, given that experienced internet technology users might reasonably be expected to have the highest mean scores and prefer the web survey, and somewhat less-experienced users might be expected to have somewhat lower mean scores and be more

Table 2.2 Mean index scores on web, e-mail, and paper pretest survey instruments.

Format	Mean
Individual Adoption Index (N=55)	3.6836
Web (N=22)	3.7864
E-Mail (N=17)	3.4588
Paper (N=16)	3.7813
Internet Attitude Index (N=55)	3.9071
Web (N=22)	4.0126
E-Mail (N=17)	3.8595
Paper (N=16)	3.9071
Computer Alienation Index (N=55)	3.7766
Web (N=22)	3.8853
E-Mail (N=17)	3.8992
Paper (N=16)	3.4970
Organizational Support Index (N=55)	4.0109
Web (N=22)	4.1909
E-Mail (N=17)	3.8706
Paper (N=16)	3.9125
Internet Use Index (N=55)	3.9576
Web (N=22)	4.2197
E-Mail (N=17)	3.7549
Paper (N=16)	3.8125

comfortable with the e-mail survey. The paper survey was sent only to individuals without active e-mail addresses, so it might reasonably be assumed that this group would be the least experienced users of internet technology and, therefore, have the lowest mean scores.

Pretest Data Gathering

The web and e-mail survey instruments are designed to pass responses to several computer programs, which parse the responses and compile them into a data matrix. The pretest provided an opportunity to test these computer programs. During the pretest, both the web and e-mail response parsing went fairly smoothly, although a few problems occurred in recording comments from the e-mail version of the survey instrument. All paper responses were entered into a data matrix manually by a single coder.

All the surveys received in the pretest were either blank or filled out more or less completely. If the survey was blank it was discarded. All other survey results were tabulated. If a respondent provided multiple responses to a single item on e-mail or paper surveys (this was impossible to do on the web version of the survey), the item was coded as a zero (no response). If the respondent provided an illegible or

unintelligible response on an e-mail or paper survey (this was impossible to do on the web version of the survey), the item was coded as a zero (no response).

Validation with Established Scales

Because the widespread use of internet technology is a relatively new phenomenon, little research has been conducted on factors that influence the use of internet technology in the workplace. There have, however, been several studies that have concerned themselves with internet use in general, the most prominent being the ongoing series of surveys conducted by the Graphics, Visualization, & Usability (GVU) Center of the Georgia Institute of Technology. While the GVU studies have garnered considerable attention, they are (a) based on self-selected samples and (b) don't employ scales or indices in their analysis. No other study of internet use was found to have employed an index or scale that could be used to validate the results of any part of the current study. Despite the lack of appropriately similar studies of internet use, an adequate model for constructing a scale to measure individuals' attitudes toward internet technology was found in Abdul-Gader and Kozar's 1995 study of the impact of computer alienation on information technology investment decisions. This Computer Alienation Scale was designed by

the authors to examine "decision makers' attitudes and internal beliefs, especially the construct of alienation, with regard to the broader context of information technology investment decisions" (Abdul-Gader and Kozar, 1995). The Computer Alienation Scale was based on a number of previously developed alienation scales, including scales measuring computer alienation (Ray and Minch, 1990) and computer anxiety (Simonson, et al., 1987). The Computer Alienation Scale is reproduced in Appendix B.

Abdul-Gader and Kozar note that Howard and Smith (1986) consider "technological alienation" to be a manifestation of computer anxiety. This suggests that there may be a relationship between the attitude people have toward computers and the attitude they have toward internet technology. At present, using internet technology requires a great deal of interaction with computers. While the software interfaces currently available to internet users are considerably more accommodating to users than those available in 1986 (the year of Howard and Smith's study), it is reasonable to assume that the prospect of using a computer to access the internet remains somewhat daunting to many individuals.

As mentioned above, three items from Abdul-Gader and Kozar's Computer Alienation Scale didn't translate particularly well into the "internet attitude" construct, so those items aren't reflected in the Internet Attitude Index. These items were:

- Computers dehumanize society by treating everyone as a number.
- I clearly understand what input computers want.
- I sometimes get nervous just thinking about computers.

The remaining items were reworded to fit the construct of "internet attitude."

Correlation analysis of the pretest results yielded a Pearson's correlation coefficient of .72 ($p<.01$) between the Internet Attitude Index and the Computer Alienation Scale, indicating that the two instruments are fairly highly correlated.

Reliability of Indexes

After the pretest data were collected, the Individual Adoption, Internet Attitude, Organizational Support, and Internet Use indexes were tested for internal consistency by calculating an alpha coefficient, or Cronbach's reliability index, for each. No reliability statistics were calculated for the

Computer Alienation Scale because it was included in the pretest only as a test of validity for the Internet Attitude Index. Results of that test are discussed below. Alpha coefficients for the remaining four indexes are as follows: Individual Adoption (.8348), Internet Attitude (.8997), Organizational Support (.9041), and Internet Use (.9066). The minimum alpha score for an index to be considered internally consistent is accepted to be .70 (Nunnally, 1978). This level of consistency indicates that each item is contributing to the measurement of the quality or construct in question. All four indexes exceed this standard.

Corrected item-total correlations were also obtained. On the basis of the corrected item-total scores, three items having relatively weak correlations were eliminated from the Individual Adoption Index, and nine items having relatively weak correlations or requesting seemingly redundant information were removed from the Internet Attitude Index. Alpha coefficients were re-calculated for these two indexes, yielding the following results: Individual Adoption (.8441), Internet Attitude (.9433). These deletions helped both to focus the indexes by increasing their internal consistency and to reduce the total number of questions in a fairly lengthy survey.

After the deletions were made, item-total correlations were again calculated as an additional check on the reliability of the indexes. These correlation scores consider both individual items and entire indexes in terms of the variance they explain. Items with high item-total correlations increase the variance explained by the index. Nunnally suggests that each item should have an item-total correlation of at least .20 to be included in the index and that the index should have a mean item-total correlation of at least .40 (Nunnally, 1978). All item-total correlations exceed Nunnally's recommended standards.

The mean item-total correlations for the four indexes are as follows: Individual Adoption Index (.6089), Internet Attitude (.7866), Organizational Support (.6659), and Internet Use (.7483). Item-total correlations and mean values for individual items in the four indexes are illustrated in Table 2.3, below.

Inter-item correlations were also calculated for the four indexes (see Table 2.4). Three asterisks (***) following an item description, below, indicates that the item was phrased and coded negatively. For the Individual Adoption Index, all correlations were positive, ranging from

Table 2.3 Corrected item-total correlations, means and standard deviations for Individual Adoption, Internet Attitude, Organizational Support, and Internet Use indexes (N=55)

Item Number*	Corrected Item-Total Correlation	Mean**	Standard Deviation
Individual Adoption			
S1_1	.7440	4.4000	1.0470
S1_2***	.5125	4.4909	.9976
S1_3	.6029	4.4545	1.1518
S1_5	.7230	3.7091	1.1168
S1_6***	.6634	3.8182	1.1237
S1_7	.4873	2.8545	1.3933
S1_8***	.5229	3.2364	1.2905

Coefficient *alpha* = .8441
*Non-consecutive item numbers result from items being removed in reliability testing. Item numbering reflects the section and question number of items in the pretest survey; for example, item "S1_1" indicates "section 1, question 1." For a listing of all items, see Appendix A.
**On a 5-point Likert scale ranging from "strongly agree" to "strongly disagree."
***Item was phrased and coded negatively.

Internet Attitude			
S2_9	.6246	4.1273	.9439
S2_11	.8155	4.0727	1.1031
S2_12	.8018	3.9636	1.1216
S2_13***	.6965	4.3091	1.0341
S2_14	.8489	4.0545	1.1290
S2_15***	.6950	4.2182	1.2276
S2_16	.6216	4.3091	.9598
S2_17***	.7050	4.5818	1.0127
S2_18***	.6442	3.8909	1.3426

Coefficient *alpha* = .9433
*Non-consecutive item numbers result from items being removed in reliability testing. Item numbering reflects the section and question number of items in the pretest survey; for example, item "S1_1" indicates "section 1, question 1." For a listing of all items, see Appendix A.
**On a 5-point Likert scale ranging from "strongly agree" to "strongly disagree."
***Item was phrased and coded negatively.

Table 2.3 (Continued)

Item Number*	Corrected Item-Total Correlation	Mean**	Standard Deviation
Organizational Support			
S4_1	.6323	4.5455	.8348
S4_2***	.6543	4.3818	1.2396
S4_3	.6978	3.6909	1.1844
S4_4***	.6128	3.6727	1.2331
S4_5	.7264	4.2545	1.2052
S4_6***	.6163	3.9818	1.3539
S4_7	.6916	3.9636	1.2760
S4_8***	.7032	3.9455	1.2970
S4_9	.7926	4.2000	1.1122
S4_10***	.5319	3.4727	1.2889

Coefficient *alpha* = .9041
*Non-consecutive item numbers result from items being removed in reliability testing. Item numbering reflects the section and question number of items in the pretest survey; for example, item "S1_1" indicates "section 1, question 1." For a listing of all items, see Appendix A.
**On a 5-point Likert scale ranging from "strongly agree" to "strongly disagree."
***Item was phrased and coded negatively.

Internet Use			
S5_1	.7678	3.7091	1.0831
S5_2	.7352	3.6182	1.1625
S5_3	.7697	3.9091	1.3645
S5_4	.6021	3.6909	1.2892
S5_5	.8220	4.5091	1.1686
S5_6	.7931	4.3091	1.4385

Coefficient *alpha* = .9066
*Non-consecutive item numbers result from items being removed in reliability testing. Item numbering reflects the section and question number of items in the pretest survey; for example, item "S1_1" indicates "section 1, question 1." For a listing of all items, see Appendix A.
**On a 5-point Likert scale ranging from "strongly agree" to "strongly disagree."

Table 2.4 Inter-item correlations for the Individual Adoption, Internet Attitude, Organizational Support, and Internet Use indexes

Individual Adoption

	S1_1	S1_2	S1_3	S1_5	S1_6
S1_1	1.0000				
S1_2	.6418	1.0000			
S1_3	.7217	.5113	1.0000		
S1_5	.5923	.4131	.3207	1.0000	
S1_6	.5194	.4115	.2940	.7982	1.0000
S1_7	.3580	.1056	.2150	.5674	.5742
S1_8	.3947	.2247	.3624	.5112	.4133

	S1_7	S1_8
S1_7	1.0000	
S1_8	.4623	1.0000

Internet Attitude

	S2_9	S2_11	S2_12	S2_13	S2_14	S2_15
S2_9	1.0000					
S2_11	.5601	1.0000				
S2_12	.5467	.9003	1.0000			
S2_13	.4712	.7429	.7284	1.0000		
S2_14	.5842	.8145	.7913	.7466	1.0000	
S2_15	.3751	.7128	.6918	.5877	.6994	1.0000
S2_16	.4259	.8004	.7504	.6110	.7361	.6490
S2_17	.5604	.7903	.7690	.6562	.7977	.7153
S2_18	.3911	.6556	.6368	.5983	.6392	.4866

	S2_16	S2_17	S2_18
S2_16	1.0000		
S2_17	.7451	1.0000	
S2_18	.6015	.6877	1.0000

Table 2.4 (Continued)

Organizational Support

	S4_1	S4_2	S4_3	S4_4
S4_1	1.0000			
S4_2	.5645	1.0000		
S4_3	.3610	.4981	1.0000	
S4_4	.3025	.5073	.6015	1.0000
S4_5	.6877	.6527	.5491	.3935
S4_6	.5005	.4566	.4006	.3402
S4_7	.4362	.4421	.6296	.5808
S4_8	.4898	.4739	.4469	.4518
S4_9	.5584	.5480	.6945	.5077
S4_10	.3411	.2790	.4372	.4021

	S4_5	S4_6	S4_7	S4_8	S4_9	S4_10
S4_5	1.0000					
S4_6	.5817	1.0000				
S4_7	.5239	.5784	1.0000			
S4_8	.5422	.4845	.5359	1.0000		
S4_9	.6659	.4821	.5141	.6367	1.0000	.3411
S4_10	.2787	.3340	.3372	.6028	.6046	1.0000

Internet Use

	S5_1	S5_2	S5_3	S5_4	S5_54	S5_6
S5_1	1.0000					
S5_2	.6896	1.0000				
S5_3	.6709	.6314	1.0000			
S5_4	.5047	.4758	.4575	1.0000		
S5_5	.7337	.7319	.6334	.5981	1.0000	
S5_6	.6174	.5812	.7976	.5617	.7088	1.0000

.1056 (opportunities to experiment with internet technology–knowledge of how to use internet technology and job security) to .7982 (find internet technology confusing*** using internet technology is easy). The mean inter-item correlation was .4482. For the Internet Attitude Index, all correlations were positive, ranging from .3751 (trust of people in charge of internet technology using internet technology is more trouble than it's worth***) to .9003 (get along well with people in charge of internet technology people in charge of internet technology are friendly and helpful). The mean inter-item correlation was .6571. For the Organizational Support Index, all correlations were positive, ranging from .2787 (many groups at my site are interested in internet technology management at my site doesn't invest enough money in internet technology***) to .6945 (have the skills/training needed to use internet technology management at my site supports the use of internet technology). The mean inter-item correlation was .4942. For the Internet Use Index, all correlations were positive, ranging from .4575 (likelihood of using internet technology if not required to how internet technology is used at work) to .7976 (likelihood of using internet technology if not required to web-browsing habits used at work). The average inter-item correlation was .6263.

The results of the inter-item correlation calculations for the four indexes provide added support for the assertion that all remaining items in the indexes should be retained.

In addition to alpha testing, a principal components factor analysis was conducted on each of the indexes. Factor analysis, while not as definitive as alpha testing, can provide additional assurance of an index's internal consistency if one factor identified in the analysis is dominant over the others.

The initial, unrotated analysis indicated that one factor accounted for the majority of the variance in each of the indexes. For the Internet Attitude and Internet Use indexes, a single, dominant eigenvalue was produced. For the Individual Adoption and Organizational Support indexes, two eigenvalues, were produced, with one dominating and the other having an eigenvalue of slightly more than 1. Eigenvalues and variance figures for each analysis are included in Table 2.5. The results of the factor analyses are consistent with the preceding analyses in supporting the reliability of the four indexes.

Table 2.5 Eigenvalues resulting from principal components factor analyses of Individual Adoption, Internet Attitude, Organizational Support, and Internet Use indexes

Index	Eigenvalues	Percentage of Variance Accounted for
Individual Adoption	3.739 1.276	53.419 18.223
Internet Attitude	6.325	70.279
Organizational Support	5.484 1.036	54.837 10.365
Internet Use	4.149	69.152

Final Survey Sample

The survey population for this study was the employees at six U.S. Department of Energy facilities in California, Idaho, New Mexico, and Tennessee—a total survey population of 26,697 (based on employee rosters received from the facilities). A survey population breakdown is shown in Table 2.6. These facilities were chosen for the survey because they had certain inherent similarities—i.e., they were all facilities administered for DOE by the Energy and Environment Sector of the

Table 2.6 Population breakdown by facility

Facility*	Population
INEEL	5694
ETTP	2616
Y-12 Plant	5094
ORNL	5084
SNL-Albuquerque	7169
SNL-Livermore	1040

*INEEL = Idaho National Engineering and Environmental Laboratory, Idaho Falls, Idaho
ETTP = East Tennessee Technology Park, Oak Ridge, Tennessee
Y-12 Plant = Oak Ridge Y-12 Plant, Oak Ridge, Tennessee
ORNL = Oak Ridge National Laboratory, Oak Ridge, Tennessee
SNL-Albuquerque = Sandia National Laboratories, Albuquerque, New Mexico
SNL-Livermore = Sandia National Laboratories, Livermore, California

Lockheed Martin Corporation, suggesting certain general similarities in the types of issues they address and the types of people they employ. In addition, the facilities were thought to have certain inherent differences—in mission, funding, management, and geographical location. The similarities suggested that comparisons among the facilities in terms of how they adopt and implement internet technology would be unlikely to be overshadowed by more basic differences. The differences among the facilities suggested that there might be considerable variation in how they adopt and implement internet technology.

At the time the survey was conducted, all of these facilities were administered for DOE by . Lockheed Martin Corporation's Energy and

Environment Sector. Employee rosters were requested and received from each facility. Each roster included employee names, work addresses, and e-mail addresses (if available). A single roster was received for the two Sandia (SNL) facilities (Albuquerque and Livermore) and was subsequently divided by facility.

Given that paper-based surveys sometimes yield response rates as low as 20% and that anecdotal evidence suggests web surveys often experience somewhat lower response rates, it was assumed that a best-case scenario would yield a response rate of about 20% for this survey. The response rate for the pretest (42.7%) wasn't considered to be a reliable predictor for the final survey because of the relatively small size of the pretest population.

In order for the survey to provide useful and significant results overall, as well as for individual facilities, relatively high sampling rates were thought to be necessary to solicit a sufficiently high number of responses for all desired levels of analysis. In the light of the expected response rates, it was determined that sampling 1600 employees from five of the six facilities would be necessary. The sixth facility, SNL-Livermore, only had about 1040 employees on their roster, so all of the employees on the

roster were included in the sample. Samples were generated by importing employee rosters into Microsoft Excel (a spreadsheet software package) and using Excel to generate a specific number of randomly selected cases. Given the sample sizes, the expected response rate of about 20% at each facility would then yield about 300 responses per facility—enough data to enable moderately strong relationships found in facility-level analyses to reach statistical significance.

Overall, 9040 survey solicitations were sent out. Of these solicitations, 7643, or 84.5%, were e-mail messages, and 1397, or 15.5%, were paper. A total of 2711 usable responses were received—a 30% response rate. Of these responses, 68.4% replied using the web-based instrument, 25.6% replied by e-mail, and 6% replied to the paper survey. It should be noted that the percentage of total responses accounted for by paper surveys (6%) is considerably lower than the percentage of total paper solicitations (15.5%). While this result suggests that the respondents to the survey do not represent a precise cross-section of the survey population, this discrepancy was not unexpected and may be an indication that a large number of the paper solicitations were directed to a portion of the population which has yet to adopt internet technology—and, therefore, had no interest in completing the survey.

Response rates broke down by facility as follows: INEEL (1600 solicitations, 547 responses, 34.2% response rate—web 63.6%, e-mail 18.5%, paper 17.9%); ETTP (1600 solicitations, 453 responses, 28.3% response rate—web 83.4%, e-mail 15.7%, paper .9%); Y-12 Plant (1600 solicitations, 384 responses, 24.0% response rate—web 79.9%, e-mail 14.6%, paper 5.5%); ORNL (1600 solicitations, 503 responses, 31.4% response rate—web 79.1%, e-mail 15.3%, paper 5.6%); SNL-Albuquerque (1600 solicitations, 521 responses, 32.6% response rate—web 51.8%, e-mail 46.3%, paper 1.9%); SNL-Livermore (1040 solicitations, 288 responses, 27.7% response rate—web 49.0%, e-mail 50.3%, paper .7%); 15 responses didn't list a facility affiliation.

Final Survey Administration

The final survey was conducted between August 22, 1997 and October 22, 1997. Using samples drawn from the facility rosters, employees were contacted in one of two ways. Employees having active e-mail addresses received survey solicitations by e-mail. A reproduction of the e-mail message and survey is included in Appendix C. (See Appendix E for more information on e-mail–related concerns). Employees receiving e-mail solicitations were asked to either respond to the e-mail survey, which was appended to the solicitation, or to use their internet browser to

complete and submit a web version of the survey instrument. A reproduction of the web version of the survey instrument is included in Appendix C. The return address on the e-mail solicitation was "spoofed" (not the address of the sender), causing responses to be mailed directly to a computer address which parsed the e-mail responses into a data matrix. The web version of the survey form submitted responses to another computer address for similar processing. A separate e-mail address was provided to report problems with the survey instruments and other survey-related concerns. Details of the automated processing of e-mail and web-based survey responses are included in Appendix E. Employees without e-mail addresses were mailed paper surveys and pre-addressed return envelopes. Return envelopes distributed at the three Oak Ridge facilities (ETTP, Y-12 Plant, and ORNL) were handled by the internal Lockheed Martin mail system and required no postage. Surveys mailed to the other three facilities contained postage-paid return envelopes. A reproduction of the paper survey is included in Appendix C. A mailing address and an e-mail address were provided to report problems with the paper survey instrument and other survey-related problems.

All three versions of the survey instrument (web, e-mail, and paper) included a statement indicating that the survey was sponsored by Lockheed Martin's Energy and Environment Sector Internet Working Group and encouraging employees to participate in this survey. It could be argued that this influence may have skewed the results of the survey by causing particularly compliant employees to be over-represented; however, it was assumed that this potential risk was very small when compared with the potential increase in response rates.

Two follow-up messages, similar to the first, were sent to each potential respondent at approximately seven and 10 days after the initial solicitation. Employees who initially received e-mail messages received follow-up e-mail messages with a copy of the survey appended to the reminder. The reminders also included references to the web version of the survey. Employees who initially received paper surveys received postcards encouraging them to respond to the initial solicitation. The cost of mailing paper surveys out with reminder cards was prohibitive, so replacement surveys were mailed out only by request. The postcards included a mailing address and an e-mail address to request replacement paper surveys. See Appendix D for reproductions of e-mail and paper reminders.

The survey and reminder schedule is shown in Table 2.7. Electronic mailings were sent and received on the dates noted. Mailings to the SNL-Albuquerque and SNL-Livermore facilities were delayed about four weeks due to various administrative difficulties, including obtaining an employee roster that separated employees with active e-mail accounts from those without them. See Appendix E for other e-mail–related concerns.

The dates listed in Table 2.7 are approximate for paper mailings, due to the processing time required for mail to pass through organizational mailrooms. Originating and receiving mailrooms were alerted to the survey in advance, so processing time was kept to a minimum. The three Oak Ridge facilities (ETTP, Y-12 Plant, and ORNL) share an internal mail system, so surveys and reminders were distributed internally without being handled by the U.S. Mail or commercial mail carriers. Packages of surveys and reminders were shipped to mailrooms at the INEEL and SNL facilities, and the facility mailrooms distributed these items internally.

Web and e-mail responses from all facilities were generally received within 14 days of the initial solicitations. Paper responses were generally

Table 2.7 Pretest and final survey schedule

Pretest Survey	
Pretest survey solicitations mailed	7/9/97
Pretest reminders mailed	7/16/97
End of pretest	7/18/97
Final Survey	
Survey solicitations mailed out to INEEL, ETTP, Y-12 Plant and ORNL	8/22/97
First reminder mailed out to INEEL ETTP, Y-12 Plant and ORNL	8/29/97
Last reminder mailed out to INEEL ETTP, Y-12 Plant and ORNL	9/2/97
Survey solicitations mailed out to SNL-Albuquerque and SNL-Livermore	9/17/97
First reminder mailed out to SNL-Albuquerque and SNL-Livermore	9/23/97
Last reminder mailed out to SNL-Albuquerque and SNL-Livermore	9/27/97

received over a slightly longer period. The last response was received on October 22, 1997.

Final Survey Instrument

The final survey instrument is similar, in most respects, to the pretest instrument described above. The final survey consists of five sections (the Computer Alienation Scale included in the pretest was not included in the final survey): four specialized indexes (described below), and a demographic information section. Individual items in all of the indexes except the Internet Use Index employ five-point Likert-type scales, ranging from "strongly agree" to "strongly disagree." The Internet Use index employs a multiple-choice format with responses graduated in order of amount or sophistication of use. Respondents' scores for each of the indexes were determined by calculating a mean score for each set of items. The web, e-mail and paper versions of the final survey instrument are reproduced in Appendix C of this study.

The first section is the Individual Adoption Index. It includes seven items based on Rogers' "characteristics of innovations" (Rogers, 1995). The Individual Adoption Index is designed to measure the extent to which internet use in the workplace is influenced by the

individual/interpersonal factors frequently cited by traditional diffusion of innovation researchers. The second section of the survey is the Internet Attitude Index. It is made up of nine items based on Abdul-Gader and Kozar's Computer Alienation Scale (Abdul-Gader and Kozar, 1995). The third section of the survey is the Organizational Support Index. It is made up of 10 items based on the five propositions offered by Markus with respect to the probability and extent of the diffusion of interactive media usage within communities (Markus, 1987). The Organizational Support Index is designed to measure the extent to which internet use in the workplace is influenced by the organizational factors frequently cited by critical mass theorists. The fourth section of the survey is the Internet Use Index. This index includes six items that measure aspects of individual internet use. The fifth and final section of the survey is made up of eight demographic items and two short-answer questions. The primary purpose of the short-answer questions is to provide additional feedback to the organizations participating in the study.

The three versions of the survey instrument (web, e-mail, and paper) are as similar as is practical, given the limitations of their respective media. The wording and order of the questions is identical from medium to

medium. Instructions are very similar, with the exception of media-specific variations. For example, on the paper version of the survey, respondents are asked to "circle one of the numbers"; on the web version, they are asked to "click one of the small, round buttons"; and on the e-mail version, they are asked to "enter your answer on the same line as the answer pointer." Each version of the final survey instrument is illustrated in Appendix C.

After the data from the final survey were collected, an ANOVA was conducted to compare the scores of the four indexes across the three survey media (web, e-mail and paper). The results of this comparison are shown in Table 2.8. The results suggest that there were significant differences among the index scores that are associated with the format of the survey. As was the case with the pretest, the mean index scores of the three survey groups (Table 2.9) illustrate a hierarchy of mean index scores: the highest for web-based survey responses, the second highest for e-mail survey responses and the lowest for paper survey responses. However, as mentioned in the discussion of the pretest, these differences are assumed to be primarily an artifact of the level of experience respondents in each group had with internet technology.

Table 2.8 Analysis of between-groups variance of final survey index scores on web, e-mail and paper survey instruments. (N=2711)

Source of Variation	Sum of Squares	Degrees of Freedom	Mean squares	F	Sig.
Individual Adoption Index	116.019	2	58.010	121.843	.000
Internet Attitude Index	51.353	2	25.676	72.439	.000
Organizational Support Index	31.294	2	15.647	45.763	.000
Internet Use Index	276.275	2	138.137	295.436	.000

Table 2.9 Mean index scores on web, e-mail and paper final survey instruments.

Format	Mean
Individual Adoption Index (N=2711)	3.9149
Web (N=1853)	4.0328
E-Mail (N=695)	3.7576
Paper (N=163)	3.2454
Internet Attitude Index (N=2711)	3.9542
Web (N=1853)	4.0246
E-Mail (N=695)	3.8799
Paper (N=163)	3.4693
Organizational Support Index (N=2711)	3.7665
Web (N=1853)	3.8012
E-Mail (N=695)	3.7731
Paper (N=163)	3.3444
Internet Use Index (N=2711)	3.4455
Web (N=1853)	3.5792
E-Mail (N=695)	3.3736
Paper (N=163)	2.2331

Final Survey Data Gathering

The web and e-mail survey instruments are designed to pass responses to several computer programs, which parse the responses and compile them into a data matrix. Responses to the web-based instrument parsed well without exception. However, in the course of the survey, it became obvious that the parsing of the e-mail survey responses was being hampered by responses that were not entered correctly. Initially, these problems were handled by editing the incorrectly parsed responses out of the data matrix and setting the offending e-mail message aside for manual processing. However, it eventually became clear that a large percentage of the e-mail responses had problems of this sort to one extent or another, so it was determined that processing all e-mail responses by hand would be the best way to proceed to ensure the integrity of the data. As a result, all e-mail responses were entered into a data matrix manually by a single coder.

Details of the automated processing of e-mail and web-based survey responses are included in Appendix E. All paper responses were also entered into a data matrix manually by a single coder.

A small number of surveys (of all types—web, e-mail, and paper) were filled out incompletely or not at all. Blank surveys were discarded. If the respondent filled out the demographics section and some fraction of the rest of the survey, the response was tabulated. If the respondent filled out only the demographic section, the response was tabulated. If the respondent filled out an entire section (an index) of the survey and nothing else, the response was tabulated. If the respondent filled out only two or three items of the entire survey (as happened on a handful of occasions), the survey was discarded. If the respondent provided multiple responses to a single item on e-mail or paper surveys (this was impossible to do on the web version of the survey), the item was coded as a zero (no response). If the respondent provided an illegible or unintelligible response on an e-mail or paper survey (this was impossible to do on the web version of the survey), the item was coded as a zero (no response).

Summary

A survey dealing with issues related to the use of internet technologies in the workplace was presented to a random sample of employees at six Department of Energy facilities in California, Idaho, New Mexico, and Tennessee, which were operated for DOE by Lockheed Martin

Corporation's Energy and Environment Sector. To ensure universal access for potential respondents, the survey was made available as a web-based form, as an e-mail message, and in paper format. The survey was composed of four indexes: Individual Adoption, Internet Attitude, Organizational Support, and Internet Use, as well as a set of demographic questions and two short-answer items.

The Individual Adoption Index was designed to measure the extent to which internet use in the workplace is influenced by the individual/interpersonal factors frequently cited by traditional diffusion of innovation researchers. The Internet Attitude Index was intended to measure the comfort level of respondents with respect to internet technology. The aim of the Organizational Support Index was to measure the extent to which internet use in the workplace is influenced by organizational factors frequently cited by critical mass theorists. Finally, the Internet Use Index attempted to gauge the extent to which individuals employ internet technology in the workplace by measuring aspects of internet use, including frequency, duration, sophistication, and motivation. The data gathered by these indexes is considered in detail in Chapter III.

Chapter III

Analysis and Results

The data gathered in the final survey were analyzed in several stages. First, reliability tests were performed on the indexes; then a descriptive analysis was performed to look for trends associated with the relationship between demographic variables and mean Internet Use Index scores. Finally, multiple regression analyses and t-tests were used to test the various hypotheses.

Reliability of Indexes

After the final data was collected, indexes were tested again for internal consistency by calculating an alpha coefficient, or Cronbach's reliability index, for each. Alpha coefficients for the four indexes are as follows: Individual Adoption (.7079), Internet Attitude (.8369), Organizational Support (.7776), and Internet Use (.8121). The minimum alpha score for an index to be considered internally consistent is accepted to be .70 (Nunnally, 1978). This level of consistency indicates that each item is contributing to the measurement of the quality or construct in question. All four indexes exceed this standard.

After the alpha coefficients were calculated, item-total correlations were calculated as an additional check on the reliability of the indexes. These correlation scores consider both individual items and entire indexes in terms of the variance they explained. Items with high item-total correlations increase the variance explained by the index. Nunnally suggests that each item should have an item-total correlation of at least .20 to be included in the index and that the index should have a mean item-total correlation of at least .40 (Nunnally, 1978).

On the basis of the item-total correlations, three items having relatively weak correlations were eliminated from the Individual Adoption index, one item having relatively weak correlations were eliminated from the Internet Attitude index, and four items having relatively weak correlations were eliminated from the Organizational Support index. Alpha coefficients were re-calculated for these three indexes, yielding the following results: Individual Adoption (.7463), Internet Attitude (.8271), Organizational Support (.7548). The effect of these deletions was to focus the indexes by increasing their internal consistency.

The mean item-total correlations were then re-calculated for the four indexes; they are as follows: Individual Adoption index (.5438), Internet

Attitude (.5534), Organizational Support (.5015), and Internet Use (.5831). All item-total correlations exceed Nunnally's recommended standards. Item-total correlations and mean values for individual items in the four indexes are illustrated in Table 3.1, below.

Inter-item correlations were also calculated for the indexes (see Table 3.2). Three asterisks (***) following an item description, below, indicates that the item was phrased and coded negatively. For the Individual Adoption index, all correlations were positive, ranging from .2257 (find internet technology confusing*** internet technology fits in with the way my organization works) to .6544 (find internet technology confusing*** using internet technology is easy). The mean inter-item correlation was .4269. For the Internet Attitude index, all correlations were positive, ranging from .2059 (trust people in charge of internet technology employer values internet technology too highly***) to .7867 (get along well with people in charge of internet technology people in charge of internet technology are friendly and helpful). The mean inter-item correlation was .3691. For the Organizational Support index, all correlations were positive, ranging from .2620 (few people I work with use internet technology*** several people at my site have promoted the use of internet technology for years) to .4876 (more and more people at my site are using

Table 3.1 Corrected item-total correlations, means, and standard deviations for Individual Adoption, Internet Attitude, Organizational Support, and Internet Use indexes (N=2711)

Item Number*	Corrected Item-Total Correlation	Mean**	Standard Deviation
Individual Adoption			
S1_1	.5174	4.1726	.8971
S1_3	.3948	3.9299	.9278
S1_4	.5615	3.8008	.9372
S1_5***	.5320	3.7562	1.0532

Coefficient *alpha* = .7463
*Non-consecutive item numbers result from items being removed in reliability testing. For a listing of all items, see Appendix C.
**On a 5-point Likert scale ranging from "strongly agree" to "strongly disagree."
***Item was phrased and coded negatively.

Internet Attitude			
S2_1	.5679	3.7407	.9690
S2_2	.6300	3.8447	.8560
S2_3	.6175	3.7388	.9037
S2_4***	.5615	4.0284	.9625
S2_5	.5326	3.8720	.8883
S2_6***	.5994	4.1970	.9040
S2_8***	.5534	4.4685	.7867
S2_9***	.3989	3.7429	.9787

Coefficient *alpha* = .8271
*Non-consecutive item numbers result from items being removed in reliability testing. For a listing of all items, see Appendix C.
**On a 5-point Likert scale ranging from "strongly agree" to "strongly disagree."
***Item was phrased and coded negatively.

Table 3.1 (Continued)

Item Number*	Corrected Item-Total Correlation	Mean**	Standard Deviation
Organizational Support			
S3_1	.4669	4.2261	.7311
S3_2***	.4824	3.9871	1.0133
S3_5	.4749	3.9698	.7914
S3_6***	.4853	3.6503	.9443
S3_7	.4496	3.4884	.9745
S3_9	.5975	3.8425	.9075

Coefficient *alpha* = .7548
*Non-consecutive item numbers result from items being removed in reliability testing. For a listing of all items, see Appendix C.
**On a 5-point Likert scale ranging from "strongly agree" to "strongly disagree."
***Item was phrased and coded negatively.

Internet Use			
S4_1	.4945	3.1523	.8435
S4_2	.5403	2.5994	.7672
S4_3	.5914	3.7794	1.0259
S4_4	.5413	3.2612	.9417
S4_5	.6717	3.9812	1.2564
S4_6	.6564	3.8997	1.3437

Coefficient *alpha* = .8121
*Non-consecutive item numbers result from items being removed in reliability testing. For a listing of all items, see Appendix C.
**On a 5-point Likert scale ranging from "strongly agree" to "strongly disagree."

Table 3.2 Inter-item correlations for the Individual Adoption, Internet Attitude, Organizational Support, and Internet Use indexes

Individual Adoption

	S1_1	S1_2	S1_3	S1_4	S1_5
S1_1	1.0000				
S1_2	.3292	1.0000			
S1_3	.5585	.3087	1.0000		
S1_4	.4398	.1222	.3256	1.0000	
S1_5	.3574	.1654	.2257	.6544	1.0000
S1_6	.1990	.0478	.1310	.2788	.2612
S1_7	.1206	.0501	.0503	.2773	.3335

	S1_6	S1_7
S1_6	1.0000	
S1_7	.5144	1.0000

Internet Attitude

	S2_1	S2_2	S2_3	S2_4	S2_5
S2_1	1.0000				
S2_2	.6899	1.0000			
S2_3	.6828	.7867	1.0000		
S2_4	.5163	.5992	.6258	1.0000	
S2_5	.2649	.2475	.2470	.2218	1.0000
S2_6	.2609	.2765	.2550	.3027	.5924
S2_7	.1888	.2254	.2077	.1976	.5037
S2_8	.2146	.2451	.2204	.3080	.4803
S2_9	.2059	.2135	.2128	.2259	.3131

	S2_6	S2_7	S2_8	S2_9
S2_6	1.0000			
S2_7	.5309	1.0000		
S2_8	.6101	.5113	1.0000	
S2_9	.3771	.2905	.3635	1.0000

Table 3.2 (Continued)

Organizational Support

	S3_1	S3_2	S3_3	S3_4
S3_1	1.0000			
S3_2	.4513	1.0000		
S3_3	.2229	.2567	1.0000	
S3_4	.1611	.2298	.3071	1.0000
S3_5	.4876	.3193	.2198	.1336
S3_6	.2653	.3346	.1774	.1922
S3_7	.3044	.2620	.2392	.1316
S3_8	.1504	.2012	.1173	.1871
S3_9	.3780	.3437	.2389	.2627
S3_10	.1245	.2182	.1749	.3338

	S3_5	S3_6	S3_7	S3_8	S3_9	S3_10
S3_5	1.0000					
S3_6	.3621	1.0000				
S3_7	.3636	.2691	1.0000			
S3_8	.2106	.3125	.3351	1.0000		
S3_9	.3679	.3547	.3720	.4008	1.0000	
S3_10	.1405	.3287	.1605	.3151	.4090	1.0000

Internet Use

	S4_1	S4_2	S4_3	S4_4	S4_5	S4_6
S4_1	1.0000					
S4_2	.4125	1.0000				
S4_3	.3514	.4292	1.0000			
S4_4	.3146	.3528	.3946	1.0000		
S4_5	.3941	.4523	.4835	.4639	1.0000	
S4_6	.3977	.3780	.5041	.4561	.5928	1.0000

internet technology many different groups at my site are interested in internet technology). The mean inter-item correlation was .3490. For the Internet Use index, all correlations were positive, ranging from .3146 (how long have you used internet technology how internet technology is used at work) to .5928 (combination of work-related tasks internet technology is used for web-browsing habits at work). The average inter-item correlation was .4252. The results of the inter-item correlation calculations for the four indexes suggest that all items remaining in the indexes should be retained.

In addition to alpha testing, a principal components factor analysis was conducted on each of the indexes. Factor analysis, while not as definitive as alpha testing, can provide additional assurance of an index's internal consistency if one factor identified in the analysis is dominant over the others.

In the case of each index, the initial, unrotated analysis indicated that one factor was dominant in terms of the percentage of variance accounted for. For the Individual Adoption index, Organizational Support index, and Internet Use index, a single, dominant eigenvalue (greater than 1.0) was produced. For the Internet Attitude index, two eigenvalues,

were produced, with one dominating and the other having a considerably smaller value. Eigenvalues and variance figures for each analysis are included in Table 3.3. The results of the factor analyses are consistent with the preceding analyses in supporting the reliability of the four indexes.

Preliminary Analyses

Initially, descriptive analyses were performed on the data in order to discover any trends or confounds that would be of importance in the subsequent phase of hypothesis testing. These analyses considered the range of values for each demographic variable and the mean Internet Use Index score associated with each value.

One of the first analyses was suggested by Babcock, Bush, and Lan's 1995 investigation of the use of information technology (a concept arguably similar to internet technology) by executives in the public sector. The authors suggest that (a) "educational background is related to executives' personal use of information technology" and (b) "personal use of information technology is negatively correlated with age" (Babcock, Bush, and Lan, 1995). Babcock, et al. also found that managers having computer science and business degrees were considerably more likely to

Table 3.3 Eigenvalues resulting from principal components factor analyses of Individual Adoption, Internet Attitude, Organizational Support, and Internet Use indexes

Index	Eigenvalues	Percentage of Variance Accounted for
Individual Adoption	2.289	57.218
Internet Attitude	3.696	46.201
	1.661	20.758
Organizational Support	2.754	45.896
Internet Use	3.140	52.328

use information technology than those with backgrounds in the natural sciences or the humanities. To test the applicability of this assertion to internet technology, the mean Internet Use Index scores of individuals who identified themselves as managers were broken down by educational background. The results of this process, reported in Table 3.4, indicate that the relationship found by Babcock, et al., with regard to educational background and information technology is not mirrored in the current study by the relationship between educational background and the use of internet technology. Mean Internet Use Index scores for respondents having backgrounds in computer science and mathematics, business, natural sciences, and the humanities are all fairly similar, with

Table 3.4 Mean Internet Use Index scores by educational background (all facilities)

	N	Mean
Business (i.e., Management, Economics, Marketing)	511	3.5127
Computer Science or Mathematics	316	3.6777
Crafts (i.e., Electrician, Pipefitter)	118	2.7881
Humanities (i.e., English, Philosophy, Art)	93	3.5287
Natural Sciences (i.e., Chemistry, Biology, Physics)	661	3.5091
Public Management (i.e., Public Administration)	21	3.3254
Other	941	3.3909

humanities graduates having a higher mean score than those with business degrees. In fact, business graduates had lower mean scores than two of the other three groups. It is not clear whether this outcome is due to differences between the survey populations of the two studies or between the concepts of information technology and internet technology.

Babcock, et al., also suggest a negative relationship between the use of information technology and age—that is, older individuals are less likely to use information technology than younger individuals. As illustrated by Table 3.5, a similar relationship between the use of internet technology and age doesn't seem to be present in the data gathered for this study. Mean Internet Use Index scores tend to fluctuate somewhat with age, not

Table 3.5 Mean Internet Use Index scores by age (all facilities)

	N	Mean
Less than 20	6	3.1111
20-29	146	3.4349
30-39	1880	3.5595
40-49	332	3.1456
50-59	266	3.1566
60-69	43	3.1085
70-79	2	4.3333
80 or over	0	n/a
prefer not to say	26	3.0897

displaying a definite trend one way or the other. If anything, they tend to increase with age through the 30-39 age range and then decrease. Again, it is not clear whether this outcome is due to differences between the survey populations or between the concepts of information technology and internet technology.

In addition to looking for the demographic trends suggested by Babcock, et al., demographic differences between high- and low- "organizational heterogeneity" facilities were investigated by generating crosstabs for each relationship. The concept of "organizational heterogeneity" is involved in several of this study's hypotheses and is explained in detail in the Organizational Heterogeneity section, below. However, briefly, each facility's organizational heterogeneity was determined to be either high or low, depending on the diversity of its funding sources. By this measure,

the INEEL, ETTP, and Y-12 Plan facilities were determined to be relatively low-heterogeneity organizations, while the ORNL, SNL-Albuquerque, and SNL-Livermore facilities were determined to be relatively high-heterogeneity organizations.

Interpretation of the chi-square values resulting from the crosstabs procedures is complicated by the fact that the chi-square statistic is a function of sample size. However, other statistics associated with chi-square can also be used to indicate the strength of the relationship between variables in the crosstabs procedure. In this case, because the crosstabs is larger than 2 x 2, Cramer's V statistic provides an appropriate measure of the level of association between variables. As illustrated by Table 3.6, two of these comparisons between high- and low-heterogeneity facilities yielded Cramer's V scores that were considerably larger than the others.

The first of these relationships is that between the facility variable (collapsed into high- and low-heterogeneity categories) and the occupation variable. Tables 3.7, 3.8, and 3.9 illustrate that the largest differences between the high- and low-heterogeneity facilities, in terms of percentage of respondents, occur in the computer-related, researcher,

Table 3.6 Contingency coefficients for demographic crosstabs

Comparison	Cramer's V
Facility by occupation	.296*
Facility by field of education	.115*
Facility by gender	.039
Facility by age	.141*
Facility by computer operating system	.301*
Facility by browser	.104*
Facility by source of news about internet resources	.170*

*p<.001

Table 3.7 Facility heterogeneity by occupation crosstab

Facility Heterogeneity	Occupation*									
	NR	AD	CL	CR	CP	MA	RS	TN	PR	OT
Low	7%	11.5%	4.8%	14.2%	3.2%	11.3%	2.7%	8.2%	37.2%	6.4%
High	.5%	12.4%	6.3%	8.6%	2.2%	9.7%	19.2%	11.0%	26.2%	4.0%

*NR=No Response, AD=Administrative, CL=Clerical, CR=Computer-Related, CP=Craftsperson, MA=Manager, RS=Researcher, TN=Technician, PR=Professional, OT=Other

Table 3.8 Chi-square tests for facility heterogeneity by occupation crosstab

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	236.156	9	.000
Likelihood Ratio	256.178	9	.000
Linear by Linear Association	2.350	1	.125
N of Valid Cases	2696		

Table 3.9 Symmetric measures for facility heterogeneity by occupation crosstab

		Value	Approx. Sig.
Nominal by Nominal	Cramer's V	.296	.000
N of Valid Cases		2696	

and professional categories. If these differences involved categories having greatly divergent mean Internet Use Index scores, then one might consider this disparity to be a factor which could potentially confound the conclusions drawn from subsequent hypothesis testing. However, the strength of the relationship between the facility and occupation variables is low to moderate at best (Cramer's V = .296) and the differences in mean Internet Use Index scores tend not to favor either high- or low-heterogeneity facilities. Low-heterogeneity facilities have a greater percentage of computer-related respondents, who have a mean Internet Use Index score of 3.7314 (well above the overall mean of 3.4455); high heterogeneity facilities have a greater percentage of researchers, who have a mean Internet Use Index score of 3.6684 (also well above the overall mean); and low-heterogeneity facilities have a greater percentage of professionals, who have a mean Internet Use Index score of 3.5125 (somewhat above the overall mean). These factors suggest that, while there are differences in the number of people in various occupational categories at high- and low-heterogeneity facilities (presumably reflecting differences in the type of work done at each of the facilities), these occupational differences are not accompanied by striking differences in internet technology use and will not, therefore, have a substantive effect on the validity of the survey.

The second source of demographic differences between the high- and low-heterogeneity facilities involves the computer operating system variable. Tables 3.10, 3.11, and 3.12 illustrate that there are considerable differences between the high- and low-heterogeneity facilities in terms of their use of computer operating systems. In broad terms, the low-heterogeneity facilities are dominated by the Windows '95/NT operating system (82.2%), while the high heterogeneity facilities report a more diverse selection of operating systems, including Windows '95/NT (62.9%), Macintosh (23.0%) and Unix (7.5%). However, in terms of basic functionality, virtually identical software products that support the use of internet technology are available at little or no cost for all of the operating systems included under the computer operating systems variable. This indicates that having or not having access to a particular computer operating system should have a negligible effect on an individual's use of internet technology. In addition, the percentage of respondents who indicated that they didn't use a computer is similar at both high- (1.4%) and low-heterogeneity (1.7%) facilities. These factors, combined with the fact that the strength of the relationship between the facility and operating system variables is low to moderate at best (Cramer's V = .301), suggest that differences in operating system use at high- and low-heterogeneity facilities will have no substantive effect on

Table 3.10 Facility heterogeneity by computer operating system crosstab

Facility Heterogeneity	Operating System							
	None	PC-DOS	Win3.1	Win'95/NT	Mac	Unix	Other	Not Sure
Low	1.7%	.4%	5.1%	82.2%	6.4%	1.4%	1.3%	.9%
High	1.4%	.3%	4.3%	62.9%	23.0%	7.5%	.2%	.1%

Table 3.11 Chi-square tests for facility heterogeneity by computer operating system crosstab

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	244.332	8	.000
Likelihood Ratio	259.723	8	.000
Linear by Linear Association	56.921	1	.000
N of Valid Cases	2696		

Table 3.12 Symmetric measures for facility heterogeneity by computer operating system crosstab

		Value	Approx. Sig.
Nominal by Nominal	Cramer's V	.301	.000
N of Valid Cases		2711	

the validity of the survey. The differences in operating system use, however, may themselves be artifacts of variations in organizational heterogeneity.

Tests of the Hypotheses

Several of the hypotheses described below involve the concept of "organizational heterogeneity." Therefore a means of determining the extent to which facilities participating in the study exhibit relatively greater or lesser organizational heterogeneity is needed. To provide this definition, organizational heterogeneity is discussed briefly below; then the tests of each of the study's hypotheses are discussed.

Organizational Heterogeneity

Critical mass theory addresses the question of how reciprocal technologies, such as the use of internet technology, begin and are sustained. In particular, critical mass theory stresses the importance of organizational features, such as the heterogeneity of the group or organization. In *The Critical Mass in Collective Action*, the originators of critical mass theory, Marwell and Oliver, stress the importance of this concept, claiming that: "Everything we do in this book turns on an understanding of the significance of group heterogeneity and how it

interacts with the determinants of collective action" (Marwell and Oliver, 1993).

Specifically, critical mass theory holds that a positive relationship, on the part of individuals, between interest in a particular behavior and the resources necessary to engage in, or promote, that behavior is a key factor in starting and sustaining collective action. In addition, group or organizational heterogeneity (in terms of interest and resources) facilitates this relationship by increasing the likelihood that some members will stand to gain more from the change than others, thus increasing their interest, and the chance that some of the interested members will possess and be willing to commit the resources necessary to achieve the change. In other words, organizations exhibiting greater heterogeneity are more likely to adopt interactive technologies. So the question becomes, what constitutes a more or less heterogeneous organization? A number of recent studies of organizational differentiation, or heterogeneity, have concentrated on two primary characteristics—structural complexity and the degree of task specialization of organizational units.

Most research in this area has focused on the relationship between these characteristics, rather than on their effects on the differentiation, or heterogeneity, of an organization. For example, the relationship between structural complexity and the degree of task specialization has been demonstrated by a number of studies, including Udy (1965), Pugh et al. (1968), and Khandwalla (1977). Citing these studies, among others, Mintzberg (1979) sums up their conclusions as follows: "The larger the organization, the more elaborate its structure, that is, the more specialized its tasks, the more differentiated its units, and the more developed its administrative component" (Mintzberg, 1979). However, when Koene, Boone, and Soeters' examined the influence of organizational structure on the diversity of organizational culture—that is, employees' attitudes, values, and perceptions—the authors noted that the degree of "cultural differentiation," or heterogeneity, of an organization "apparently reflects the degree of structural differentiation in larger organizations" (Koene, Boone, and Soeters, 1997). The authors go on to suggest that cultural differentiation, or heterogeneity, is a result of differences in the tasks of the various organizational units: "the more specialized tasks are, the more differentiated are [the organization's] units and the more developed its administrative component" (Koene, Boone, and Soeters, 1997).

It is important to note that, unlike earlier researchers, Koene, Boone, and Soeters draw a distinction between structural differentiation (differences in tasks among organizational units) and the sheer number of organizational units. The results of Koene, Boone, and Soeters' study suggests that the level of task specialization within an organization will have an effect on the cultural differentiation, or heterogeneity, of that organization. So it follows that, to assess the level of heterogeneity at the six facilities involved in this study, one might reasonably consider their respective levels of task specialization.

Four of the facilities participating in this survey (INEEL, ORNL and the two SNL facilities) are considered by DOE to be multiprogram research and development laboratories. However, this is only a rough measure of task specialization, indicating that each facility receives substantial funding from more than one DOE Program Office (each of which concentrates on a specific set of energy-related activities). The other two facilities, the Y-12 Plant (historically a nuclear weapons production facility; now involved in dismantling weapon components, highly enriched uranium storage, and collaborative manufacturing efforts with private industry) and ETTP (formerly a uranium enrichment facility, now involved in reindustrialization, waste management, and environmental

restoration), are not national laboratories and, therefore, do not have single-program laboratory or multiprogram laboratory designations.

A more precise and objective measure of a facility's level of task specialization than the DOE "multiprogram laboratory" designation is the diversity of the facility's funding sources. All of these facilities are funded primarily through DOE program offices, each of which oversees a different set of energy-related activities. This funding is sometimes supplemented by other governmental entities, such as the U.S. Department of Defense.

This study makes the assumption that, in broad terms, the more sources of funding an organization has, the more differentiated the set of tasks it will perform and the more differentiated the organizational structures it will develop to implement these tasks, report progress back to the funding sources, document results, etc. This assumption is in line with Koene, Boone, and Soeters' contention that "the more specialized tasks are, the more differentiated are [the organization's] units" (Koene, Boone, and Soeters, 1997). It is this cultural differentiation, or heterogeneity, that Marcus argues is the key to increasing the likelihood that, in a given

organization, an individual will have sufficient resources and interest to adopt an innovation and begin the diffusion process (Markus, 1987).

Major funding sources for the various facilities are broken down in Table 3.13. The figures include all principal program activities which accounted for 5% or more of each facility's budget. The breakdown illustrates that the Y-12 Plant, ETTP, and INEEL facilities receive two-thirds or more of their funding from a single DOE program office; whereas, ORNL and the SNL facilities in Albuquerque and Livermore depend on a broader cross-section of funding sources (funding sources for the two SNL facilities are combined—separate figures were not available). The relatively diverse funding of these latter organizations suggests that they exhibit a greater degree of task specialization. This, in turn, suggests that their level of cultural differentiation, or heterogeneity, will be greater than that of the Y-12 Plant, ETTP, and INEEL organizations.

As noted above, organizational heterogeneity is considered by critical mass theorists to be a key factor in determining the outcome of the diffusion of interactive technologies, such as internet technology, within in organizations. Therefore, the hypotheses offered below make

Table 3.13 Low-heterogeneity and high-heterogeneity facilities

Facility	Funding Source
Low-Heterogeneity Facilities	
Y-12 Plant*	100% DOE Defense Programs
ETTP**	100% DOE Environmental Management
INEEL***	67% DOE Energy Management 9% DOE Nuclear Energy 9% Other Federal and Non-federal
High-Heterogeneity Facilities	
ORNL****	33% DOE Energy Research 19% Work for Others (Including Nuclear Regulatory Commission) 18% DOE Environmental Management 14% DOE Energy Efficiency and Renewable Energy 6% Other DOE
SNL (Albuquerque and Livermore Facilities)*****	47% DOE Defense Programs 17% U.S. Department of Defense 10% DOE Environmental Management 7% DOE Nonproliferation and National Security 6% Other Non-DOE

*1997 funding figures (U.S. Department of Energy, Oak Ridge Operations, DOE Facts: Y-12 Plant, 1998)
**1997 funding figures (U.S. Department of Energy, Oak Ridge Operations, DOE Facts: East Tennessee Technology Park, 1998)
***1995 funding figures (U.S. Department of Energy, Office of Energy Research, DOE Laboratory Fact Sheets: Idaho National Engineering Laboratory, 1998)
****1995 funding figures (U.S. Department of Energy, Office of Energy Research, DOE Laboratory Fact Sheets: Oak Ridge National Laboratory, 1998)
*****1995 funding figures (U.S. Department of Energy, Office of Energy Research, DOE Laboratory Fact Sheets: Sandia National Laboratories, 1998)

several assumptions based on differences in organizational heterogeneity between the two groups of facilities.

Heterogeneity and the Iterative Nature of Internet Technology

A characteristic of many interactive technologies that sets them apart from non-interactive technologies is the speed with which they evolve. In the case of traditional technological innovations, like the television for instance, the initial innovation was followed by a long period of time—a technological plateau—during which the innovation was adequate for the task it was designed for. For example, a television manufactured in 1940 can still be used to receive broadcast VHF frequencies (channels 2-13) today.

In the case of internet technology; however, the innovation's rate of evolution has, for practical purposes, eliminated technological plateaus. This evolution is best illustrated by the rapid development and deployment of successive versions of browser or "communication suite" software. New versions of popular browsers offering enhanced capabilities appear about every six months (minor upgrades appear at even closer intervals). In addition, rapid changes in internet technology have caused browsers that are more than a year or two old to become

obsolete for many applications. Other software designed to support internet-related functions, such as e-mail, multimedia applications, and database interactivity, are updated at similar intervals.

Because these innovations occur continuously, it has become impractical to view the adoption process (at least at the organizational level) as a series of individual adoption acts. Instead, it appears to be a two-stage process. The first stage is the initial adoption of internet technology. This stage follows Rogers' familiar steps of knowledge, persuasion, decision, implementation, and confirmation (Rogers, 1995). Once the first stage is complete and the adopting organization is committed to using the technology for critical business processes, it is immediately faced with changes in the technology—changes that, if left unaddressed, have the potential to rapidly make their recently-adopted technology obsolete. Therefore, the second stage of the process is a maintenance loop that involves the adoption of enhancements and refinements of the original technology.

This loop magnifies the importance of organizational heterogeneity because, in order to take full advantage of enhancements to internet technology, the loop must be completed repeatedly. Critical mass theory

suggests that the loop, like the initial adoption process, is more likely to be completed in heterogeneous organizations. Therefore, because enhancements and refinements of the technology occur at close intervals, organizations having the ability to traverse the loop relatively quickly and relatively often—organizations having greater heterogeneity—have a competitive advantage over less heterogeneous organizations. In light of these factors, it is conceivable that less heterogeneous organizations could eventually lag several generations behind the state-of-the-art in their implementation of internet technology, adopting refinements only as the business cost of not doing so becomes prohibitive.

Discussion of Hypotheses

The hypotheses addressed by this study are listed below and then discussed in detail.

- H1: Mean Internet Use Index scores will be higher at facilities having greater heterogeneity.
- H2: Mean Internet Attitude Index scores will be higher at facilities having greater heterogeneity.
- H3: Mean Organizational Support Index scores will be higher at facilities having greater heterogeneity.

- H4: Managers' mean Internet Use Index scores will be higher at facilities having greater heterogeneity.
- H5: Perceived management support for internet technology will be higher at facilities having greater heterogeneity.
- H6: In a regression model containing both Organizational Support and Individual Adoption variables, the relationship between Organizational Support and Internet Use will be stronger at low-heterogeneity facilities and weaker at high-heterogeneity facilities, while the relationship between Individual Adoption and Internet Use will be weaker at low-heterogeneity facilities and stronger at high-heterogeneity facilities.
- H7: In a regression model containing both the Organizational Support and Individual Adoption variables, the relationship between Individual Adoption and Internet Attitude will be weaker at low-heterogeneity facilities and stronger at high-heterogeneity facilities, while the relationship between Organizational Support and Internet Attitude will be stronger at low-heterogeneity facilities and weaker at high-heterogeneity facilities.

Hypothesis 1

Mean Internet Use Index scores will be higher at facilities having greater heterogeneity.

To test H1, mean Internet Use Index scores for each facility were calculated. As Table 3.14 illustrates, when these scores are arranged in a hierarchy, a pattern very similar to that which characterizes the previously mentioned high- and low-heterogeneity facility groupings appears—the only difference being that the ORNL and ETTP scores are virtually identical. To ensure that the means for these high- and low-heterogeneity groupings were significantly different, a t-test was performed. As shown in Table 3.15, significant differences ($t=8.489$; $p<.001$) exist between the means of the two groups.

A somewhat clearer demonstration of H1 may be obtained by eliminating the Oak Ridge facilities (ETTP, ORNL, and the Y-12 Plant) from the analysis. The rationale for doing so is that, until January of 1997, these three facilities were part of the same organization (Energy Systems) within Lockheed Martin Corporation. As a result, despite differences in their funding sources, they were operated as a single organization. In January of 1997, ORNL separated from ETTP and the Y-12 Plant,

Table 3.14 Mean Internet Use Index scores by facility

	N	Mean
INEEL	547	3.1578
Y-12 Plant	384	3.3403
ORNL	503	3.5199
ETTP	453	3.5206
SNL - Albuquerque	521	3.5809
SNL - Livermore	288	3.6383

Table 3.15 Planned comparison of mean Internet Use between high- and low-heterogeneity facilities (N=2696)

	Mean	df	t
Low-Heterogeneity Facilities ETTP, INEEL, Y-12 Plant	3.3272		
vs.		2694	8.489*
High-Heterogeneity Facilities ORNL, SNL - Albuquerque, SNL - Livermore	3.5701		

* $p < .001$

becoming a separate organization (Energy Research). Therefore, it can be argued that, at the time of the survey, these facilities were still in the process of developing their own distinctive approaches to implementing internet technology and were still exerting a moderating influence on one another in many areas of information technology, including the use of internet technology. Table 3.16 illustrates that, when the Oak Ridge facilities are removed from the analysis, somewhat larger differences ($t=10.815$; $p<.001$) appear between the mean scores of the remaining high- and low-heterogeneity facilities. All of these findings support H1.

Investigation of the data pertinent to H1 also revealed tentative evidence of an effect identified by Fichman and Kemerer (1995) as the "assimilation gap," a lag, between the acquisition of a technology and its actual use or deployment (discussed in Chapter I). This evidence came to light in an examination of responses to item S4_5 (the fifth item in section 4 of the survey— shown below). This item, a component of the Internet Use index, is a simple measure of the complexity of tasks respondents are using internet technology to complete:

5) Which of the following combinations of work-related tasks best describes what you use internet technology for at work on a regular basis? (Choose only one)

a) nothing
b) finding organizational information
c) finding organizational information, performing administrative tasks

Table 3.16 Limited planned comparison of mean Internet Use between high- and low-heterogeneity facilities (N=1356)

	Mean	df	t
Low-Heterogeneity Facility INEEL	3.1578		
vs.		1354	10.815*
High-Heterogeneity Facilities SNL - Albuquerque, SNL - Livermore	3.6014		

* p < .001

d) finding organizational information, performing administrative tasks, doing everyday work
e) finding organizational information, performing administrative tasks, doing everyday work, searching databases

When this item is analyzed separately from the rest of the index, the results suggest that there are not only differences in the amount of internet use between high- and low heterogeneity facilities, but also in the type of tasks internet technology is being used for. As shown in Table 3.17, significant differences (t=5.891; p<.001) exist between the responses of the high- and low heterogeneity groups to item S4_5. Table 3.18 illustrates that, when the Oak Ridge facilities are removed from the analysis, larger differences (t=8.367; p<.001) appear between the responses of the high- and low heterogeneity groups on item S4_5.

Table 3.17 Planned comparison of mean depth of internet use between high- and low-heterogeneity facilities (N=2696)

	Mean	df	t
Low-Heterogeneity Facilities ETTP, INEEL, Y-12 Plant	3.8425		
vs.		2694	5.891*
High-Heterogeneity Facilities ORNL, SNL - Albuquerque, SNL - Livermore	4.1258		

* p < .001

Table 3.18 Limited planned comparison of mean depth of internet use between high- and low-heterogeneity facilities (N=1356)

	Mean	df	t
Low-Heterogeneity Facility INEEL	3.3287		
vs.		1354	8.367*
High-Heterogeneity Facilities SNL - Albuquerque, SNL - Livermore	3.5701		

* p < .001

Whether or not this is a case of replacing "old tools with new ones," rather than taking advantage of the technology's higher-level features as Liker, Fleischer, and Arnsdorf found in their study of CAD technology systems (Liker, Fleischer, and Arnsdorf, 1992) is a subject for further research. However, the data suggest that *adoption, use,* and *assimilation* of internet technology can be three very different things.

Hypothesis 2

Mean Internet Attitude Index scores will be higher at facilities having greater heterogeneity.

One might expect the difference between high- and low-heterogeneity facilities to be less pronounced in this comparison than in that considered in the analysis of Hypothesis 1 because, while organizations can effectively control the extent of their employees' internet *use* at work (The focus of H1), they have considerably less influence over employees' internet use habits outside the workplace and, as a result, less influence over the *attitudes* employees form with regard to internet technology (the focus of H2).

To test H2, mean Internet Attitude Index scores for each facility were calculated. As Table 3.19 illustrates, when these scores are broken down

Table 3.19 Mean Internet Attitude Index scores by facility

	N	Mean
INEEL	547	3.7509
Y-12 Plant	384	3.9840
SNL - Albuquerque	521	3.9981
SNL - Livermore	288	3.9818
ORNL	503	4.0097
ETTP	453	4.0458

by facility and arranged in a hierarchy, a pattern similar, but not identical, to that which characterized high- and low-heterogeneity and Internet Use facility groupings appears. Despite these differences, a t-test comparing the means of the high- and low-heterogeneity groupings, shown in Table 3.20, demonstrates that the group means were still significantly different ($t=3.700$; $p<.001$) though to a lesser extent than those for Internet Use. Table 3.21 illustrates that, when the Oak Ridge facilities are removed, a greater difference ($t=7.141$; $p<.001$) between the high- and low-heterogeneity facilities appears. These findings support H2.

Hypothesis 3

Mean Organizational Support Index scores will be higher at facilities having greater heterogeneity.

Table 3.20 Planned comparison of mean Internet Attitude Index scores between high- and low-heterogeneity facilities (N=2696)

	Mean	df	t
Low-Heterogeneity Facilities ETTP, INEEL, Y-12 Plant	3.9121		
vs.		2694	3.700*
High-Heterogeneity Facilities ORNL, SNL - Albuquerque, SNL - Livermore	3.9990		

* p < .001

Table 3.21 Limited planned comparison of mean Internet Attitude scores between high- and low-heterogeneity facilities (N=1356)

	Mean	df	t
Low-Heterogeneity Facility INEEL	3.7509		
vs.		1354	7.141*
High-Heterogeneity Facilities SNL - Albuquerque, SNL - Livermore	3.9923		

* p < .001

As Table 3.22 illustrates, when these scores are broken down by facility and arranged in a hierarchy, the pattern that characterizes the previously established high- and low-heterogeneity facility groupings again appear. To ensure that the means for these high- and low-use groupings were significantly different, a t-test was performed. As shown in Table 3.23, significant differences ($t=9.615$; $p < .001$) exist between the means of the two groups. Table 3.24 illustrates that, when the Oak Ridge facilities are removed, a somewhat greater difference ($t=10.272$; $p<.001$) between the high- and low-heterogeneity facilities appears. These findings support H3.

Hypothesis 4

Managers at facilities having higher mean Internet Use Index scores will have significantly higher mean Internet Use Index scores.

To test H4, the 284 responses from respondents who identified themselves as managers were divided into the high-and low-use facility groupings, and a t-test was performed to determine whether significant differences existed between their mean Internet Use Index scores. Table 3.25 shows that no significant differences exist between the means of the two groups. Table 3.26 illustrates that, when the Oak Ridge facilities are removed, a slightly greater, yet still insignificant, difference appears

Table 3.22 Mean Organizational Support Index scores by facility

	N	Mean
INEEL	547	3.5850
Y-12 Plant	384	3.6603
ETTP	453	3.7581
ORNL	503	3.8353
SNL - Albuquerque	521	3.8996
SNL - Livermore	288	3.9177

Table 3.23 Planned comparison of mean Organization Support scores between high- and low heterogeneity facilities (N=2696)

	Mean	df	t
Low-Heterogeneity Facilities ETTP, INEEL, Y-12 Plant	3.6626		
vs.		2694	9.615*
High-Heterogeneity Facilities ORNL, SNL - Albuquerque, SNL - Livermore	3.8789		

* $p < .001$

Table 3.24 Limited planned comparison of mean Organization Support scores between high- and low heterogeneity facilities (N=1356)

	Mean	df	t
Low-Heterogeneity Facility INEEL	3.5850		
vs.		1354	10.272*
High-Heterogeneity Facilities SNL - Albuquerque, SNL - Livermore	3.9061		

* $p < .001$

Table 3.25 Planned comparison of mean Internet Use between managers from high- and low-heterogeneity facilities (N=284)

	Mean	df	t
Low-Heterogeneity Facilities ETTP, INEEL, Y-12 Plant	3.5159		
vs.		282	.334
High-Heterogeneity Facilities ORNL, SNL - Albuquerque, SNL - Livermore	3.5420		

Table 3.26 Limited planned comparison of mean Internet Use between managers from high- and low-heterogeneity facilities (N=123)

	Mean	df	t
Low-Heterogeneity Facility			
INEEL	3.3243		
vs.		121	1.027
High-Heterogeneity Facilities			
SNL - Albuquerque, SNL - Livermore	3.4651		

between the high- and low-heterogeneity facilities. These findings fail to support H4.

Hypothesis 5

Perceived management support for internet technology will be higher at facilities having greater heterogeneity.

As Table 3.27 illustrates, when these scores are broken down by facility and arranged in a hierarchy, the previously established high- and low-heterogeneity facility groupings again appear. To ensure that the means for these high- and low-heterogeneity groupings were significantly different, a t-test was performed. As shown in Table 3.28, significant

Table 3.27 Mean perceived management support for internet technology

	N	Mean
INEEL	547	3.6106
ETTP	453	3.7344
Y-12 Plant	384	3.7792
ORNL	503	3.8708
SNL - Livermore	288	4.0208
SNL - Albuquerque	521	4.1056

Table 3.28 Planned comparison of perceived management support for internet technology between high- and low-heterogeneity facilities (N=2696)

	Mean	df	t
Low-Heterogeneity Facilities			
ETTP, INEEL, Y-12 Plant	3.7001		
vs.		2694	8.625*
High-Heterogeneity Facilities			
ORNL, SNL - Albuquerque, SNL - Livermore	3.9970		

* $p < .001$

differences (t=8.625; p < .001) exist between the means of the two groups. Table 3.29 illustrates that, when the Oak Ridge facilities are removed, a somewhat greater difference (t=9.616; p<.001) between high- and low-heterogeneity facilities appears. These findings support H5.

Hypothesis 6

In a regression model containing both Organizational Support and Individual Adoption variables, the relationship between Organizational Support and Internet Use will be stronger at low-heterogeneity facilities and weaker at high-heterogeneity facilities, while the relationship between Individual Adoption and Internet Use will be weaker at low-heterogeneity facilities and stronger at high-heterogeneity facilities.

This hypothesis assumes that organizational support for internet technology has potential effects ranging from passive encouragement of the use of internet technology at high-heterogeneity facilities to active discouragement of its use at low-heterogeneity facilities. Therefore, the Organizational Support variable will have greater influence over the use of internet technology where it is the most active—that is at low-heterogeneity facilities. The hypothesis goes on to assert that, as a result of this variation in organizational support, individual adoption decisions will have greater influence over the use of internet technology at high-

Table 3.29 Limited planned comparison of perceived management support for internet technology between high- and low-heterogeneity facilities (N=1356)

	Mean	df	t
Low-Heterogeneity Facility			
INEEL	3.6106		
vs.		1354	9.616*
High-Heterogeneity Facilities			
SNL - Albuquerque, SNL - Livermore	4.0754		

* $p < .001$

heterogeneity facilities (where such decisions are less constrained by the organization) than at low-heterogeneity facilities.

Hypothesis 6 was tested using hierarchical multiple regression. Because large data sets tend to skew the results of significance testing in multiple regression procedures, resulting in significance scores that suggest stronger relationships among variables than may actually exist, Beta coefficients were used to measure the relative strength of the relationships between each of the independent variables and the dependent variable. Unlike significance tests, correlation coefficients provide a measure of the strength of relationships between variables that is relatively independent of sample size.

The results of this procedure are shown in Table 3.30. As suggested by H6, the relationship between Organizational Support and Internet Use was strongest at low-heterogeneity facilities (Beta =.190 vs. .126; p<.001). However, the relationship between Individual Adoption and Internet Use was also strongest at low-heterogeneity facilities (Beta =.554 vs. .510; p<.001). Table 3.31 illustrates that, when the Oak Ridge facilities are removed, a similar pattern appears. Again the relationship between Organizational Support and Internet Use was slightly stronger at low-heterogeneity facilities (Beta =.133 vs. .117; p<.001). However, the relationship between Individual Adoption and Internet Use was again strongest at low-heterogeneity facilities (Beta =.615 vs. .462; p<.001).

While these results support the contention that the Organizational Support variable exerts a somewhat greater influence over Internet Use at low-heterogeneity facilities than at high-heterogeneity facilities, the Organizational Support variable apparently does not interact in a reciprocal-like fashion with the Individual Adoption variable (the Organizational Support Index score rising when the Individual Attitude Index scores falls, and vice versa).

Table 3.30 Beta coefficients generated by a regression analysis of Internet Use on Organizational Support and Individual Adoption at high and low-heterogeneity facilities

Variables	Beta Coefficient at Low-Heterogeneity Facilities (N=1384)	Beta Coefficient at High-Heterogeneity Facilities (N=1312)
Organizational Support	.190*	.126*
Individual Adoption	.554*	.510*

* $p < .001$.

Table 3.31 Beta coefficients generated by a regression analysis of Internet Use on Organizational Support and Individual Adoption at selected high and low-heterogeneity facilities

Variables	Beta Coefficient at Low-Heterogeneity Facilities (N=547)	Beta Coefficient at High-Heterogeneity Facilities (N=809)
Organizational Support	.133*	.117*
Individual Adoption	.615*	.462*

* $p < .001$.

These findings partially support H6 and present new questions regarding the relationships among the Organizational Support, Individual Adoption and Internet Use variables.

Hypothesis 7

In a regression model containing both the Organizational Support and Individual Adoption variables, the relationship between Individual Adoption and Internet Attitude will be weaker at low-heterogeneity facilities and stronger at high-heterogeneity facilities, while the relationship between Organizational Support and Internet Attitude will be stronger at low-heterogeneity facilities and weaker at high-heterogeneity facilities.

This hypothesis asserts that organizational support for internet technology (or the lack thereof) will have greater influence over attitudes toward internet technology at low-heterogeneity facilities than at high-heterogeneity facilities. It goes on to assert that, as a result of this variation in organizational support, individual adoption decisions will have greater influence over the attitudes toward internet technology at high-heterogeneity facilities (where such decisions are less constrained by the organization) than at low-heterogeneity facilities.

Hypothesis 7 was tested using hierarchical multiple regression. Because large data sets tend to skew the results of significance testing in multiple regression procedures, resulting in significance scores that suggest stronger relationships among variables than may actually exist, Beta coefficients were used to measure the strength of the relationships between each of the independent variables and the dependent variable.

The results of this procedure are shown in Table 3.32. As suggested by H7, the relationship between Organizational Support and Internet Attitude was strongest at low-heterogeneity facilities (Beta =.259 vs. .203; p<.001). However, the relationship between Individual Adoption and Internet Attitude was virtually identical at both high- and low-heterogeneity facilities (Beta =.484 at low-heterogeneity facilities vs. .482 at high-heterogeneity facilities; p<.001). Table 3.33 illustrates that, when the Oak Ridge facilities are removed, the relationship between Organizational Support and Internet Attitude is again strongest at low-heterogeneity facilities (Beta =.265 vs. .165; p<.001). In addition, the relationship between Individual Adoption and Internet Attitude is slightly stronger, as predicted by H7, at high-heterogeneity facilities (Beta =.491 vs. .470; p<.001).

Table 3.32 Beta coefficients generated by a regression analysis of Internet Attitude on Organizational Support and Individual Adoption at high and low-heterogeneity facilities

Variables	Beta Coefficient at Low-Heterogeneity Facilities (N=1384)	Beta Coefficient at High-Heterogeneity Facilities (N=1312)
Organizational Support	.259*	.203*
Individual Adoption	.484*	.482*

* p < .001.

Table 3.33 Beta coefficients generated by a regression analysis of Internet Attitude on Organizational Support and Individual Adoption at selected high and low-heterogeneity facilities

Variables	Beta Coefficient at Low-Heterogeneity Facilities (N=547)	Beta Coefficient at High-Heterogeneity Facilities (N=809)
Organizational Support	.265*	.165*
Individual Adoption	.470*	.491*

* p < .001.

Therefore, while these results support the contention that the Organizational Support variable exerts a somewhat greater influence over Internet Attitude at low-heterogeneity facilities at high-heterogeneity facilities, there is little indication that the Organizational Support variable interacts in a reciprocal-like fashion with the Individual Adoption variable (the Organizational Support Index score rising when the Individual Attitude Index scores falls, and vice versa).

These findings partially support H7 and present new questions regarding the relationships among the Organizational Support, Individual Adoption and Internet Adoption variables.

Chapter IV

Discussion and Conclusions

Since the public release of the first web browser software in 1993, the internet—or more precisely, internet technology—has become the *lingua franca* for an increasingly large number of communication systems around the world. Nowhere is this trend more apparent than in large corporations, where internet technology in the form of corporate intranets is becoming the standard means of communicating among employees, between employees and corporate information systems, and between employees and the internet.

Despite this accelerating trend toward broader application of internet technology, few studies have sought to determine which factors influence the diffusion of internet technology—either in society in general or in an organizational setting. As noted in Chapter I, a number of studies conducted since the mid 1970s have explored the diffusion of the use of computers, various forms of information technology, and internet precursors, such as BITNET and electronic messaging systems. However, studies that address internet technology either deal indirectly with the

issue of diffusion—in the course of gathering marketing information, for example—or they deal with a very specialized aspect of the diffusion process, as do LaRose and Hoag in their examination of the role of innovation clusters in the adoption of internet technology by organizations (LaRose and Hoag, 1996).

To begin to provide a broader view of the process by which internet technologies are adopted by organizations, this study examined how organizational and individual/interpersonal factors influence the diffusion process. The results of this analysis should help to clarify the applicability of both sets of factors to interactive media in general and to internet technology in particular.

Theoretical Implications

Effects of Organizational Heterogeneity

Critical mass theorists from Marwell and Oliver to Markus have stressed the importance of heterogeneity of interests and resources to the process of starting and sustaining collective action. In the case of this study, the collective action of note is the diffusion and adoption of internet technology within organizations. The findings of this study provide broad support for the contention that organizational heterogeneity—defined as

a diversity of resources and interests and measured by the diversity of organizational funding sources—catalyzes the diffusion process. In particular, the study finds that organizational heterogeneity is positively related to (a) the use of internet technology, (b) attitudes toward internet technology, (c) organizational support for internet technology, and (d) perceived managerial support of internet technology. It should be noted that funding diversity has apparently not been used previously as a measure of organizational heterogeneity, and further research into its effectiveness as a predictor is needed to determine its appropriateness.

Relationship Between Organizational and Individual/Interpersonal Factors

The findings of this study also suggest that level of organizational support for internet technology has a greater impact on internet use and attitudes toward internet technology at low-heterogeneity facilities than at high-heterogeneity facilities. This relationship translates into lower levels of support, use and attitude at low-heterogeneity facilities and higher levels at high-heterogeneity facilities. In light of the associations among these variables, two generalizations regarding the influence of organizational support on the use of, and attitudes toward, internet technology in high- and low-heterogeneity organizations can be made:

- High-heterogeneity organizations tend to create an environment within which organizational factors enable the diffusion reaction to proceed unimpeded—possibly reaching critical mass.
- Low-heterogeneity organizations tend to create an environment within which organizational factors moderate the diffusion reaction, either slowing or stopping its progress toward critical mass.

These findings suggest that critical mass theory provides a set of organizational environment variables within which traditional, individual/interpersonal diffusion of innovation variables operate under greater or lesser constraints. Rather than defining divergent views of the diffusion process, critical mass theory and traditional diffusion of innovation theory seem to provide complementary explanations of different aspects of the process by which interactive innovations diffuse through organizations. Further research into the interaction between organizational and individual/interpersonal factors is needed to determine the precise nature of their relationship.

Evidence of an Assimilation Gap

An unintended finding of this study is evidence of an effect identified by Fichman and Kemerer (1995) as the "assimilation gap"—a lag, between

the acquisition of a technology and its actual use or deployment. As suggested in Chapter I, consideration of this phenomenon may be particularly important in studies of the diffusion of clustered technologies, such as internet technology, because the composite nature of these innovations enables the extent of their implementation to be effectively camouflaged by broad measures of use. As noted in Chapter III, five hours a week reading e-mail does not represent the same level of implementation as five hours a week querying on-line databases, yet both scenarios represent five hours of internet technology use.

While this study provides limited evidence of an assimilation gap, further research will be required to determine whether such an effect is actually present and whether it is inherent to the implementation of clustered innovations in general and interactive technologies in particular. Such research might also explore the long-term effects of "moderating" the diffusion of rapidly evolving, or iterative, innovations and whether this practice leads simply to increasingly late implementation of innovations or to disruptive technological "leapfrogging"—skipping several generations of technology in an attempt to rapidly achieve technological currency. Similarly, future research should also consider whether the assimilation gap behaves like Tichenor, Donohue and Olien's "knowledge

gap" (Tichenor, Donohue and Olien, 1965) and tends to widen over time, making the technologically rich progressively richer and the poor poorer.

Importance of Management Support

As mentioned in Chapter I, several studies in recent years have suggested that organizational management plays a critical role in the adoption and diffusion of computer-related technologies. In his discussion of critical mass theory, Rogers notes that the composition of the community of adopters of interactive technology can influence the level at which critical mass is attained: "a small number of highly influential individuals who adopt a new idea may represent a stronger critical mass than a very large number of individual adopters who have little influence" (Rogers, 1995). This highly influential group may also be in a position to "provide resources for the adoption of an interactive technology and thus lower individuals' perceived cost of adopting" (Rogers, 1995).

Although none of this study's hypotheses directly consider the effect of management support on the use of internet technology, the fact that (a) perceived management support for internet technology rises and falls with organizational heterogeneity, (b) management is influential by

definition, and (c) management is in a position to provide or withhold resources for the adoption of internet technology suggests that organizational management controls whether the diffusion of internet technology within the organization is moderated some extent or allowed to proceed unimpeded.

It may be worthwhile to note that while levels of internet use are significantly different at high- and low-heterogeneity facilities, levels of internet use *by managers* at high- and low-heterogeneity facilities are virtually identical. The underlying cause of this disparity is not readily apparent; however, it recall's Abdul-Gader and Kozar's observation regarding managerial control of access to technology through their control of financial resources. The authors note that, "the manager who is confident that computers will not challenge his/her control is more likely to purchase than the one who perceives threats from computers" (Abdul-Gader and Kozar, 1995).

Additional research is needed to determine not only the extent of management's ability to influence the diffusion reaction but also whether the level or direction of managerial influence is dependent upon the level of organizational heterogeneity or operates independently of it.

Limitations and Directions for Future Research

External Validity

The primary limitation of this study is its external validity. First, there is the question of whether survey respondents are like non-respondents. As noted in Chapter II, the percentage of survey responses received from respondents without e-mail addresses was well below the percentage of the survey population without e-mail addresses. This result suggests that respondents tended to be more familiar with internet technology than non-respondents. This result was not unexpected and seems to be a result of individuals who are less familiar with internet technology choosing not to participate in the survey. The external validity of the study also would have been enhanced by the addition of a comparison of demographic information between the survey population and survey respondents to determine whether systematic difference existed between the two groups; however such information was not readily available.

The second question of external validity concerns the extent to which the study's findings may be generalized beyond the six participating organizations. It seems reasonable to suggest that the findings of this study could be applied to other organizations engaged in large-scale research and development and/or engineering efforts, based on the

similarities of their activities, to the organizations participating in the study. One would expect the findings to be particularly applicable to government-related organizations active in these fields. The demographic profile of the participating organizations, at least in terms of educational and occupational backgrounds, also suggests that the findings may be applicable to large private-sector research corporations, as well as technically oriented academic institutions.

While it would not be surprising to discover that the survey's findings were applicable to a wider range of organizations and populations, there is nothing in the current study to suggest a broader applicability. Further research into the diffusion of internet technology in other types of organizations would be required to construct credible hypotheses in this area.

Pretest Sample

It is conceivable that the nature of the pretest sample used in this study could have had an impact of the quality of the final survey. As noted in Chapter II, pretest respondents were found to be somewhat younger and somewhat more likely to be female that final survey respondents; additionally, the pretest sample was relatively small. Concerns related to

the quality of the pretest sample are significant because results from the pretest were used to refine the indexes employed in this study. It is possible that pretest sample could have been sufficiently atypical as to have affected the reliability measures, which in turn would have affected which index items were deleted or retained. However, the reliability scores achieved by all of the indexes used in the pretest were well above the minimum accepted level, making it is unlikely that irregularities in the pretest sample would have any substantive impact on the results of the final survey.

Management Support for Completing the Survey

It is possible that potential respondents could have chosen not to complete the survey based on a perception that their management would frown on their participation. Therefore, perceived variations in management's support for completing the survey could be a limitation of this study and may have caused corresponding variations in the number of survey responses received from various facilities. This concern is addressed to some extent by the fact that survey response rates across the six facilities were fairly similar, ranging from approximately 24% to 34%. It is noteworthy that the highest response rate came from the facility having the lowest mean score for perceived management support

of internet technology. These facts, combined with the anonymity of responses suggest that it is unlikely that the perceived level of management support for completing the survey played a significant role in determining who responded to the survey.

Definition of Organizational Heterogeneity

The decision to measure organizational heterogeneity in terms of diversity of organizational funding sources could be considered a limitation of this study. While the contention that funding diversity is a reasonable measure of task specialization seems sound on its face, it is apparently not a measure of organizational heterogeneity that has been previously employed or studied. Further research into both the appropriateness of funding diversity as a measure of organizational heterogeneity and into alternative measures of organizational heterogeneity will be necessary to effectively address this question.

Self-Selection

Clearly, any random survey runs the risk of attracting an atypical group of respondents. It could be argued that, even in a random sample, some respondents will be more motivated to respond than others (perhaps those most and least well-disposed toward the technology). This

possibility is counterbalanced to some extent by the fact that the survey was made available in three different formats to accommodate the technological comfort level of a wide range of respondents.

Self-Reporting

Any study that relies solely on the word of the individual, without some means of independent confirmation, is subject to self-reporting error. Unfortunately, tools that measure the fine details of internet usage are not generally available, and where they are, they are most often configured to record and monitor organization-level statistics, rather than to characterize individual internet use. It should also be noted that many of the concepts addressed in this study, such as attitudes toward internet technology and perceptions of support for internet technology, are most accessible using a self-reporting format. Concern over self-reporting is addressed to some extent by employing indexes (rather than individual survey items) to measure the key concepts in this study, such as internet use and internet attitude. This approach, Babbie notes, "avoids the biases inherent in single items" (Babbie, 1973). In addition, the anonymity provided by the largely automated administration and collection of the form should have encouraged honest responses.

Multiple Survey Formats

The fact that the survey was administered in three formats (web, e-mail and paper) could be considered a threat to the survey's validity. Ideally, the survey would have been administered in a single format under identical circumstances for all respondents; however, that wasn't a practical possibility for a survey of this geographical breadth. Additionally, using a single survey format could have posed an even greater threat to the survey's validity by excluding, for practical purposes, respondents who felt uncomfortable with (or had restricted access to) whichever medium was chosen.

Summary

The history of technological innovation is dominated by instances and moments, by snapshots and singular achievements—*the* Folsom point, *the* printing press, *the* automobile, *the* internet. However, these snapshots don't tell us much about how innovation works. By the same token, an organization doesn't simply decide to use an innovation; the innovation is adopted as a result of a process that involves a variety of organizational and individual/interpersonal factors.

This study is a small step in the direction of understanding the processes and identifying the factors that influence the diffusion of internet technology in the workplace. Its findings include support for the following assertions:

1) Higher levels of organizational heterogeneity catalyze the diffusion process by positively influencing factors associated with internet technology in the following areas: level of use, attitudes, organizational support, and perceived managerial support.

2) Critical mass theory provides a set of organizational environment variables within which traditional, individual/interpersonal diffusion of innovation variables operate under greater or lesser constraints. This relationship can be described by two generalizations:
   - High-heterogeneity organizations tend to create an environment within which organizational factors enable the diffusion reaction to proceed unimpeded—possibly reaching critical mass.
   - Low-heterogeneity organizations tend to create an environment within which organizational factors moderate the diffusion reaction, either slowing or stopping its progress toward critical mass.

3) Rather than defining divergent views of the diffusion process, critical mass theory and traditional diffusion of innovation theory seem to provide complementary explanations of different aspects of the process by which interactive innovations diffuse through organizations.

The rapid pace of innovation in the area of internet technology has magnified the need to understand the process by which interactive technologies are adopted by organizations and the roles played by organizational and individual/interpersonal factors. This study has attempted to shed some light on this subject; however, much remains unilluminated. Questions to be answered by further research on the diffusion of internet technology in the workplace include the following:

- Can the findings of this study concerning (a) the effects of organizational heterogeneity on the use of and attitudes toward internet technology and (b) the relationship between individual/interpersonal and organizational factors be confirmed?
- To what extent can the findings of this study be generalized to other, similar organizations or beyond?
- Is funding diversity an effective measures of organizational heterogeneity?

- How does organizational management influence the diffusion reaction, and is this influence dependent upon organizational heterogeneity?
- Are clustered innovations, such as internet technology particularly susceptible to the "assimilation gap" effect, and do "iterative" innovations exacerbate this effect over time?

References

Abdul-Gader, A. H., & Kozar, K. A. (1995). The impact of computer alienation on information technology investment decisions: an explanatory cross-national analysis. *MIS Quarterly,* 19(4), 553 559.

Abrahamson, Eric, & Rosenkopf, Lori (1997). Social network effects on the extent of innovation diffusion: A computer simulation. *Organization Science,* 8(3), 289 309.

Achen, Christopher H. (1982). *Interpreting and using regression.* Beverly Hills, California: Sage Publications, Inc.

Allen, David (1988). New telecommunications services: network externalities and critical mass. *Telecommunications Policy*, 257 271.

Babbie, Earl R. (1973). *Survey research methods*. Belmont, California: Wadsworth Publishing Company, Inc.

Babcock, Thomas., Bush, Michael, & Lan, Zhiyong (1995). Executive use of information technology in the public sector: an empirical examination. *Journal of Government Information,* 22, 119 130.

Bertot, John Carlo, & McClure, Charles R. (1996). Electronic surveys: implications for using the World Wide Web to collect survey data. *Proceedings of the Annual ASIS Meeting,* 33, 173 185.

Cohen, Jacob (1969). *Statistical power analysis for the behavioral sciences*. New York: Academic Press.

CommerceNet/Nielsen Media Research (1995). *The CommerceNet/Nielsen internet demographics survey: executive summary.* (http://www.commerce.net/).

CommerceNet/Nielsen Media Research (1997). *Electronic commerce on the rise according to CommerceNet/Nielsen media research survey.* (http://www.nielsenmedia.com/)

Constant, David, & Kiesler, Sara (1996). The kindness of strangers: the usefulness of electronic weak ties for technical advice. *Organization Science*, 7(2), 119 135.

Dozier, David M, & Rice, Ronald E. (1983). Rival theories of electronic newsreading. In Everett. M. Rogers (Ed.) *The new media*. Beverly Hills, California: Sage Publications.

Dunphy, Steven M., Herbig, Paul R. & Howes, Mary E. (1996). The innovation funnel, *Technological Forecasting and Social Change,* 53, 279 292.

Emery, Margot (1995). *Internet adoption and use by innovator and early adopter communicators in Tennessee.* Thesis: University of Tennessee.

Fichman, Robert G., & Kemerer, Chris F. (1995). *The illusory diffusion of innovation: an examination of assimilation gaps.* (http://www.pitt.edu/~ckemerer/illusory.htm).

Fulk, Janet, & DeSanctis, Geraldine (1995). Electronic communication and changing organizational forms. *Organization Science*, 6, 337 348.

Fulk, Janet, Steinfeld, Charles W., Schmitz, Joseph, & Power, J. Gerard (1987). A social information processing model on media use in organizations. *Communication Research*, 14, 529 552.

Graphics, Visualization, & Usability Center (1998). *GVU's WWW surveys.* (http://www.cc.gatech.edu/gvu/user_surveys/).

Gurbaxani, Vijay (1990). Diffusion in computing networks: the case of BITNET. *Communications of the ACM,* 33(12), 65 75.

Hardin, Garrett (1968). The tragedy of the commons. *Science,* 162, 1243 1248.

Herbert Marilynne, & Benbasat, Izak (1994). Adopting information technology in hospitals: the relationship between attitudes/expectations and behavior. *Hospital and Health Services Administration,* 39, 369 383.

Herbig, Paul A., & Palumbo, Fred (1994). The effect of culture on the adoption process: a comparison of Japanese and American behavior. *Technological Forecasting and Social Change,* 46, 71 101.

Hinds, Pamela, & Kiesler, Sara (1995). Communication across boundaries: work, structure, and use of communication technologies in a large organization. *Organization Science*, 6, 373 393.

Howard, G., & Smith, R. (1986). Computer anxiety in management: myth or reality, *Communications of the ACM,* 29, 611 615.

Igbaria, M. (1993). User acceptance of microcomputer technology: an empirical test, *Omega International Journal of Management Science,* 21, 73 90.

Kakabasde, Nada Korac, & Kouzmin, Alexander (1996). Innovation strategies for the adoption of new information technology in government: an Australian experience. *Public Administration and Development,* 4, 317 330.

Khandwalla, P. N. (1977). *The design of organizations,* New York: Harcourt Brace Jovanovich.

Koene, Bas A., Boone, A. J. J., & Soeters, Joseph L. (1997) Organizational factors influencing homogeneity and heterogeneity of organizational cultures. In Sonja A. Sackmann (Ed.), *Cultural complexity in organizations : inherent contrasts and contradictions*, Thousand Oaks: Sage Publications.

LaRose, Robert, & Hoag, Anne (1996). *Organizational adoptions of the internet and the clustering of innovations.* (http://www.telecommunication.msu.edu/faculty/larose/html /inno6.htm).

Liker, Jeffrey K., Fleischer, Mitchell, & Arnsdorf, David (1992). Fulfilling the promises of CAD. *Sloan Management Review,* Spring 1992, 74 86.

Long, R. J. (1994). The adoption of white-collar computerization by Canadian business firms, *Canadian Journal of Administrative Sciences,* 11(4), 295 310.

Mahajan, Vijay (1985). *Models for innovation diffusion.* Beverly Hills, California: Sage Publications.

Maier, Frank H. (1996). Substitution among successive product generations—an almost neglected problem in innovation diffusion models. *The 1996 international system dynamics conference virtual proceedings.* (http://web.mit.edu/jsterman/www/SD96 /papers.html).

Malone, Thomas W. (1997). Is empowerment just a fad? Control, decision making, and IT. *Sloan Management Review,* 38(2), 23 35.

Markus, M. Lynne (1994). Electronic mail as the medium of managerial choice. *Organization Science*, 5, 502 527.

Markus, M. Lynne (1987). Toward a "critical mass" theory of interactive media. *Communication Research*, 5, 491 511.

Marwell, Gerald, & Oliver, Pamela (1993). *The critical mass in collective action: a micro-social theory*. Cambridge, Massachusetts: Cambridge University Press.

Mintzberg, Henry (1979). *The structuring of organizations*. Englewood Cliffs, New Jersey: Prentice-Hall, Inc.

Moeller, Michael (1996). Boeing network takes flight with pioneering intranet project. *PC Week Online*. (http://www.pcweek.com /archive/960219/pcwk0002.htm).

Morris, Merrill, & Ogan, Christine (1996). The internet as mass medium. *Journal of Communication,* 46(1), 39 50.

Nord, Walter R., & Tucker, Sharon (1987). *Implementing routine and radical innovations*. Lexington Massachusetts: Lexington Books.

Norton, John A., & Bass, Frank M. (1987). A diffusion theory model of adoption and substitution for successive generations of high-technology products. *Management Science,* 33(9), 1069 1086.

Norton, John A., & Bass, Frank M. (1992). Evolution of technological generations: the law of capture. *Sloan Management Review,* Winter, 1992, 66 77.

Nunnally, Jum C. (1978). *Psychometric theory.* New York: McGraw-Hill, Inc.

O'Brien, Gerald J., & Wilde, W. David (1996). Australian managers' perceptions attitudes and use of information technology. *Information and Software Technology,* 38, 783 789.

Oliver, P., Marwell, G., & Teixeira, R. (1985). A theory of critical mass: interdependence, group heterogeneity, and the production of collective action. *American Journal of Sociology*, 91(3), 522 556.

O'Reilly and Associates (1995). *Defining the internet opportunity.* (http://www.ora.com/research/users/charts/pop-proj.html).

Orlikowski, Wanda J, Yates, Joanne, Okamura, Kazuo, & Fujimoto, Masayo (1995). Shaping electronic communication: the metastructuring of technology in the context of use. *Organization Science*, 6, 423 444.

Pickering, Jeanne M., & King, John Leslie (1995). Hardwiring weak ties: interorganizational computer-mediated communication, occupational communities, and organizational change. *Organization Science*, 6(4), 479 486.

Pitkow, James (1997). In search of reliable usage data on the WWW. (http://proceedings.www6conf.org/HyperNews/get /PAPER126.html).

Pitkow, James, & Kehoe, Colleen. (1996). *Surveying the territory: GVU's five WWW user surveys.* (http://www.cc.gatech.edu/gvu /user_surveys/papers/w3j.html).

Pugh, D. S., Hickson, D. J., Hinings, C. R., & Turner, C. (1968). Dimensions of Organization. *Administrative Science Quarterly*, 13(1), 65 105.

Ray N., & Minch R. (1990). Computer anxiety and alienation toward a definitive and parsimonious measure. *Human Factors,* 32(4), 477 491.

RHI Consulting (1998). *Survey shows intranets and extranets emerge as latest use of 'net' technology.* (http://www.rhic.com/jobsRHIC /About_RHIC/032798.html).

Rice, Ronald E. (1984). Evaluating new media systems. *New Directions in Program Evaluation,* 23, 53 72.

Rice, Ronald E. (1993). Media appropriateness: using social presence theory to compare traditional and new organization media. *Human Communication Research*, 19, 451 484.

Rogers, Everett. M. (1986). *Communication technology: the new media in society*. New York: The Free Press.

Rogers, Everett. M. (1995). *Diffusion of innovations*. New York: The Free Press.

Rogers, Everett. M. (1983). *The new media*. Beverly Hills, California: Sage Publications.

Rosetti, Daniel K., & DeZoort, Frank A. (1989). Organizational Adaptation to Technology Innovation. *S.A.M. Advanced Management Journal,* 54(4), 29 33.

Schelling, Thomas C. (1978). *Micromotives and macrobehavior.* New York: W. W. Norton & Company.

Silverman, Leslie J., & Bailey, Wilfrid C. (1961). *Trends in the adoption of recommended farm practices.* State College, Mississippi Agricultural Experiment Station Bulletin 617. RS(E).

Simonson, M., Maurer, M., Montag, M., & Whitaker, M. (1987). Development of a standardized test of computer literacy and a computer anxiety index. *Journal of Educational Computing Research,* 3, 231 247.

Swanson, E. Burton (1994). Information systems innovation among organizations. *Management Science,* 40(5), 1069 1092.

Tan, Alexis S. (1985). *Mass communication theories and research*. New York: John Wiley & Sons.

Tichenor, P. J., Donohue, G. A., & Olien, C. N. (1970). Mass media flow and differential growth in knowledge," *Public Opinion Quarterly,* 34, 159.

Udy, S. H., Jr. (1965). The comparative analysis of organizations. In J. G. March (Ed.), *Handbook of organizations.* Chicago: Rand McNally, 1965.

U.S. Department of Energy, Oak Ridge Operations (1998). *DOE facts: East Tennessee Technology Park.* (http://www.ornl.gov/doe_oro/factsheets/k-25fact.htm).

U.S. Department of Energy, Oak Ridge Operations (1998). *DOE facts: Y-12 Plant.* (http://www.ornl.gov/doe_oro/factsheets/y12fact.htm).

U.S. Department of Energy, Office of Energy Research (1998). *DOE laboratory fact sheets: Idaho National Engineering Laboratory.* (http://www.er.doe.gov/production/er-07/page2a3.html).

U.S. Department of Energy, Office of Energy Research (1998). *DOE laboratory fact sheets: Oak Ridge National Laboratory.* (http://www.er.doe.gov/production/er-07/page2a7.html).

U.S. Department of Energy, Office of Energy Research (1998). *DOE Laboratory fact sheets: Sandia National Laboratories.* (http://www.er.doe.gov/production/er-07/page2a9.html).

Valente, Thomas W. (1995). *Network models of the diffusion of innovation.* Cresskill, New Jersey: Hampton Press, Inc.

Vlahos, George E., & Ferratt, Thomas W. (1995). Information technology use by managers in Greece to support decision making: amount, perceived value, and satisfaction. *Information and Management,* 29, 305 315.

Witt, Ulrich (1997). "Lock-in" vs. "critical masses"—industrial change under network externalities. *International Journal of Industrial Organization,* 15, 753 773.

Walther, Joseph B. (1995). Relational aspects of computer-mediated communication: experimental observations over time. *Organization Science*, 6, 186 203.

Zakon, Robert H. (1998). *Hobbes' internet timeline v3.3*. (http://info.isoc.org/guest/zakon/Internet/History/HIT.html).

Appendixes

Appendix A: Pretest Survey Instruments

Web Survey Instrument

Internet Technology Use Survey: Pretest

This survey is part of a "dry run" for an Internet Technologies Use Survey that will be conducted across several Lockheed Martin Energy and Environment Sector sites, including ORNL. This version of the survey is only being given to CIND staff and has the blessing of CIND management (so you can spend a few minutes filling it out without feeling guilty).

No names, e-mail addresses, or IP addresses (computer addresses) will be included among the data gathered from the survey--out of respect for individual privacy, as well to encourage honest answers. When "**internet technology**" is mentioned in this survey, it refers to the tools used to communicate through either internal computer networks, also known as "intranets," or through the public internet. Examples of these tools include e-mail, internet browsers (like Microsoft Internet Explorer, Netscape, and Lynx), newsgroups, listservs, etc.

The survey includes six sections, containing a total of 75 items--73 of them can be answered by clicking your mouse; two will ask you for a written answer. Most folks will finish the survey in 15-30 minutes. Thanks for your time and support. Your participation will help to make internet technologies more useful for all of us.

Section 1

Section 1 is 10 items long. Each item includes a statement for you to agree or disagree with. You can indicate how much you agree or disagree by clicking one of the small, round buttons to the right of the statement. Clicking the button in the 5 column means you strongly agree; clicking 4 means you agree; clicking 3 means you don't really agree or disagree (you're neutral); clicking 2 means you disagree; and clicking 1 means you strongly disagree.

	Agree - Disagree				
	5	**4**	**3**	**2**	**1**
1) Using internet technology makes my work easier.	○	○	○	○	○
2) Knowing how to use internet technology won't improve my career and job security.	○	○	○	○	○
3) Internet technology fits in with the way my organization works.	○	○	○	○	○
4) I've learned what I know about internet technology from people who are very different from me.	○	○	○	○	○
5) Using internet technology is easy.	○	○	○	○	○

	Agree - Disagree				
	5	4	3	2	1
6) I find internet technology confusing.	○	○	○	○	○
7) I had opportunities to experiment with internet technology before I had to use it myself.	○	○	○	○	○
8) I had to rush into using internet technology.	○	○	○	○	○
9) I had many opportunities to observe other people using internet technology before I used it myself.	○	○	○	○	○
10) Few of my coworkers use internet technology.	○	○	○	○	○

Section 2

Section 2 is 18 items long. Each item includes a statement for you to agree or disagree with. You can indicate how much you agree or disagree by clicking one of the small, round buttons to the right of the statement. Clicking the button in the 5 column means you strongly agree; clicking 4 means you agree; clicking 3 means you don't really agree or disagree (you're neutral); clicking 2 means you disagree; and clicking 1 means you strongly disagree.

	Agree - Disagree				
	5	4	3	2	1
1) I have control over internet technology, rather than it having control over me.	○	○	○	○	○
2) I know what I'm doing when I use internet technology.	○	○	○	○	○
3) Internet technology doesn't have the potential to control my job.	○	○	○	○	○
4) I usually have to make my work fit internet technology instead of the other way around.	○	○	○	○	○
5) Internet technology is too complicated to understand.	○	○	○	○	○
	Agree - Disagree				
	5	4	3	2	1
6) Using internet technology requires a lot of terminology that I don't understand.	○	○	○	○	○
7) I understand how to use internet technology.	○	○	○	○	○

8) Using internet technology encourages unethical practices.	○	○	○	○	○
9) I trust the people who are in charge of internet technology in my organization.	○	○	○	○	○
10) There's a big difference between what internet technology is supposed to be able to do and what it really does.	○	○	○	○	○
	Agree - Disagree				
	5	**4**	**3**	**2**	**1**
11) I get along well with the people who are in charge of internet technology in my organization.	○	○	○	○	○
12) The people who are in charge of internet technology in my organization are naturally friendly and helpful.	○	○	○	○	○
13) I don't like to be associated with the people who are in charge of internet technology in my organization.	○	○	○	○	○
14) Using internet technology is an enjoyable experience.	○	○	○	○	○
15) Using internet technology is more trouble than it's worth.	○	○	○	○	○
	Agree - Disagree				
	5	**4**	**3**	**2**	**1**
16) I would use internet technology even if it were not expected of me.	○	○	○	○	○
17) I don't care what other people say, internet technology is not for me.	○	○	○	○	○
18) My employer values internet technology too highly.	○	○	○	○	○

Section 3

Section 3 is 21 items long. Each item includes a statement for you to agree or disagree with. You can indicate how much you agree or disagree by clicking one of the small, round buttons to the right of the statement. Clicking the button in the 5 column means you strongly agree; clicking 4 means you agree; clicking 3 means you don't really agree or disagree (you're neutral); clicking 2 means you disagree; and clicking 1 means you strongly disagree.

	Agree - Disagree				
	5	4	3	2	1
1) I feel that I control computers rather than computers control me.	○	○	○	○	○
2) Computers dehumanize society by treating everyone as a number.	○	○	○	○	○
3) I don't feel helpless when using the computer.	○	○	○	○	○
4) Computers don't have the potential to control our lives.	○	○	○	○	○
5) I usually have to make my work fit the computer rather than the computer fit my work.	○	○	○	○	○
	Agree - Disagree				
	5	4	3	2	1
6) I clearly understand what input computers want.	○	○	○	○	○
7) Working with computers is so complicated it is difficult to know what's going on.	○	○	○	○	○
8) Computer terminology sounds like confusing jargon to me.	○	○	○	○	○
9) I understand computer output.	○	○	○	○	○
10) Computers encourage unethical practices.	○	○	○	○	○
	Agree - Disagree				
	5	4	3	2	1
11) I trust computer suppliers.	○	○	○	○	○
12) There is a big discrepancy between computer and software qualities claimed by computer elite and the real qualities.	○	○	○	○	○
13) I get along well with computer professionals.	○	○	○	○	○
14) Computer professionals are just naturally friendly and helpful.	○	○	○	○	○
15) I do not like to be associated with any computer department.	○	○	○	○	○

	Agree - Disagree				
	5	4	3	2	1
16) Using a computer is an enjoyable experience.	○	○	○	○	○
17) If I had a computer, it would probably be more trouble than it's worth.	○	○	○	○	○
18) I sometimes get nervous just thinking about computers.	○	○	○	○	○
19) I would use computers even if it were not expected of me.	○	○	○	○	○
20) I don't care what other people say, computers are not for me.	○	○	○	○	○
	Agree - Disagree				
	5	**4**	**3**	**2**	**1**
21) Society values computers too highly.	○	○	○	○	○

Section 4

Section 4 is 10 items long. Each item includes a statement for you to agree or disagree with. You can indicate how much you agree or disagree by clicking one of the small, round buttons to the right of the statement. Clicking the button in the 5 column means you strongly agree; clicking 4 means you agree; clicking 3 means you don't really agree or disagree (you're neutral); clicking 2 means you disagree; and clicking 1 means you strongly disagree.

	Agree - Disagree				
	5	4	3	2	1
1) More and more people at my site are using internet technology.	○	○	○	○	○
2) Few of the people I work with use internet technology.	○	○	○	○	○
3) I have the skills and/or training I need to use internet technology.	○	○	○	○	○
4) I don't have all the equipment I need to use internet technology.	○	○	○	○	○
5) Many different groups at my site are interested in internet technology.	○	○	○	○	○

	Agree - Disagree				
	5	4	3	2	1
6) Few groups at my site have invested time and money in internet technology.	○	○	○	○	○
7) I can think of several people at my site who have promoted the use of internet technology for years.	○	○	○	○	○
8) I can think of few, if any, managers at my site who have promoted the use of internet technology for several years.	○	○	○	○	○
9) Management at my site supports the use of internet technology.	○	○	○	○	○
10) Management at my site doesn't invest enough money in internet technology.	○	○	○	○	○

Section 5

Section 5 is six questions long. For each of the questions, pick the answer that fits you best.

1) How long have you used internet technology?

○ **don't use it** ○ **less than 1 year** ○ **1 to 3 years** ○ **4 to 6 years** ○ **6 years or more**

2) On the average, how many hours a day do you use internet technology in your job?

○ **don't use it** ○ **less than 1 hour** ○ **1 to 3 hours** ○ **3 to 6 hours** ○ **6 hours or more**

3) How likely are you to use internet technology for a task at work if you're not required to?

○ **wouldn't use it** ○ **unlikely** ○ **not sure** ○ **likely** ○ **very likely**

4) Which of the following combinations of capabilities best describes how you use internet technology at work on a regular basis?

○ **none**

○ **e-mail**

○ **e-mail, web browser**

○ **e-mail, web browser, newsgroups**

○ **e-mail, web browser, newsgroups, multimedia (audio or video applications)**

5) Which of the following combinations of work-related tasks best describes what you use internet technology for at work on a regular basis?

- ○ **nothing**
- ○ **finding organizational information**
- ○ **finding organizational information, performing administrative tasks**
- ○ **finding organizational information, performing administrative tasks, doing everyday work**
- ○ **finding organizational information, performing administrative tasks, doing everyday work, searching databases**

6) Which of the following combinations of web-browsing habits best describes how you use internet technology at work on a regular basis?

- ○ **don't browse**
- ○ **following links from local homepages**
- ○ **following links from local homepages using bookmarks or hotlists**
- ○ **following links from local homepages using bookmarks or hotlists, searching the internal network (or "intranet")**
- ○ **following links from local homepages using bookmarks or hotlists, searching the internal network (or "intranet"), searching the entire internet**

Section 6

Section 6 is 10 questions long. For questions 1-8, pick the answer that fits you best. Questions 9-10 ask you for some of your opinions--write as much or as little as you like.

1) For which of the following LM organizations do you work?

- ○ **Idaho National Engineering and Environmental Laboratory**
- ○ **Lockheed Martin Energy Systems (East Tennessee Technology Park--K-25 Site)**
- ○ **Lockheed Martin Energy Systems (Oak Ridge Y-12 Plant)**
- ○ **Lockheed Martin Utility Services (Paducah)**
- ○ **Oak Ridge National Laboratory (Lockheed Martin Energy Research)**
- ○ **Sandia National Laboratories (Albuquerque)**
- ○ **Sandia National Laboratories (Livermore)**

2) Which one of the following categories best describes your primary occupation?

- ○ **administrative**
- ○ **clerical**
- ○ **computer-related**
- ○ **craftsperson**
- ○ **manager**
- ○ **researcher**
- ○ **technician**
- ○ **professional**
- ○ **other**

3) What was the primary field covered in your formal education?

- ○ **Business (i.e., Management, Economics, Marketing)**
- ○ **Computer Science or Mathematics**
- ○ **Crafts (i.e., Electrician, Pipefitter)**
- ○ **Humanities (i.e., English, Philosophy, Art)**
- ○ **Natural Sciences (i.e., Chemistry, Biology, Physics)**
- ○ **Public Management (i.e., Public Administration)**
- ○ **other**

4) What is your gender?

○ **female** ○ **male** ○ **prefer not to say**

5) What is your age?

- ○ **less than 20**
- ○ **20-29**
- ○ **30-39**
- ○ **40-49**
- ○ **50-59**
- ○ **60-69**
- ○ **70-79**
- ○ **80 or over**
- ○ **prefer not to say**

6) What is your computer's operating system?

- ○ don't use a computer
- ○ PC with DOS
- ○ PC with Windows 3.1
- ○ PC with Windows '95 or NT
- ○ Macintosh
- ○ Workstation with UNIX
- ○ NeXT
- ○ other
- ○ not sure

7) What is your primary internet browser?

- ○ don't use a browser
- ○ Microsoft Internet Explorer
- ○ Netscape
- ○ text-based browser (such as Lynx)
- ○ other

8) Which of the following methods do you use most frequently to find out about new internet resources?

- ○ never hear about new internet resources
- ○ "what's new?" pages on your local server
- ○ e-mail from co-workers or friends
- ○ e-mail advertising
- ○ newsgroups
- ○ newspapers, magazines, or other printed material
- ○ electronic publications
- ○ word of mouth
- ○ radio or television

9) What would it take to make internet technology more useful in your everyday work?

10) Are there any other comments you'd like to pass along concerning internet technology?

Send It In! | Throw It Out!

Thanks for completing the survey. You can send it in by pressing the "Send It In!" button above.

E-Mail Survey Instrument

Internet Technology Use Survey: Pretest - 6/97

The name of this survey, "Internet Use Survey: Pretest," means that it's being used to tune-up both the survey itself and some statistical odds and ends for use in a larger survey to be conducted across several LM sites. So, it would be really helpful if you'd take the time to fill it out and send it in. No names, e-mail addresses, or anything else will be included among the data gathered from the survey--out of respect for individual privacy, as well to encourage honest answers.

When "internet technology" is mentioned in this survey, it refers to the tools used to communicate through either internal computer networks, also known as "intranets," or through the public internet. Examples of these tools include e-mail, internet browsers (like Microsoft Internet Explorer, Netscape, and Lynx), newsgroups, listservs, etc.

The survey includes six sections, containing a total of 75 items--72 of them are multiple-choice items; two will ask for a written answer. Most folks will finish the survey in 15-30 minutes.

Responses to this survey will be read by a computer, so it's important that you enter your answers in the right places. At the beginning of each section, there's a brief description of the items in the section and the kind of answers the computer will recognize. Below each question, there is an "answer pointer" that looks something like this:

=>S1_1=> <

You'll need to enter your answers on the same line as the answer pointer. For example, if you wanted to answer one of the survey items with a "3", you'd enter it right beside the answer pointer, like so:

=>S1_1=>3<

To fill out this survey, just reply to this mail message, and enter your answers to the survey items next to the "answer pointers." When you're finished, mail it back to where it came from (the return address).

If you have questions or comments about this survey, don't send them to the return address on this message (that's just for submitting completed surveys). Instead, send them to survey@ornl.gov with the Subject line "Internet Use Survey: Pretest - 6/97" comment on this survey.

You don't need to delete these instructions before you mail the survey back.

Thanks for your time and support. Your participation will help to make internet technologies more useful for all of us.

PLEASE DON'T DELETE ANYTHING BEYOND THIS POINT.

=>BEGIN_SURVEY=>

Section 1

Section 1 is 10 items long. Each item includes a statement for you to agree or disagree with. You can indicate how much you agree or disagree by entering a number in the answer area below each item. Entering 5 means you strongly agree; entering 4 means you agree; entering 3 means you don't really agree or disagree (you're neutral); entering 2 means you disagree; and entering 1 means you strongly disagree.

For items 1-10, respond with: 5 (strongly agree), 4 (agree), 3 (neutral), 2 (disagree), or 1 (strongly disagree).

1) Using internet technology makes my work easier.
=>S1_1=> <

2) Knowing how to use internet technology won't improve my career and job security.
=>S1_2=> <

3) Internet technology fits in with the way my organization works.
=>S1_3=> <

4) I've learned what I know about internet technology from people who are very different from me.
=>S1_4=> <

5) Using internet technology is easy.
=>S1_5=> <

Respond with: 5 (strongly agree), 4 (agree), 3 (neutral), 2 (disagree), or 1 (strongly disagree).

6) I find internet technology confusing.
=>S1_6=> <

7) I had opportunities to experiment with internet technology before I had to use it myself.
=>S1_7=> <

8) I had to rush into using internet technology.
=>S1_8=> <

9) I had many opportunities to observe other people using internet technology before I used it myself.
=>S1_9=> <

10) Few of my coworkers use internet technology.
=>S1_10=> <

Section 2

Section 2 is 18 items long. Each item includes a statement for you to agree or disagree with. You can indicate how much you agree or disagree by entering a number in the answer area below each item. Entering 5 means you strongly agree; entering 4 means you agree; entering 3 means you don't really agree or disagree (you're neutral); entering 2 means you disagree; and entering 1 means you strongly disagree.

For items 1-18, respond with: 5 (strongly agree), 4 (agree), 3 (neutral), 2 (disagree), or 1 (strongly disagree).

1) I have control over internet technology, rather than it having control over me.
=>S2_1=> <

2) I know what I'm doing when I use internet technology.
=>S2_2=> <

3) Internet technology doesn't have the potential to control my job.
=>S2_3=> <

4) I usually have to make my work fit internet technology instead of the other way around.
=>S2_4=> <

5) Internet technology is too complicated to understand.
=>S2_5=> <

Respond with: 5 (strongly agree), 4 (agree), 3 (neutral), 2 (disagree), or 1 (strongly disagree).

6) Using internet technology requires a lot of terminology that I don't understand.
=>S2_6=> <

7) I understand how to use internet technology.
=>S2_7=> <

8) Using internet technology encourages unethical practices.
=>S2_8=> <

9) I trust the people who are in charge of internet technology in my organization.
=>S2_9=> <

10) There's a big difference between what internet technology is supposed to be able to do and what it really does.
=>S2_10=> <

11) I get along well with the people who are in charge of internet technology in my organization.
=>S2_11=> <

12) The people who are in charge of internet technology in my organization are naturally friendly and helpful.
=>S2_12=> <

13) I don't like to be associated with the people who are in charge of internet technology in my organization.
=>S2_13=> <

14) Using internet technology is an enjoyable experience.
=>S2_14=> <

15) Using internet technology is more trouble than it's worth.
=>S2_15=> <

Respond with: 5 (strongly agree), 4 (agree), 3 (neutral), 2 (disagree), or 1 (strongly disagree).

16) I would use internet technology even if it were not expected of me.
=>S2_16=> <

17) I don't care what other people say, internet technology is not for me.
=>S2_17=> <

18) My employer values internet technology too highly.
=>S2_18=> <

Section 3

Section 3 is 21 items long. Each item includes a statement for you to agree or disagree with. You can indicate how much you agree or disagree by entering a number in the answer area below each item. Entering 5 means you strongly agree; entering 4 means you agree; entering 3 means you don't really agree or disagree (you're neutral); entering 2 means you disagree; and entering 1 means you strongly disagree.

For items 1-21, respond with: 5 (strongly agree), 4 (agree), 3 (neutral), 2 (disagree), or 1 (strongly disagree).

1) I feel that I control computers rather than computers control me.
=>S3_1=> <

2) Computers dehumanize society by treating everyone as a number.
=>S3_2=> <

3) I don't feel helpless when using the computer.
=>S3_3=> <

4) Computers don't have the potential to control our lives.
=>S3_4=> <

5) I usually have to make my work fit the computer rather than the computer fit my work.
=>S3_5=> <

6) I clearly understand what input computers want.
=>S3_6=> <

7) Working with computers is so complicated it is difficult to know what's going on.
=>S3_7=> <

8) Computer terminology sounds like confusing jargon to me.
=>S3_8=> <

9) I understand computer output.
=>S3_9=> <

10) Computers encourage unethical practices.
=>S3_10=> <

Respond with: 5 (strongly agree), 4 (agree), 3 (neutral), 2 (disagree), or 1 (strongly disagree).

11) I trust computer suppliers.
=>S3_11=> <

12) There is a big discrepancy between computer and software qualities claimed by computer elite and the real qualities.
=>S3_12=> <

13) I get along well with computer professionals.
=>S3_13=> <

14) Computer professionals are just naturally friendly and helpful.
=>S3_14=> <

15) I do not like to be associated with any computer department.
=>S3_15=> <

Respond with: 5 (strongly agree), 4 (agree), 3 (neutral), 2 (disagree), or 1 (strongly disagree).

16) Using a computer is an enjoyable experience.
=>S3_16=> <

17) If I had a computer, it would probably be more trouble than it's worth.
=>S3_17=> <

18) I sometimes get nervous just thinking about computers.
=>S3_18=> <

19) I would use computers even if it were not expected of me.
=>S3_19=> <

20) I don't care what other people say, computers are not for me.
=>S3_20=> <

Respond with: 5 (strongly agree), 4 (agree), 3 (neutral), 2 (disagree), or 1 (strongly disagree).

21) Society values computers too highly.
=>S3_21=> <

Section 4

Section 4 is 10 items long. Each item includes a statement for you to agree or disagree with. You can indicate how much you agree or disagree by entering a number in the answer area below each item. Entering 5 means you strongly agree; entering 4 means you agree; entering 3 means you don't really agree or disagree (you're neutral); entering 2 means you disagree; and entering 1 means you strongly disagree.

For items 1-10, respond with: 5 (strongly agree), 4 (agree), 3 (neutral), 2 (disagree), or 1 (strongly disagree).

1) More and more people at my site are using internet technology.
=>S4_1=> <

2) Few of the people I work with use internet technology.
=>S4_2=> <

3) I have the skills and/or training I need to use internet technology.
=>S4_3=> <

4) I don't have all the equipment I need to use internet technology.
=>S4_4=> <

5) Many different groups at my site are interested in internet technology.
=>S4_5=> <

Respond with: 5 (strongly agree), 4 (agree), 3 (neutral), 2 (disagree), or 1 (strongly disagree).

6) Few groups at my site have invested time and money in internet technology.
=>S4_6=> <

7) I can think of several people at my site who have promoted the use of internet technology for years.
=>S4_7=> <

8) I can think of few, if any, managers at my site who have promoted the use of internet technology for several years.
=>S4_8=> <

9) Management at my site supports the use of internet technology.
=>S4_9=> <

10) Management at my site doesn't invest enough money in internet technology.
=>S4_10=> <

Section 5

Section 5 is six questions long. For each of the questions, pick the answer that fits you best.

For items 1-6, respond with: a, b, c, d, or e.

1) How long have you used internet technology?

a) don't use it
b) less than 1 year
c) 1 to 3 years
d) 4 to 6 years
e) 6 years or more
=>S5_1=> <

2) On the average, how many hours a day do you use internet technology in your job?

a) don't use it
b) less than 1 hour
c) 1 to 3 hours
d) 3 to 6 hours
e) 6 hours or more
=>S5_2=> <

3) How likely are you to use internet technology for a task at work if you're not required to?

a) wouldn't use it
b) unlikely
c) not sure
d) likely
e) very likely
=>S5_3=> <

4) Which of the following combinations of capabilities best describes how you use internet technology at work on a regular basis?

a) none
b) e-mail
c) e-mail, web browser
d) e-mail, web browser, newsgroups
e) e-mail, web browser, newsgroups, multimedia (audio or video applications)
=>S5_4=> <

5) Which of the following combinations of work-related tasks best describes what you use internet technology for at work on a regular basis?

a) nothing
b) finding organizational information
c) finding organizational information, performing administrative tasks
d) finding organizational information, performing administrative tasks, doing everyday work
e) finding organizational information, performing administrative tasks, doing everyday work, searching databases

=>S5_5=> <

6) Which of the following combinations of web-browsing habits best describes how you use internet technology at work on a regular basis?

a) don't browse
b) following links from local homepages
c) following links from local homepages using bookmarks or hotlists
d) following links from local homepages using bookmarks or hotlists, searching the internal network (or "intranet")
e) following links from local homepages using bookmarks or hotlists, searching the internal network (or "intranet"), searching the entire internet

=>S5_6=> <

Section 6

Section 6 is 10 questions long.

For questions 1-8, pick the answer that fits you best. Questions 9-10 ask you for some of your opinions--write as much or as little as you like.

1) For which of the following LM organizations do you work?

a) Idaho National Engineering and Environmental Laboratory
b) Lockheed Martin Energy Systems (East Tennessee Technology Park--K-25 Site)
c) Lockheed Martin Energy Systems (Oak Ridge Y-12 Plant)
d) Lockheed Martin Utility Services (Paducah)
e) Lockheed Martin Utility Services (Portsmouth)
f) Oak Ridge National Laboratory (Lockheed Martin Energy Research)
g) Sandia National Laboratories (Albuquerque)
h) Sandia National Laboratories (Livermore)

=>S6_1=> <

2) Which one of the following categories best describes your primary occupation?

a) administrative
b) clerical
c) computer-related
d) craftsperson
e) manager
f) researcher
g) technician
h) professional
i) other
=>S6_2=> <

3) What was the primary field covered in your formal education?

a) Business (i.e., Management, Economics, Marketing)
b) Computer Science or Mathematics
c) Crafts (i.e., Electrician, Pipefitter)
d) Humanities (i.e., English, Philosophy, Art)
e) Natural Sciences (i.e., Chemistry, Biology, Physics)
f) Public Management (i.e., Public Administration)
g) other
=>S6_3=> <

4) What is your gender?

a) female
b) male
c) prefer not to say
=>S6_4=> <

5) What is your age?

a) less than 20
b) 20-29
c) 30-39
d) 40-49
e) 50-59
f) 60-69
g) 70-79
h) 80 or over
i) prefer not to say
=>S6_5=> <

6) What is your computer's operating system?

a) don't use a computer
b) PC with DOS
c) PC with Windows 3.1
d) PC with Windows '95 or NT
e) Macintosh
f) Workstation with UNIX
g) NeXT

h) other
i) not sure
=>S6_6=> <

7) What is your primary internet browser?

a) don't use a browser
b) Microsoft Internet Explorer
c) Netscape
d) text-based browser (such as Lynx)
e) other
=>S6_7=> <

8) Which of the following methods do you use most frequently to find out about new internet resources?

a) never hear about new internet resources
b) "what's new?" pages on your local server
c) e-mail from co-workers or friends
d) e-mail advertising
e) newsgroups
f) newspapers, magazines, or other printed material
g) electronic publications
h) word of mouth
i) radio or television
=>S6_8=> <

9) What would it take to make internet technology more useful in your everyday work?
=>S6_9=>

<=><END_COMMENT=>

10) Are there any other comments you'd like to pass along concerning internet technology?
=>S6_10=>

<=><END_COMMENT=>

=><END_SURVEY=>

Thanks for completing the survey. You can send it in by e-mailing it back the return address.

Again, if you have questions or comments about this survey, don't send them to the return address on this message (that's just for submitting completed surveys). Instead, send them to survey@ornl.gov with the Subject line "Internet Use Survey: Pretest - 6/97."

Paper Survey Instrument

Internet Technology Use Survey: Pretest

This survey is part of a "dry run" for an Internet Technologies Use Survey that will be conducted across several Lockheed Martin Energy and Environment Sector sites, including ORNL. This version of the survey is only being given to CIND staff and has the blessing of CIND management (so you can spend a few minutes filling it out without feeling guilty).

No names, e-mail addresses, or IP addresses (computer addresses) will be included among the data gathered from the survey--out of respect for individual privacy, as well to encourage honest answers. When **"internet technology"** is mentioned in this survey, it refers to the tools used to communicate through either internal computer networks, also known as "intranets," or through the public internet. Examples of these tools include e-mail, internet browsers (like Microsoft Internet Explorer, Netscape, and Lynx), newsgroups, listservs, etc.

The survey includes six sections, containing a total of 75 items--73 of them can be answered by clicking your mouse; two will ask you for a written answer. Most folks will finish the survey in 15-30 minutes. Thanks for your time and support. Your participation will help to make internet technologies more useful for all of us.

Section 1

Section 1 is 10 items long. Each item includes a statement for you to agree or disagree with. You can indicate how much you agree or disagree by clicking one of the small, round buttons to the right of the statement. Clicking the button in the 5 column means you strongly agree; clicking 4 means you agree; clicking 3 means you don't really agree or disagree (you're neutral); clicking 2 means you disagree; and clicking 1 means you strongly disagree.

	Agree - Disagree				
	5	**4**	**3**	**2**	**1**
1) Using internet technology makes my work easier.	○	○	○	○	○
2) Knowing how to use internet technology won't improve my career and job security.	○	○	○	○	○
3) Internet technology fits in with the way my organization works.	○	○	○	○	○
4) I've learned what I know about internet technology from people who are very different from me.	○	○	○	○	○
5) Using internet technology is easy.	○	○	○	○	○

	Agree - Disagree				
	5	4	3	2	1
6) I find internet technology confusing.	○	○	○	○	○
7) I had opportunities to experiment with internet technology before I had to use it myself.	○	○	○	○	○
8) I had to rush into using internet technology.	○	○	○	○	○
9) I had many opportunities to observe other people using internet technology before I used it myself.	○	○	○	○	○
10) Few of my coworkers use internet technology.	○	○	○	○	○

Section 2

Section 2 is 18 items long. Each item includes a statement for you to agree or disagree with. You can indicate how much you agree or disagree by clicking one of the small, round buttons to the right of the statement. Clicking the button in the 5 column means you strongly agree; clicking 4 means you agree; clicking 3 means you don't really agree or disagree (you're neutral); clicking 2 means you disagree; and clicking 1 means you strongly disagree.

	Agree - Disagree				
	5	4	3	2	1
1) I have control over internet technology, rather than it having control over me.	○	○	○	○	○
2) I know what I'm doing when I use internet technology.	○	○	○	○	○
3) Internet technology doesn't have the potential to control my job.	○	○	○	○	○
4) I usually have to make my work fit internet technology instead of the other way around.	○	○	○	○	○
5) Internet technology is too complicated to understand.	○	○	○	○	○
	Agree - Disagree				
	5	4	3	2	1
6) Using internet technology requires a lot of terminology that I don't understand.	○	○	○	○	○
7) I understand how to use internet technology.	○	○	○	○	○

8) Using internet technology encourages unethical practices.	○	○	○	○	○
9) I trust the people who are in charge of internet technology in my organization.	○	○	○	○	○
10) There's a big difference between what internet technology is supposed to be able to do and what it really does.	○	○	○	○	○
	Agree - Disagree				
	5	**4**	**3**	**2**	**1**
11) I get along well with the people who are in charge of internet technology in my organization.	○	○	○	○	○
12) The people who are in charge of internet technology in my organization are naturally friendly and helpful.	○	○	○	○	○
13) I don't like to be associated with the people who are in charge of internet technology in my organization.	○	○	○	○	○
14) Using internet technology is an enjoyable experience.	○	○	○	○	○
15) Using internet technology is more trouble than it's worth.	○	○	○	○	○
	Agree - Disagree				
	5	**4**	**3**	**2**	**1**
16) I would use internet technology even if it were not expected of me.	○	○	○	○	○
17) I don't care what other people say, internet technology is not for me.	○	○	○	○	○
18) My employer values internet technology too highly.	○	○	○	○	○

Section 3

Section 3 is 21 items long. Each item includes a statement for you to agree or disagree with. You can indicate how much you agree or disagree by clicking one of the small, round buttons to the right of the statement. Clicking the button in the 5 column means you strongly agree; clicking 4 means you agree; clicking 3 means you don't really agree or disagree (you're neutral); clicking 2 means you disagree; and clicking 1 means you strongly disagree.

	Agree - Disagree				
	5	4	3	2	1
1) I feel that I control computers rather than computers control me.	○	○	○	○	○
2) Computers dehumanize society by treating everyone as a number.	○	○	○	○	○
3) I don't feel helpless when using the computer.	○	○	○	○	○
4) Computers don't have the potential to control our lives.	○	○	○	○	○
5) I usually have to make my work fit the computer rather than the computer fit my work.	○	○	○	○	○
	Agree - Disagree				
	5	4	3	2	1
6) I clearly understand what input computers want.	○	○	○	○	○
7) Working with computers is so complicated it is difficult to know what's going on.	○	○	○	○	○
8) Computer terminology sounds like confusing jargon to me.	○	○	○	○	○
9) I understand computer output.	○	○	○	○	○
10) Computers encourage unethical practices.	○	○	○	○	○
	Agree - Disagree				
	5	4	3	2	1
11) I trust computer suppliers.	○	○	○	○	○
12) There is a big discrepancy between computer and software qualities claimed by computer elite and the real qualities.	○	○	○	○	○
13) I get along well with computer professionals.	○	○	○	○	○
14) Computer professionals are just naturally friendly and helpful.	○	○	○	○	○
15) I do not like to be associated with any computer department.	○	○	○	○	○

	Agree - Disagree				
	5	4	3	2	1
16) Using a computer is an enjoyable experience.	○	○	○	○	○
17) If I had a computer, it would probably be more trouble than it's worth.	○	○	○	○	○
18) I sometimes get nervous just thinking about computers.	○	○	○	○	○
19) I would use computers even if it were not expected of me.	○	○	○	○	○
20) I don't care what other people say, computers are not for me.	○	○	○	○	○
	Agree - Disagree				
	5	**4**	**3**	**2**	**1**
21) Society values computers too highly.	○	○	○	○	○

Section 4

Section 4 is 10 items long. Each item includes a statement for you to agree or disagree with. You can indicate how much you agree or disagree by clicking one of the small, round buttons to the right of the statement. Clicking the button in the 5 column means you strongly agree; clicking 4 means you agree; clicking 3 means you don't really agree or disagree (you're neutral); clicking 2 means you disagree; and clicking 1 means you strongly disagree.

	Agree - Disagree				
	5	4	3	2	1
1) More and more people at my site are using internet technology.	○	○	○	○	○
2) Few of the people I work with use internet technology.	○	○	○	○	○
3) I have the skills and/or training I need to use internet technology.	○	○	○	○	○
4) I don't have all the equipment I need to use internet technology.	○	○	○	○	○
5) Many different groups at my site are interested in internet technology.	○	○	○	○	○

	Agree - Disagree				
	5	4	3	2	1
6) Few groups at my site have invested time and money in internet technology.	○	○	○	○	○
7) I can think of several people at my site who have promoted the use of internet technology for years.	○	○	○	○	○
8) I can think of few, if any, managers at my site who have promoted the use of internet technology for several years.	○	○	○	○	○
9) Management at my site supports the use of internet technology.	○	○	○	○	○
10) Management at my site doesn't invest enough money in internet technology.	○	○	○	○	○

Section 5

Section 5 is six questions long. For each of the questions, pick the answer that fits you best.

1) How long have you used internet technology?

○ **don't use it** ○ **less than 1 year** ○ **1 to 3 years** ○ **4 to 6 years** ○ **6 years or more**

2) On the average, how many hours a day do you use internet technology in your job?

○ **don't use it** ○ **less than 1 hour** ○ **1 to 3 hours** ○ **3 to 6 hours** ○ **6 hours or more**

3) How likely are you to use internet technology for a task at work if you're not required to?

○ **wouldn't use it** ○ **unlikely** ○ **not sure** ○ **likely** ○ **very likely**

4) Which of the following combinations of capabilities best describes how you use internet technology at work on a regular basis?

○ **none**

○ **e-mail**

○ **e-mail, web browser**

○ **e-mail, web browser, newsgroups**

○ **e-mail, web browser, newsgroups, multimedia (audio or video applications)**

5) Which of the following combinations of work-related tasks best describes what you use internet technology for at work on a regular basis?

- ○ **nothing**
- ○ **finding organizational information**
- ○ **finding organizational information, performing administrative tasks**
- ○ **finding organizational information, performing administrative tasks, doing everyday work**
- ○ **finding organizational information, performing administrative tasks, doing everyday work, searching databases**

6) Which of the following combinations of web-browsing habits best describes how you use internet technology at work on a regular basis?

- ○ **don't browse**
- ○ **following links from local homepages**
- ○ **following links from local homepages using bookmarks or hotlists**
- ○ **following links from local homepages using bookmarks or hotlists, searching the internal network (or "intranet")**
- ○ **following links from local homepages using bookmarks or hotlists, searching the internal network (or "intranet"), searching the entire internet**

Section 6

Section 6 is 10 questions long. For questions 1-8, pick the answer that fits you best. Questions 9-10 ask you for some of your opinions--write as much or as little as you like.

1) For which of the following LM organizations do you work?

- ○ **Idaho National Engineering and Environmental Laboratory**
- ○ **Lockheed Martin Energy Systems (East Tennessee Technology Park--K-25 Site)**
- ○ **Lockheed Martin Energy Systems (Oak Ridge Y-12 Plant)**
- ○ **Lockheed Martin Utility Services (Paducah)**
- ○ **Oak Ridge National Laboratory (Lockheed Martin Energy Research)**
- ○ **Sandia National Laboratories (Albuquerque)**
- ○ **Sandia National Laboratories (Livermore)**

2) Which one of the following categories best describes your primary occupation?

- ○ **administrative**
- ○ **clerical**
- ○ **computer-related**
- ○ **craftsperson**
- ○ **manager**
- ○ **researcher**
- ○ **technician**
- ○ **professional**
- ○ **other**

3) What was the primary field covered in your formal education?

- ○ **Business (i.e., Management, Economics, Marketing)**
- ○ **Computer Science or Mathematics**
- ○ **Crafts (i.e., Electrician, Pipefitter)**
- ○ **Humanities (i.e., English, Philosophy, Art)**
- ○ **Natural Sciences (i.e., Chemistry, Biology, Physics)**
- ○ **Public Management (i.e., Public Administration)**
- ○ **other**

4) What is your gender?

○ **female** ○ **male** ○ **prefer not to say**

5) What is your age?

- ○ **less than 20**
- ○ **20-29**
- ○ **30-39**
- ○ **40-49**
- ○ **50-59**
- ○ **60-69**
- ○ **70-79**
- ○ **80 or over**
- ○ **prefer not to say**

6) What is your computer's operating system?

- ○ don't use a computer
- ○ PC with DOS
- ○ PC with Windows 3.1
- ○ PC with Windows '95 or NT
- ○ Macintosh
- ○ Workstation with UNIX
- ○ NeXT
- ○ other
- ○ not sure

7) What is your primary internet browser?

- ○ don't use a browser
- ○ Microsoft Internet Explorer
- ○ Netscape
- ○ text-based browser (such as Lynx)
- ○ other

8) Which of the following methods do you use most frequently to find out about new internet resources?

- ○ never hear about new internet resources
- ○ "what's new?" pages on your local server
- ○ e-mail from co-workers or friends
- ○ e-mail advertising
- ○ newsgroups
- ○ newspapers, magazines, or other printed material
- ○ electronic publications
- ○ word of mouth
- ○ radio or television

9) What would it take to make internet technology more useful in your everyday work?

10) Are there any other comments you'd like to pass along concerning internet technology?

Send It In! | Throw It Out!

Thanks for completing the survey. You can send it in by pressing the "Send It In!" button above.

Appendix B: Abdul-Gader and Kozar's Computer Alienation Scale

Abdul-Gader and Kozar's
Computer Alienation Scale Items

Powerlessness

1. I feel that I control computers rather than computers control me.
2 Computers dehumanize society by treating everyone as a number.
3 I don't feel helpless when using the computer.
4 Computers don't have the potential to control our lives.
5 I usually have to make my work fit the computer rather than computer fit my work.

Meaninglessness

6 I clearly understand what input computers want.
7 Working with computers is so complicated it is difficult to understand what is going on.
8 Computer terminology sounds like confusing jargon to me.
9 I understand computer output.

Normlessness

10 Computers encourage unethical practices.
11 I trust computer suppliers.
12 There is a big discrepancy between computer and software qualities claimed by computer elite and the real qualities.

Social Isolation

13 I get along well with computer professionals.
14 Computer professionals are just naturally friendly and helpful.
15 I do not like to be associated with any computer department.

Self-Estrangement

16 Using a computer is an enjoyable experience.
17 If I had to use a computer, it would probably be more trouble than it's worth.
18 I sometimes get nervous just thinking about computers.

Cultural Estrangement

19 I would use computers even if it were not expected of me.
20 I don't care what other people say, computers are not for me.
21 Society values computers too highly.

Appendix C: Final Survey Instruments

Web Survey Instrument

Web and Internet Technologies User Survey

Sponsored by the Lockheed Martin Energy and Environment Sector Internet Working Group

This Web and Internet Technologies User Survey is sponsored by the Lockheed Martin Energy and Environment Sector Internet Working Group.

The results of the survey will help our organizations get a better idea of whether or not people are using the web and internet on the job, how they feel about this new technology, what they use it for, and how they learn about new web resources, new software, and other changes. This information can be used to determine what sort of information people want to have available on the web, to develop new training priorities, to improve communication about web- and internet-related issues, to target areas for specialized training, and to help web developers provide resources that meet more of their user's needs.

It doesn't matter whether you've never used the internet or you use it all day long, we need everyone who gets this message to take the opportunity to fill out the survey and send it in. That's because, at most sites, only a fraction of staff members will receive this survey, so every completed survey we get back will be helping make the web and internet more useful and accessible for all of us.

The survey is 43 questions long; almost all the questions are multiple choice; and it takes about 15 minutes to finish.

No names, e-mail addresses, or IP addresses (computer addresses) will be included among the data gathered from the survey--out of respect for individual privacy, as well to encourage honest answers. (You will have the option to provide your e-mail address to avoid being bothered by e-mail reminders; however, e-mail addresses are separated from the other responses as soon as the survey is submitted.)

When "internet technology" is mentioned in this survey, it refers to the tools used to communicate through internal computer networks, also known as "intranets," or through the public internet, or World Wide Web. Examples of these tools include e-mail, internet browsers (like Netscape, Microsoft Internet Explorer, and Lynx), newsgroups, etc.

If you've got any comments or questions, send them to survey@ornl.gov.

Thanks in advance for filling out the survey. Every response counts.

Section 1

Section 1 is seven items long. Each item includes a statement for you to agree or disagree with. You can indicate how much you agree or disagree by clicking one of the small, round buttons to the right of the statement. Clicking the button in the 5 column means you strongly agree; clicking 4 means you agree; clicking 3 means you're neutral or undecided; clicking 2 means you disagree; and clicking 1 means you strongly disagree.

	Agree - Disagree				
	5	4	3	2	1
1) Using internet technology makes my work easier.	○	○	○	○	○
2) Knowing how to use internet technology won't improve my career and job security.	○	○	○	○	○
3) Internet technology fits in with the way my organization works.	○	○	○	○	○
4) Using internet technology is easy.	○	○	○	○	○
5) I find internet technology confusing.	○	○	○	○	○
	Agree - Disagree				
	5	**4**	**3**	**2**	**1**
6) I had opportunities to experiment with internet technology before I had to use it myself.	○	○	○	○	○
7) I had to rush into using internet technology.	○	○	○	○	○

Section 2

Section 2 is nine items long. Each item includes a statement for you to agree or disagree with. You can indicate how much you agree or disagree by clicking one of the small, round buttons to the right of the statement. Clicking the button in the 5 column means you strongly agree; clicking 4 means you agree; clicking 3 means you're neutral or undecided; clicking 2 means you disagree; and clicking 1 means you strongly disagree.

	Agree - Disagree				
	5	4	3	2	1
1) I trust the people who are in charge of internet technology in my organization.	○	○	○	○	○
2) I get along well with the people who are in charge of internet technology in my organization.	○	○	○	○	○
3) The people who are in charge of internet technology in my organization are naturally friendly and helpful.	○	○	○	○	○
4) I don't like to be associated with the people who are in charge of internet technology in my organization.	○	○	○	○	○
5) Using internet technology is an enjoyable experience.	○	○	○	○	○

	Agree - Disagree				
	5	4	3	2	1
6) Using internet technology is more trouble than it's worth.	○	○	○	○	○
7) I would use internet technology even if it were not expected of me.	○	○	○	○	○
8) I don't care what other people say, internet technology is not for me.	○	○	○	○	○
9) My employer values internet technology too highly.	○	○	○	○	○

Section 3

Section 3 is 10 items long. Each item includes a statement for you to agree or disagree with. You can indicate how much you agree or disagree by clicking one of the small, round buttons to the right of the statement. Clicking the button in the 5 column means you strongly agree; clicking 4 means you agree; clicking 3 means you're neutral or undecided; clicking 2 means you disagree; and clicking 1 means you strongly disagree.

	Agree - Disagree				
	5	4	3	2	1
1) More and more people at my site are using internet technology.	○	○	○	○	○
2) Few of the people I work with use internet technology.	○	○	○	○	○
3) I have the skills and/or training I need to use internet technology.	○	○	○	○	○
4) I don't have all the equipment I need to use internet technology.	○	○	○	○	○
5) Many different groups at my site are interested in internet technology.	○	○	○	○	○
	Agree - Disagree				
	5	**4**	**3**	**2**	**1**
6) Few groups at my site have invested time and money in internet technology.	○	○	○	○	○
7) I can think of several people at my site who have promoted the use of internet technology for years.	○	○	○	○	○
8) I can think of few, if any, managers at my site who have promoted the use of internet technology for several years.	○	○	○	○	○

9) Management at my site supports the use of internet technology.	○	○	○	○	○
10) Management at my site doesn't invest enough money in internet technology.	○	○	○	○	○

Section 4

Section 4 is six items long. For each item, pick the one answer that fits you best.

1) How long have you used internet technology?

○ **don't use it** ○ **less than 1 year** ○ **1 to 3 years** ○ **4 to 6 years** ○ **6 years or more**

2) On the average, how many hours a day do you use internet technology in your job?

○ **don't use it** ○ **less than 1 hour** ○ **1 to 3 hours** ○ **3 to 6 hours** ○ **6 hours or more**

3) How likely are you to use internet technology for a task at work if you're not required to?

○ **wouldn't use it** ○ **unlikely** ○ **not sure** ○ **likely** ○ **very likely**

4) Which of the following combinations of capabilities best describes how you use internet technology at work on a regular basis?

○ **none**

○ **e-mail**

○ **e-mail, web browser**

○ **e-mail, web browser, newsgroups**

○ **e-mail, web browser, newsgroups, multimedia (audio or video applications)**

5) Which of the following combinations of work-related tasks best describes what you use internet technology for at work on a regular basis?

○ **nothing**

○ **finding organizational information**

○ **finding organizational information, performing administrative tasks**

○ **finding organizational information, performing administrative tasks, doing everyday work**

○ **finding organizational information, performing administrative tasks, doing everyday work, searching databases**

6) Which of the following combinations of web-browsing habits best describes how you use internet technology at work on a regular basis?

- ○ **don't browse**
- ○ **following links from local homepages**
- ○ **following links from local homepages using bookmarks or hotlists**
- ○ **following links from local homepages using bookmarks or hotlists, searching the internal network (or "intranet")**
- ○ **following links from local homepages using bookmarks or hotlists, searching the internal network (or "intranet"), searching the entire internet**

Section 5

Section 5 is 11 items long. For items 1-8, pick the one answer that fits you best. Item 9 is optional and asks for your e-mail address. Items 10-11 ask you for some of your opinions--write as much or as little as you like.

1) For which of the following LM organizations do you work?

- ○ **Idaho National Engineering and Environmental Laboratory**
- ○ **Lockheed Martin Energy Systems (East Tennessee Technology Park--K-25 Site)**
- ○ **Lockheed Martin Energy Systems (Oak Ridge Y-12 Plant)**
- ○ **Oak Ridge National Laboratory (Lockheed Martin Energy Research)**
- ○ **Sandia National Laboratories (Albuquerque)**
- ○ **Sandia National Laboratories (Livermore)**

2) Which one of the following categories best describes your primary occupation?

- ○ **administrative**
- ○ **clerical**
- ○ **computer-related**
- ○ **craftsperson**
- ○ **manager**
- ○ **researcher**
- ○ **technician**
- ○ **professional**
- ○ **other**

3) What was the primary field covered in your formal education?

- ○ **Business (i.e., Management, Economics, Marketing)**
- ○ **Computer Science or Mathematics**
- ○ **Crafts (i.e., Electrician, Pipefitter)**
- ○ **Humanities (i.e., English, Philosophy, Art)**
- ○ **Natural Sciences (i.e., Chemistry, Biology, Physics)**
- ○ **Public Management (i.e., Public Administration)**
- ○ **other**

4) What is your gender?

○ **female** ○ **male** ○ **prefer not to say**

5) What is your age?

- ○ **less than 20**
- ○ **20-29**
- ○ **30-39**
- ○ **40-49**
- ○ **50-59**
- ○ **60-69**
- ○ **70-79**
- ○ **80 or over**
- ○ **prefer not to say**

6) What is your computer's operating system?

- ○ **don't use a computer**
- ○ **PC with DOS**
- ○ **PC with Windows 3.1**
- ○ **PC with Windows '95 or NT**
- ○ **Macintosh**
- ○ **Workstation with UNIX**
- ○ **other**
- ○ **not sure**

7) What is your primary internet browser?

- ○ **don't use a browser**
- ○ **Microsoft Internet Explorer**
- ○ **Netscape**
- ○ **text-based browser (such as Lynx)**
- ○ **other**

8) Which of the following methods do you use most frequently to find out about new internet resources?

- ○ **never hear about new internet resources**
- ○ **"what's new?" pages on your local server**
- ○ **e-mail from co-workers or friends**
- ○ **e-mail advertising**
- ○ **newsgroups**
- ○ **newspapers, magazines, or other printed material**
- ○ **electronic publications**
- ○ **word of mouth**
- ○ **radio or television**

9) Optional - What is your e-mail address? (If you have more than one, enter the one that was used to contact you about this survey. Your e-mail address will only be used to ensure that you won't be bothered by follow-up e-mail asking you to fill out the survey.)

10) What would it take to make internet technology more useful in your everyday work?

11) Are there any other comments you'd like to pass along concerning internet technology?

Send It In! | Throw It Out!

Thanks for completing the survey. You can send it in by pressing the "Send It In!" button above. If you want to start over, press the "Throw It Out" button to clear the form.

E-Mail Survey Instrument

Web and Internet User Survey

This Web and Internet User Survey is sponsored by the Lockheed Martin Energy and Environment Sector Internet Working Group.

The results of the survey will help our organizations get a better idea of whether or not people are using the web and internet on the job, how they feel about this new technology, what they use it for, and how they learn about new web resources, new software, and other changes. This information can be used to determine what sort of information people want to have available on the web, to develop new training priorities, to improve communication about web- and internet-related issues, to target areas for specialized training, and to help web developers provide resources that meet more of their user's needs.

It doesn't matter whether you've never used the internet or you use it all day long, we need everyone who gets this message to take the opportunity to fill out the survey and send it in. That's because, at most sites, only a fraction of staff members will receive this survey, so every completed survey we get back will be helping make the web and internet more useful and accessible for all of us.

There are three ways to take the survey:

- On the Web: Go to the survey web site at <http://www.ornl.gov/survey/> and follow the instructions you find there.

- By E-mail: There's a copy of the survey at the bottom of this message. Just follow the instructions below, fill out the survey, and e-mail it back to us.

- On Paper: If you'd rather fill out the survey on a paper form, drop us a line at survey@ornl.gov (include your mailing address) and we'll send you a paper copy.

The survey is 43 questions long; almost all the questions are multiple choice; and it takes about 15 minutes to finish.

Responses to this survey will be read by a computer, so it's important that you enter your answers in the right places. At the beginning of each section, there's a brief description of the items in the section and the kind of answers the computer will recognize. Below each question, there is an "answer pointer" that looks something like this:

=>S1_1=> <

You'll need to enter your answers on the same line as the answer pointer. For example, if you wanted to answer one of the survey items with a "3", you'd enter it right beside the answer pointer, like so:

=>S1_1=>3<

To fill out this survey, just reply to this mail message, and enter your answers to the survey items next to the "answer pointers." When you're finished, mail it back to where it came from (the return address).

No names, e-mail addresses, or IP addresses (computer addresses) will be included among the data gathered from the survey--out of respect for individual privacy, as well to encourage honest answers. (You will have the option to provide your e-mail address to avoid being bothered by e-mail reminders; however, e-mail addresses are separated from the other responses as soon as the survey is submitted.)

When "internet technology" is mentioned in this survey, it refers to the tools used to communicate through internal computer networks, also known as "intranets," or through the public internet, or World Wide Web. Examples of these tools include e-mail, internet browsers (like Netscape, Microsoft Internet Explorer, and Lynx), newsgroups, etc.

If you've got any comments, questions, etc., don't send them to the return address on this message; instead, send them to survey@ornl.gov.

Thanks in advance for filling out the survey. Every response counts.

Web and Internet User Survey (E-mail Version)

<!=>BEGIN_SURVEY=>

Section 1

Section 1 is seven items long. Each item includes a statement for you to agree or disagree with. You can indicate how much you agree or disagree by entering a number in the answer area below each item. Entering 5 means you strongly agree; entering 4 means you agree; entering 3 means you're neutral or undecided; entering 2 means you disagree; and entering 1 means you strongly disagree.

1) Using internet technology makes my work easier.
=>S1_1=> <!

2) Knowing how to use internet technology won't improve my career and job security.
=>S1_2=> <!

3) Internet technology fits in with the way my organization works.
=>S1_3=> <!

4) Using internet technology is easy.
=>S1_4=> <!

5) I find internet technology confusing.
=>S1_5=> <!

6) I had opportunities to experiment with internet technology before I had
to use it myself.
=>S1_6=> <!

7) I had to rush into using internet technology.
=>S1_7=> <!

Section 2

Section 2 is nine items long. Each item includes a statement for you to agree or disagree with. You can indicate how much you agree or disagree by entering a number in the answer area below each item. Entering 5 means you strongly agree; entering 4 means you agree; entering 3 means you're neutral or undecided; entering 2 means you disagree; and entering 1 means you strongly disagree.

1) I trust the people who are in charge of internet technology in my organization.
=>S2_1=> <!

2) I get along well with the people who are in charge of internet technology in my organization.
=>S2_2=> <!

3) The people who are in charge of internet technology in my organization
are naturally friendly and helpful.
=>S2_3=> <!

4) I don't like to be associated with the people who are in charge of internet technology in my organization.
=>S2_4=> <!

5) Using internet technology is an enjoyable experience.
=>S2_5=> <!

6) Using internet technology is more trouble than it's worth.
=>S2_6=> <!

7) I would use internet technology even if it were not expected of me.
=>S2_7=> <!

8) I don't care what other people say, internet technology is not for me.
=>S2_8=> <!

9) My employer values internet technology too highly.
=>S2_9=> <!

Section 3

Section 3 is 10 items long. Each item includes a statement for you to agree or disagree with. You can indicate how much you agree or disagree by entering a number in the answer area below each item. Entering 5 means you strongly agree; entering 4 means you agree; entering 3 means you're neutral or undecided; entering 2 means you disagree; and entering 1 means you strongly disagree.

1) More and more people at my site are using internet technology.
=>S3_1=> <!

2) Few of the people I work with use internet technology.
=>S3_2=> <!

3) I have the skills and/or training I need to use internet technology.
=>S3_3=> <!

4) I don't have all the equipment I need to use internet technology.
=>S3_4=> <!

5) Many different groups at my site are interested in internet technology.
=>S3_5=> <!

6) Few groups at my site have invested time and money in internet technology.
=>S3_6=> <!

7) I can think of several people at my site who have promoted the use of
internet technology for years.
=>S3_7=> <!

8) I can think of few, if any, managers at my site who have promoted the
use of internet technology for several years.
=>S3_8=> <!
9) Management at my site supports the use of internet technology.
=>S3_9=> <!

10) Management at my site doesn't invest enough money in internet technology.
=>S3_10=> <!

Section 4

Section 4 is six items long. For each item, pick the one answer that fits you best.

1) How long have you used internet technology? (Pick only the best response)

a) don't use it
b) less than 1 year
c) 1 to 3 years
d) 4 to 6 years
e) 6 years or more
=>S4_1=> <!

2) On the average, how many hours a day do you use internet technology in your job? (Choose only one)

a) don't use it
b) less than 1 hour
c) 1 to 3 hours
d) 3 to 6 hours
e) 6 hours or more
=>S4_2=> <!

3) How likely are you to use internet technology for a task at work if you're not required to? (Choose only one)
a) wouldn't use it
b) unlikely
c) not sure
d) likely
e) very likely
=>S4_3=> <!

4) Which of the following combinations of capabilities best describes how you use internet technology at work on a regular basis? (Choose only one)

a) none
b) e-mail
c) e-mail, web browser
d) e-mail, web browser, newsgroups
e) e-mail, web browser, newsgroups, multimedia (audio or video applications)
=>S4_4=> <!

5) Which of the following combinations of work-related tasks best describes what you use internet technology for at work on a regular basis? (Choose
only one)

a) nothing
b) finding organizational information
c) finding organizational information, performing administrative tasks
d) finding organizational information, performing administrative tasks,
doing everyday work

e) finding organizational information, performing administrative tasks,
doing everyday work,
searching databases
=>S4_5=> <!

6) Which of the following combinations of web-browsing habits best describes how you use internet technology at work on a regular basis? (Choose only one)

a) don't browse
b) following links from local homepages
c) following links from local homepages using bookmarks or hotlists
d) following links from local homepages using bookmarks or hotlists,
searching the internal network (or "intranet")
e) following links from local homepages using bookmarks or hotlists,
searching the internal network (or "intranet"), searching the entire internet
=>S4_6=> <!

Section 5
Section 5 is 11 items long. Item 9 (e-mail address) is optional. For items 1-8, pick the on answer that fits you best. Questions 10-11 ask you for some of your opinions--write as much r as little as you like.

1) For which of the following LM organizations do you work? (Choose only one)

a) Idaho National Engineering and Environmental Laboratory
b) Lockheed Martin Energy Systems (East Tennessee Technology Park--K-25 site)
c) Lockheed Martin Energy Systems (Oak Ridge Y-12 Plant)
d) Oak Ridge National Laboratory (Lockheed Martin Energy Research)
e) Sandia National Laboratories (Albuquerque)
f) Sandia National Laboratories (Livermore)
=>S5_1=> <!

2) Which one of the following categories best describes your primary occupation? (Choose only one)

a) administrative
b) clerical
c) computer-related
d) craftsperson
e) manager
f) researcher
g) technician

h) professional
i) other
=>S5_2=> <!

3) What was the primary field covered in your formal education? (Choose only one)

a) Business (i.e., Management, Economics, Marketing)
b) Computer Science or Mathematics
c) Crafts (i.e., Electrician, Pipefitter)
d) Humanities (i.e., English, Philosophy, Art)
e) Natural Sciences (i.e., Chemistry, Biology, Physics)
f) Public Management (i.e., Public Administration)
g) other
=>S5_3=> <!

4) What is your gender? (Choose only one)

a) female
b) male
c) prefer not to say
=>S5_4=> <!

5) What is your age? (Choose only one)

a) less than 20
b) 20-29
c) 30-39
d) 40-49
e) 50-59
f) 60-69
g) 70-79
h) 80 or over
i) prefer not to say
=>S5_5=> <!

6) What is your primary computer's operating system? (Choose only one)

a) don't use a computer
b) PC with DOS
c) PC with Windows 3.1
d) PC with Windows '95 or NT
e) Macintosh
f) Workstation with UNIX
g) other
h) not sure
=>S5_6=> <!

7) What is your primary internet browser? (Choose only one)

a) don't use a browser
b) Microsoft Internet Explorer
c) Netscape
d) text-based browser (such as Lynx)

e) other
=>S5_7=> <!

8) Which of the following methods do you use most frequently to find out about new internet resources? (Choose only one)

a) never hear about new internet resources
b) "what's new?" pages on your local server
c) e-mail from co-workers or friends
d) e-mail advertising
e) newsgroups
f) newspapers, magazines, or other printed material
g) electronic publications
h) word of mouth
i) radio or television
=>S5_8=> <!

9) Optional - What is your e-mail address? (If you have more than one, enter the one that was used to contact you about this survey. Your e-mail address will only be used to ensure that you won't be bothered by follow-up e-mail asking you to fill out the survey.)
=>S5_9=> <!

10) What would it take to make internet technology more useful in your everyday work?
=>S5_10=>

<!
11) Are there any other comments you'd like to pass along concerning internet technology?
=>S5_11=>

<!
<=>END_SURVEY=>

Thanks for completing the survey. You can send it in by e-mailing it back the return address.

Again, if you have questions or comments about this survey, don't send them to the return address on this message (that's just for submitting completed surveys). Instead, send them to survey@ornl.gov.

Paper Survey Instrument

Web and Internet Technologies User Survey

Sponsored by the Lockheed Martin Energy and Environment Sector Internet Working Group

This Web and Internet Technologies User Survey is sponsored by the Lockheed Martin Energy and Environment Sector Internet Working Group.

The results of the survey will help our organizations get a better idea of whether or not people are using the web and internet on the job, how they feel about this new technology, what they use it for, and how they learn about new web resources, new software, and other changes. This information can be used to determine what sort of information people want to have available on the web, to develop new training priorities, to improve communication about web- and internet-related issues, to target areas for specialized training, and to help web developers provide resources that meet user's needs.

It doesn't matter whether you've never used the internet or you use it all day long, we need everyone who gets this message to take the opportunity to fill out the survey and send it in. That's because, at most sites, only a fraction of staff members will receive this survey, so every completed survey we get back will help to make the web and internet more useful and accessible for all of us.

The survey is 42 questions long; almost all the questions are multiple choice; and it takes about 15 minutes to finish. When "internet technology" is mentioned in this survey, it refers to the tools used to communicate through internal computer networks, also known as "intranets," or through the public internet, or "World Wide Web." These tools include e-mail, internet browsers (like Netscape, Microsoft Internet Explorer, and Lynx), newsgroups, etc.

The survey is printed on both the front and back of the paper, so be sure you don't miss a side.

If you've got any comments or questions, drop us a line at Web and Internet User Survey, Oak Ridge National Laboratory, P.O. Box 2008 MS 6144, Oak Ridge, TN 37831-6144, or e-mail us at survey@ornl.gov.

Thanks in advance for filling out the survey. Every response counts.

Web and Internet Technologies User Survey

Section 1

Section 1 is seven items long. Each item includes a statement for you to agree or disagree with. You can indicate how much you agree or disagree by circling one of the numbers to the right of the statement. Circling 5 means you strongly agree; circling 4 means you agree; circling 3 means you're neutral or undecided; circling 2 means you disagree; and circling 1 means you strongly disagree.

		Agree - Disagree
1)	Using internet technology makes my work easier.	5 4 3 2 1
2)	Knowing how to use internet technology won't improve my career and job security.	5 4 3 2 1
3)	Internet technology fits in with the way my organization works.	5 4 3 2 1
4)	Using internet technology is easy.	5 4 3 2 1
5)	I find internet technology confusing.	5 4 3 2 1
6)	I had opportunities to experiment with internet technology before I had to use it myself.	5 4 3 2 1
7)	I had to rush into using internet technology.	5 4 3 2 1

Section 2

Section 2 is nine items long. Each item includes a statement for you to agree or disagree with. You can indicate how much you agree or disagree by circling one of the numbers to the right of the statement. Circling 5 means you strongly agree; circling 4 means you agree; circling 3 means you're neutral or undecided; circling 2 means you disagree; and circling 1 means you strongly disagree.

		Agree - Disagree
1)	I trust the people who are in charge of internet technology in my organization.	5 4 3 2 1
2)	I get along well with the people who are in charge of internet technology in my organization.	5 4 3 2 1
3)	The people who are in charge of internet technology in my organization are naturally friendly and helpful.	5 4 3 2 1
4)	I don't like to be associated with the people who are in charge of internet technology in my organization.	5 4 3 2 1
5)	Using internet technology is an enjoyable experience.	5 4 3 2 1
6)	Using internet technology is more trouble than it's worth.	5 4 3 2 1
7)	I would use internet technology even if it were not expected of me.	5 4 3 2 1
8)	I don't care what other people say, internet technology is not for me.	5 4 3 2 1
9)	My employer values internet technology too highly.	5 4 3 2 1

Section 3

Section 3 is 10 items long. Each item includes a statement for you to agree or disagree with. You can indicate how much you agree or disagree by circling one of the numbers to the right of the statement. Circling 5 means you strongly agree; circling 4 means you agree; circling 3 means you're neutral or undecided; circling 2 means you disagree; and circling 1 means you strongly disagree.

		Agree - Disagree
1)	More and more people at my site are using internet technology.	5 4 3 2 1

2)	Few of the people I work with use internet technology.	5	4	3	2	1
3)	I have the skills and/or training I need to use internet technology.	5	4	3	2	1
4)	I don't have all the equipment I need to use internet technology.	5	4	3	2	1
5)	Many different groups at my site are interested in internet technology.	5	4	3	2	1
6)	Few groups at my site have invested time and money in internet technology.	5	4	3	2	1
7)	I can think of several people at my site who have promoted the use of internet technology for years.	5	4	3	2	1
8)	I can think of few, if any, managers at my site who have promoted the use of internet technology for several years.	5	4	3	2	1
9)	Management at my site supports the use of internet technology.	5	4	3	2	1
10)	Management at my site doesn't invest enough money in internet technology.	5	4	3	2	1

Section 4

Section 4 is six items long. For each of the items, circle the one answer that fits you best.

1) How long have you used internet technology? (Circle only one)
   (a) don't use it (b) less than 1 year (c) 1 to 3 years (d) 4 to 6 years (e) 6 years or more
2) On the average, how many hours a day do you use internet technology in your job? (Circle only one)
   (a) don't use it (b) less than 1 hour (c) 1 to 3 hours (d) 3 to 6 hours (e) 6 hours or more
3) How likely are you to use internet technology for a task at work if you're not required to? (Circle only one)
   (a) wouldn't use it (b) unlikely (c) not sure (d) likely (e) very likely
4) Which of the following combinations of capabilities best describes how you use internet technology at work on a regular basis? (Circle only one)
   (a) none
   (b) e-mail
   (c) e-mail, web browser
   (d) e-mail, web browser, newsgroups
   (e) e-mail, web browser, newsgroups, multimedia (audio or video applications)
5) Which of the following combinations of work-related tasks best describes what you use internet technology for at work on a regular basis? (Circle only one)
   (a) nothing
   (b) finding organizational information
   (c) finding organizational information, performing administrative tasks
   (d) finding organizational information, performing administrative tasks, doing everyday work
   (e) finding organizational information, performing administrative tasks, doing everyday work, searching databases
6) Which of the following combinations of web-browsing habits best describes how you use internet technology at work on a regular basis? (Circle only one)
   (a) don't browse
   (b) following links from local homepages
   (c) following links from local homepages using bookmarks or hotlists
   (d) following links from local homepages using bookmarks or hotlists, searching the internal network (or "intranet")
   (e) following links from local homepages using bookmarks or hotlists, searching the internal network (or "intranet"), searching the entire internet

Section 5

Section 5 is 10 questions long. For items 1-8, circle the one answer that fits you best. Items 9-10 ask you for some of your opinions--write as much or as little as you like.

1) For which of the following LM organizations do you work? (Circle only one)
   (a) Idaho National Engineering and Environmental Laboratory
   (b) Lockheed Martin Energy Systems (East Tennessee Technology Park--K-25 Site)
   (c) Lockheed Martin Energy Systems (Oak Ridge Y-12 Plant)
   (d) Oak Ridge National Laboratory (Lockheed Martin Energy Research)
   (e) Sandia National Laboratories (Albuquerque)
   (f) Sandia National Laboratories (Livermore)
2) Which one of the following categories best describes your primary occupation? (Circle only one)
   (a) administrative
   (b) clerical
   (c) computer-related
   (d) craftsperson
   (e) manager
   (f) researcher
   (g) technician
   (h) professional
   (i) other
3) What was the primary field covered in your formal education? (Circle only one)
   (a) Business (i.e., Management, Economics, Marketing)
   (b) Computer Science or Mathematics
   (c) Crafts (i.e., Electrician, Pipefitter)
   (d) Humanities (i.e., English, Philosophy, Art)
   (e) Natural Sciences (i.e., Chemistry, Biology, Physics)
   (f) Public Management (i.e., Public Administration)
   (g) other
4) What is your gender? (Circle only one)
   (a) female (b) male (c) prefer not to say
5) What is your age? (Circle only one)
   (a) less than 20
   (b) 20-29
   (c) 30-39
   (d) 40-49
   (e) 50-59
   (f) 60-69
   (g) 70-79
   (h) 80 or over
   (i) prefer not to say
6) What is your computer's operating system? (Circle only one)
   (a) don't use a computer
   (b) PC with DOS
   (c) PC with Windows 3.1
   (d) PC with Windows '95 or NT
   (e) Macintosh
   (f) Workstation with UNIX
   (g) other
   (h) not sure

7) What is your primary internet browser? (Circle only one)
   (a) don't use a browser
   (b) Microsoft Internet Explorer
   (c) Netscape
   (d) text-based browser (such as Lynx)
   (e) other
8) Which of the following methods do you use most frequently to find out about new internet resources? (Circle only one)
   (a) never hear about new internet resources
   (b) "what's new?" pages on your local server
   (c) e-mail from co-workers or friends
   (d) e-mail advertising
   (e) newsgroups
   (f) newspapers, magazines, or other printed material
   (g) electronic publications
   (h) word of mouth
   (i) radio or television

9) What would it take to make internet technology more useful in your everyday work?

10) Are there any other comments you'd like to pass along concerning internet technology?

Thanks for participating in the survey. Once you've finished, place the survey in the self-addressed return envelope that came with it, and drop it in the mail--it doesn't need a stamp.

Thanks again.

Appendix D: E-Mail and Paper Reminder Notices

E-Mail Reminder Notice

Just a reminder...

You should have already gotten a notice about the "Web and Internet User
Survey," sponsored by the Lockheed Martin Energy and Environment
Sector Internet Working Group. If you've already responded to the survey,
thanks a million. If you haven't, please try to find about 15 minutes to
fill out the survey--it's available in web, e-mail and paper forms. All the
details you'll need are included below.

Thanks!

Web and Internet User Survey

This Web and Internet User Survey is sponsored by the Lockheed Martin
Energy and Environment Sector Internet Working Group.

The results of the survey will help our organizations get a better idea
of whether or not people are using the web and internet on the job, how
they feel about this new technology, what they use it for, and how they
learn about new web resources, new software, and other changes. This
information can be used to determine what sort of information people
want to have available on the web, to develop new training priorities,
to improve communication about web- and internet-related issues, to
target areas for specialized training, and to help web developers
provide resources that meet more of their user's needs.

It doesn't matter whether you've never used the internet or you use it
all day long, we need everyone who gets this message to take the
opportunity to fill out the survey and send it in. That's because, at
most sites, only a fraction of staff members will receive this survey,
so every completed survey we get back will be helping make the web and
internet more useful and accessible for all of us.

There are three ways to take the survey:

- On the Web: Go to the survey web site at
<http://www.ornl.gov/survey/> and follow the instructions you find
there.

- By E-mail: There's a copy of the survey at the bottom of this
message. Just follow the instructions below, fill out the survey, and
e-mail it back to us.

- On Paper: If you'd rather fill out the survey on a paper form, drop
us a line at survey@ornl.gov (include your mailing address) and we'll
send you a paper copy.

The survey is 43 questions long; almost all the questions are multiple choice; and it takes about 15 minutes to finish.

Responses to this survey will be read by a computer, so it's important that you enter your answers in the right places. At the beginning of each section, there's a brief description of the items in the section and the kind of answers the computer will recognize. Below each question, there is an "answer pointer" that looks something like this:

=>S1_1=> <

You'll need to enter your answers on the same line as the answer pointer. For example, if you wanted to answer one of the survey items with a "3", you'd enter it right beside the answer pointer, like so:

=>S1_1=>3<

To fill out this survey, just reply to this mail message, and enter your answers to the survey items next to the "answer pointers." When you're finished, mail it back to where it came from (the return address).

No names, e-mail addresses, or IP addresses (computer addresses) will be included among the data gathered from the survey--out of respect for individual privacy, as well to encourage honest answers. (You will have the option to provide your e-mail address to avoid being bothered by e-mail reminders; however, e-mail addresses are separated from the other responses as soon as the survey is submitted.)

When "internet technology" is mentioned in this survey, it refers to the tools used to communicate through internal computer networks, also known as "intranets," or through the public internet, or World Wide Web. Examples of these tools include e-mail, internet browsers (like Netscape, Microsoft Internet Explorer, and Lynx), newsgroups, etc.

If you've got any comments, questions, etc., don't send them to the return address on this message; instead, send them to survey@ornl.gov.

Thanks in advance for filling out the survey. Every response counts.

Web and Internet User Survey (E-mail Version)

<!=>BEGIN_SURVEY=>

Section 1

Section 1 is seven items long. Each item includes a statement for you to agree or disagree with. You can indicate how much you agree or disagree by entering a number in the answer area below each item. Entering 5 means you strongly agree; entering 4 means you agree;

entering 3 means you're neutral or undecided; entering 2 means you disagree; and entering 1 means you strongly disagree.

1) Using internet technology makes my work easier.
=>S1_1=> <!

2) Knowing how to use internet technology won't improve my career and job security.
=>S1_2=> <!

3) Internet technology fits in with the way my organization works.
=>S1_3=> <!

4) Using internet technology is easy.
=>S1_4=> <!

5) I find internet technology confusing.
=>S1_5=> <!

6) I had opportunities to experiment with internet technology before I had
to use it myself.
=>S1_6=> <!

7) I had to rush into using internet technology.
=>S1_7=> <!

Section 2

Section 2 is nine items long. Each item includes a statement for you to agree or disagree with. You can indicate how much you agree or disagree by entering a number in the answer area below each item. Entering 5 means you strongly agree; entering 4 means you agree; entering 3 means you're neutral or undecided; entering 2 means you disagree; and entering 1 means you strongly disagree.

1) I trust the people who are in charge of internet technology in my organization.
=>S2_1=> <!

2) I get along well with the people who are in charge of internet technology in my organization.
=>S2_2=> <!

3) The people who are in charge of internet technology in my organization
are naturally friendly and helpful.
=>S2_3=> <!

4) I don't like to be associated with the people who are in charge of internet technology in my organization.
=>S2_4=> <!

5) Using internet technology is an enjoyable experience.
=>S2_5=> <!

6) Using internet technology is more trouble than it's worth.
=>S2_6=> <!

7) I would use internet technology even if it were not expected of me.
=>S2_7=> <!

8) I don't care what other people say, internet technology is not for me.
=>S2_8=> <!

9) My employer values internet technology too highly.
=>S2_9=> <!

Section 3

Section 3 is 10 items long. Each item includes a statement for you to agree or disagree with. You can indicate how much you agree or disagree by entering a number in the answer area below each item. Entering 5 means you strongly agree; entering 4 means you agree; entering 3 means you're neutral or undecided; entering 2 means you disagree; and entering 1 means you strongly disagree.

1) More and more people at my site are using internet technology.
=>S3_1=> <!

2) Few of the people I work with use internet technology.
=>S3_2=> <!

3) I have the skills and/or training I need to use internet technology.
=>S3_3=> <!

4) I don't have all the equipment I need to use internet technology.
=>S3_4=> <!

5) Many different groups at my site are interested in internet technology.
=>S3_5=> <!

6) Few groups at my site have invested time and money in internet technology.
=>S3_6=> <!

7) I can think of several people at my site who have promoted the use of
internet technology for years.
=>S3_7=> <!

8) I can think of few, if any, managers at my site who have promoted the
use of internet technology for several years.
=>S3_8=> <!

9) Management at my site supports the use of internet technology.
=>S3_9=> <!

10) Management at my site doesn't invest enough money in internet technology.
=>S3_10=> <!

Section 4

Section 4 is six items long. For each item, pick the one answer that fits you best.

1) How long have you used internet technology? (Pick only the best response)

a) don't use it
b) less than 1 year
c) 1 to 3 years
d) 4 to 6 years
e) 6 years or more
=>S4_1=> <!

2) On the average, how many hours a day do you use internet technology in your job? (Choose only one)

a) don't use it
b) less than 1 hour
c) 1 to 3 hours
d) 3 to 6 hours
e) 6 hours or more
=>S4_2=> <!

3) How likely are you to use internet technology for a task at work if you're not required to? (Choose only one)
a) wouldn't use it
b) unlikely
c) not sure
d) likely
e) very likely
=>S4_3=> <!

4) Which of the following combinations of capabilities best describes how you use internet technology at work on a regular basis? (Choose only one)

a) none
b) e-mail
c) e-mail, web browser
d) e-mail, web browser, newsgroups
e) e-mail, web browser, newsgroups, multimedia (audio or video applications)
=>S4_4=> <!

5) Which of the following combinations of work-related tasks best describes what you use internet technology for at work on a regular basis? (Choose
only one)

a) nothing
b) finding organizational information
c) finding organizational information, performing administrative tasks
d) finding organizational information, performing administrative tasks,
doing everyday work
e) finding organizational information, performing administrative tasks,
doing everyday work,
searching databases
=>S4_5=> <!

6) Which of the following combinations of web-browsing habits best describes how you use internet technology at work on a regular basis? (Choose only one)

a) don't browse
b) following links from local homepages
c) following links from local homepages using bookmarks or hotlists
d) following links from local homepages using bookmarks or hotlists,
searching the internal network (or "intranet")
e) following links from local homepages using bookmarks or hotlists,
searching the internal network (or "intranet"), searching the entire internet
=>S4_6=> <!

Section 5
Section 5 is 11 items long. Item 9 (e-mail address) is optional. For items 1-8, pick the on answer that fits you best. Questions 10-11 ask you for some of your opinions--write as much r as little as you like.

1) For which of the following LM organizations do you work? (Choose only one)

a) Idaho National Engineering and Environmental Laboratory
b) Lockheed Martin Energy Systems (East Tennessee Technology Park--K-25 site)
c) Lockheed Martin Energy Systems (Oak Ridge Y-12 Plant)
d) Oak Ridge National Laboratory (Lockheed Martin Energy Research)
e) Sandia National Laboratories (Albuquerque)
f) Sandia National Laboratories (Livermore)
=>S5_1=> <!

2) Which one of the following categories best describes your primary occupation? (Choose only one)

a) administrative
b) clerical
c) computer-related
d) craftsperson
e) manager
f) researcher
g) technician
h) professional
i) other
=>S5_2=> <!

3) What was the primary field covered in your formal education? (Choose only one)

a) Business (i.e., Management, Economics, Marketing)
b) Computer Science or Mathematics
c) Crafts (i.e., Electrician, Pipefitter)
d) Humanities (i.e., English, Philosophy, Art)
e) Natural Sciences (i.e., Chemistry, Biology, Physics)
f) Public Management (i.e., Public Administration)
g) other
=>S5_3=> <!

4) What is your gender? (Choose only one)

a) female
b) male
c) prefer not to say
=>S5_4=> <!

5) What is your age? (Choose only one)

a) less than 20
b) 20-29
c) 30-39
d) 40-49
e) 50-59
f) 60-69
g) 70-79
h) 80 or over
i) prefer not to say
=>S5_5=> <!

6) What is your primary computer's operating system? (Choose only one)

a) don't use a computer
b) PC with DOS
c) PC with Windows 3.1
d) PC with Windows '95 or NT
e) Macintosh
f) Workstation with UNIX

g) other
h) not sure
=>S5_6=> <!

7) What is your primary internet browser? (Choose only one)

a) don't use a browser
b) Microsoft Internet Explorer
c) Netscape
d) text-based browser (such as Lynx)
e) other
=>S5_7=> <!

8) Which of the following methods do you use most frequently to find out about new internet resources? (Choose only one)

a) never hear about new internet resources
b) "what's new?" pages on your local server
c) e-mail from co-workers or friends
d) e-mail advertising
e) newsgroups
f) newspapers, magazines, or other printed material
g) electronic publications
h) word of mouth
i) radio or television
=>S5_8=> <!

9) Optional - What is your e-mail address? (If you have more than one, enter the one that was used to contact you about this survey. Your e-mail address will only be used to ensure that you won't be bothered by follow-up e-mail asking you to fill out the survey.)
=>S5_9=> <!

10) What would it take to make internet technology more useful in your everyday work?
=>S5_10=>

<!
11) Are there any other comments you'd like to pass along concerning internet technology?
=>S5_11=>

<!
<=>END_SURVEY=>

Thanks for completing the survey. You can send it in by e-mailing it back the return address.

Again, if you have questions or comments about this survey, don't send them to the return address on this message (that's just for submitting completed surveys). Instead, send them to survey@ornl.gov.

Paper Reminder Notice

GUESS WHAT?

You should have already gotten a copy of the "Web and Internet User Survey," sponsored by the Lockheed Martin Energy and Environment Sector Internet Working Group. If you've already returned it, thanks a million. If you haven't, please try to find about 15 minutes to fill out the survey, put it in its pre-addressed return envelope, and drop it in the mail by September 5.

If you never got a copy of the survey (and you want one) or if you've got questions or comments, drop us a line at Web and Internet User Survey, Oak Ridge National Laboratory, P.O. Box 2008 MS 6144, Oak Ridge, TN 37831-6144, or e-mail us at survey@ornl.gov.

Thanks for your support. You're helping to make the web and internet more useful and accessible for all of us.

Appendix E: Notes on Automated Processing of Web and E-Mail Survey Responses

E-Mail Survey Instrument

The most difficult aspect of using e-mail as a survey medium is structuring the instrument in such a way that responses can be automatically parsed by a computer program and arranged in a data matrix. This is usually accomplished by embedding a unique sequence of characters in the instrument immediately before (and possibly after) each survey response. These characters are recognized by the computer program and allow it to separate survey responses from the body of the survey. A reproduction of the e-mail survey instrument is included in Appendix D. Other peculiarities with e-mail survey instruments are discussed below.

Notes on Active and Inactive E-mail Addresses

In virtually any list of organizational e-mail addresses, there will be addresses that are invalid. This can be caused by changes of e-mail address, people leaving the organization, changes in network structure, etc. Therefore, a small percentage of the e-mail addresses on any listing can reasonably be expected to be invalid. Generally speaking, mail sent to these addresses will be returned by the mailserver (the computer that

handles e-mail) that receives it with some sort of indication that the address is invalid.

In some organizations, however, a larger problem (at least for survey research) exists. Some organizations assign all of their employees an e-mail address, regardless of whether the employees use e-mail or not. Therefore, it is important to verify that the lists of e-mail addresses include only "active" addresses (those that have been used recently). This will help to ensure that mail is sent only to individuals who are regular e-mail users. Individuals having "inactive" e-mail addresses should be contacted by alternate means.

Notes on Processing E-Mail Responses

In the course of this study, the primary problem with automatically processing e-mail survey responses was that the responses were often entered incorrectly. These surveys were not parsed correctly by the computer, and caused "garbage" to be written to the data matrix. Initially, these problems were handled by editing the garbage out of the data matrix and setting the offending e-mail message aside for manual processing. However, it eventually became clear that a large percentage of the e-mail responses had problems of this sort to one extent or another, so it was determined that processing all e-mail responses by

hand would be the best way to proceed to ensure the integrity of the data.

This problem arises because, when a computer program is parsing an e-mail message, it depends on finding responses only where it expects them to be. Responses that appear in other places are ignored. In this survey, respondents were to place their responses between the angle brackets "> <" provided on the line below each item. In many cases that's exactly what happened. In many others, however, responses were placed outside the brackets, entered on other lines, entered as a group at the end of the survey, or entered along with extraneous comments between the brackets. In still other cases the brackets were deleted and replaced with responses. In a couple of extreme cases, the entire survey was deleted and replaced with a block of variable names and responses. These response entry problems often caused a line or two of garbage to be written to the data matrix. In two cases they apparently caused the comment file logs to crash, resulting in comment data not being collected for short periods of time (only comment data, not data from the body of the survey—the two types of input were logged separately).

Although some of these problems could probably be overcome with lengthy explanations and illustrations or more complex programming,

the fact remains that e-mail surveys designed to be automatically processed will generate a relatively large number of responses that will need to be coded manually. Given this eventuality, it is important that the e-mail message containing the survey instrument is set up to either (a) send a response both to the computer address where processing will occur and to the survey researcher (in order to enable the researcher to diagnose problem responses) or (b) send responses only to the researcher, so he or she can implement some quality control procedures to ensure that messages will be amenable to automated processing before they are forwarded to the computer.

Notes on Processing Web-Based Responses

Almost everything that is wrong with processing e-mail survey responses is right with processing web-based survey responses. This difference is due to the fact that information entered into a web-based survey form is assigned a specific variable name and value the moment the form is submitted. This information is clearly identified, doesn't have to be winnowed out of a file of unrelated information, and most importantly, there's nothing the (non-malicious) respondent can do to cause the information to be misinterpreted by the computer program it's being submitted to. None of the responses received from the web-based survey form during this study had any problems at all.

Notes on Preventing Multiple Responses

A number of processes have been developed to guard against individuals' submitting multiple responses to on-line surveys. However, many of these involve gathering information that could be perceived by respondents as compromising their anonymity. In this case, the threat of individuals intentionally submitting multiple responses was thought to be relatively low for several reasons. First, the survey was conducted in a business environment, so it was unlikely that multiple responses would be submitted as a prank. Second, the pretest survey showed no evidence that multiple responses had been submitted. Therefore, a relatively simple mechanism was employed to guard against this problem. In the case of e-mail responses, the return e-mail address of each respondent was first compared to a list of previous respondents. If the address appeared in the log, then the message was disregarded (and the responses were not added to the data matrix). If the address was not in log, it was added to the log, the message was processed, and the responses were added to the data matrix. It is important to note that, in a survey of this size, there is no reliable way to associate entries in the e-mail address log with responses in the data matrix. In the case of web-based responses, respondents were asked to provide an e-mail address (which most respondents supplied) in order to avoid receiving reminder messages. When the web-based survey was submitted, the e-mail

address was compared to the log file. If the address appeared in the log, then the survey was disregarded (and the responses were not added to the data matrix). If the address was not in the log, it was added to the log, the survey was processed, and the responses were added to the data matrix. Again, there is no reliable way to associate entries in the e-mail address log with responses in the data matrix.

While this approach to avoiding duplicate responses was adequate for this study, it provides little protection against individuals who are actively seeking to provide multiple survey responses. For example, it is relatively easy to make it appear that a series of e-mail responses, sent by one individual, has come from a number of different e-mail addresses (a practice known as "spoofing"). It is even easier for an individual replying to the web-based survey form to simply provide a different e-mail address with each response.

To ensure that it would be relatively difficult for an individual to provide multiple responses, one would have to either collect a unique identifier from each respondent when they send their response (such as a static IP address—a unique identifier for every networked computer) or assign a unique identifier to each potential respondent. The latter option would be most effective because it would prevent the tabulation of more than one

response to each solicitation—regardless of who is sending the response (using IP addresses would still allow a series of responses sent from different computers by the same individual to be tabulated). However, the usefulness of either of these more extreme measures would have to be weighed against their real and/or perceived threat to the anonymity of respondents.

The system used in this study was also not completely effective in preventing individuals who had already completed the survey and provided their e-mail addresses from getting e-mail reminder notices. This is a relatively minor problem that arises from the way e-mail addresses are sometimes constructed. For example, if a survey solicitation is sent to John Doe at his e-mail address (doejm@facility.gov), when the message gets to the mailserver (the computer that handles e-mail) at his facility, the mailserver might re-route the message to yet another mailserver—changing the John's address to doejm@mailserver2.facility.gov. On the other hand, the e-mail address the survey was originally sent to may have included an alias (in this example, a shortened version of John's official e-mail name—"doejm") so the mailserver may re-route the message to his actual e-mail name (john_doe@facility.gov) or it may change both the e-mail name and the mailserver name (john_doe@mailserver2.facility.gov). Similar changes in

e-mail address can occur when the respondent returns the e-mail survey response. As a result of this variability, the return address of the e-mail survey response (or the e-mail address provided by web survey respondents) may not match that provided on the employee roster. Because the addresses provided on the employee roster were used to send out survey solicitations and reminders, the permutations that occured as e-mail was routed back and forth among computers can resulted in reminders being sent out to individuals who had already responded to the survey.

These variations in e-mail addressing don't happen all the time, but they do happen enough to make e-mail address-based procedures less than completely efficient. Therefore it's a good idea to either (a) determine all possible permutations of e-mail addresses ahead of time or (b) confine the use of e-mail address identifiers to situations in which their performance has little or no bearing on the validity of the data being gathered.

E-mail Input Processing Scripts

In this study, when an e-mail survey response was mailed to the computer used to process survey results, it was processed by two computer programs, known as scripts. These scripts work as follows:

- The first script simply removes the e-mail message's header and introductory information and copies the rest of the e-mail message, now containing only the survey instrument and responses, to a holding area. As it copies the message to the holding area, it starts a second script that handles the remainder of the processing.

The second script performs the following functions (a few functions have been combined to clarify the explanation):

- Indicate in the data matrix that the response was generated by an e-mail survey.
- Check for a specific character string to ensure that the file it's processing is a survey
- Split the file into individual survey items (by locating specific character strings and item identifiers).
- Record the e-mail address.
- Extract the variable values (except comments)
- Remove extra spaces from the values
- Remove the extraneous characters from the values
- Set missing values to zero.
- Calculate index values
- Write variable and index values to the data matrix.

- Compare the e-mail address with those in the incoming survey log to see if the respondent has already submitted a survey. If so, exit. If not, add the e-mail address to the incoming survey log.
- Remove the respondent's e-mail address from the reminder list.
- Reverse scoring on negatively phrased items.
- Convert the alpha values to numeric values for appropriate questions in Internet Use and demographic sections.
- Match the facility value with the corresponding position in the comment log. This enables the grouping of comments by facility.
- Extract comment values.
- Write comments to the comment log files

The result of this processing is a line of data in the data matrix and, if comments were submitted, entries in the comment log files (there is a log file, broken down by facility, for each of the two comment items).

Web Input Processing Script

The web input processing script performs the following functions (a few functions have been combined to clarify the explanation):

- Return a message to the respondent's screen confirming the receipt of their survey and thanking them for their participation. No confirmation response was included in the e-mail version of the

survey because it was assumed that most e-mail users are relatively certain that their e-mail goes where they send it, and they're not interested in receiving any more e-mail than is absolutely necessary. It was also assumed that some web users are unaccustomed to and less trusting of web forms, so a response screen would assure them that they had submitted the survey correctly.

- Indicate in the data matrix that the response was generated by a web-based survey.
- Record the e-mail address.
- Compare the e-mail address with those in the incoming survey log to see if the respondent has already submitted a survey. If so, exit. If not, add the e-mail address to the incoming survey log.
- Remove the respondent's e-mail address from the reminder list.
- Extract the variable values (except comments)
- Calculate index values
- Write variable and index values to the data matrix
- Match the facility value with the corresponding position in the comment log. This enables the grouping of comments by facility.
- Write comments to the comment log files.