Information and Communication: Alternative Uses of the Internet in Households

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Is the Internet a superhighway to information or a high-tech extension of the home telephone? We address this question by operationalizing information acquisition and entertainment as the use of the World Wide Web and interpersonal communication as the use of electronic mail (e-mail), and examine how 229 members of 110 households used these services during their first year on the Internet. The results show that e-mail drives people's use of the Internet. Participants used e-mail in more Internet sessions and more consistently than they used the World Wide Web, and they used e-mail first in sessions where they used both. Participants used the Internet more after they had used e-mail heavily, but they used the Internet less after they had used the Web heavily. While participants' use of both e-mail and the Web declined with time, the decline in Web use was steeper. Those who used e-mail more than they used the Web were also more likely to continue using the Internet over the course of a year. Our findings have implications for engineering and policies for the Internet and, more generally, for studies of the social impact of new technology.
(*Interpersonal Communication*; *Family Communication*; *Social Impact*; *Computer-Mediated Communication*; *Internet*; *World Wide Web*; *Online Services*; *User Studies*; *Technology Adoption*; *E-Mail*; *Electronic Mail*)

Before the 1990s, few households included a computer. Mostly, men working in offices used computers and networks (Venkatesh and Vitalari 1992). Today, many more households own a computer; more people within households use a computer, and they use it for many tasks (Venkatesh 1996). In 1993, a third of all United States households included a computer and over 60% of the richest quartile did so (Anderson et al. 1995). For example, basing their estimates on a national survey, Mediamark Research (1998) estimates that in the fall of 1998 over 35 million adults, 18% of the U.S. population, had accessed the Internet at home within the past 30 days. The Internet is rapidly becoming a pervasive household technology, and, if the public press is to be believed, it portends large changes in people's lives.

Because the Internet can be used for very different purposes, the evolution and social impact of the Internet has been hard to predict. The Internet may become the future household's "information superhighway" to libraries and schools, its virtual shopping mall, or the center of home entertainment. Alternatively perhaps,

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the Internet could become a basic interpersonal communication technology in the home, like the telephone. The popularity of both the World Wide Web and electronic mail suggest both might be happening. The dominating style of use could have large ramifications for society. The Internet as an information and entertainment technology would affect education, government, publishing, the retail industry, banking, broadcast services, and health care delivery. The Internet as a communications technology would probably have more subtle and personal effects—on people's connections to friends, family, and their geographic communities, on the social system of informal support and help, and on the functioning of groups and teams.

We can only anticipate the social impact of the Internet if we understand how people are using it. Rational industry R&D and government policy also depend on knowledge of what the public is actually doing with the Internet. Our belief in starting this research in 1995 was that current investment policies were not being driven sufficiently by an adequate knowledge of what the public wants and would use. Other research on innovations has emphasized understanding initial purchase or adoption decisions (Rogers 1983, Coleman et al. 1957). Our purpose was instead to describe how people who obtain access to the Internet at home use it during their first year.

Contrasting Information and Entertainment with Interpersonal Communication

In this article, we make a conceptual distinction between a preference for information and entertainment as compared with a preference for interpersonal communication. We operationalize this distinction by comparing people's use of the World Wide Web with their use of personal electronic mail (e-mail). This operationalization is not perfect. When people use Internet services—the World Wide Web, electronic mail, Telnet, Usenet groups, MUDs, and so forth, they may be finding out the weather in the Bahamas, downloading games, chatting with friends, learning about hobbies, or sending coworkers a report. A single session on the Internet can fulfill multiple information, entertainment, and communication goals. Nonetheless, the World Wide Web and e-mail are the most popular of all Internet services and most distinctly represent people's preference for information and entertainment as compared with their preference for interpersonal communication, respectively. Our prior research (Kraut et al. 1996, Table 2) suggested that use of the Web and e-mail are sufficiently independent of each other to have some distinctive causes and effects.

World Wide Web (Web) technology was created in 1992 so that high energy physicists could share data and results with others (Leiner et al. 1997). Though the technology continues to rapidly evolve, by comparison with e-mail, the Web is a broadcast and publishing medium—like billboards, magazines, radio, and television. Content providers post information and entertainment in a public place and identical content is distributed to a wide range of consumers. On the Web, however, almost anyone can be a broadcaster and a publisher, a characteristic that has drastically diversified its size and content and increased its potential appeal. Some websites, designed and implemented by professionals, offer production values and aesthetic appeal; some let people sample goods and services such as free legal forms or pornography.

E-mail's appeal is different. E-mail was an early innovation in data networking: The first messages were sent over the precursor to the Internet in 1969 (King 1997, Leiner et al. 1997). E-mail has undergone only minor changes since its inception. Those with access to networks discovered that e-mail is just as personalized but more convenient and faster than postal mail, and offers automatic replies, distribution lists, computerized search, and other amenities. People find communication through e-mail to be relatively spontaneous and interactive, a form of written conversation (Sproull and Kiesler 1991). Senders can tailor their messages to their recipients, taking into account their prior interactions and the nature of the relationship. Their access to the previous written messages helps support their memory of the ongoing interaction. The conversational and relationship-oriented attributes of e-mail have by now engaged millions of people. As the online services have discovered, people love to talk with others, and e-mail provides a new way for millions of them to do so. E-mail links people and reinforces relationships.

An important distinction between the Web and e-mail is that a website is typically crafted for a broad audience while an e-mail message is written to a particular reader. For this reason, the Web may be less

important to people than e-mail. Historical evidence suggests that consumer demand for information and entertainment is inelastic in comparison to interpersonal communication. When a new broadcast medium, like television, becomes available, people tend to reduce the amount of time they devote to older media, such as newspapers or movies, for acquiring similar content (Carey 1989). By comparison, whenever interpersonal communication becomes easier or cheaper, people communicate more (Mayer 1977).

From Telephone to E-Mail

Our arguments regarding the relative value of the Web and e-mail in households are based on more certainty about the value of e-mail than about the value of the Web. We have experienced nearly two decades of exploration and research about corporate and Internet e-mail whereas little is known about how people use the Web and how it may evolve (see Kiesler 1997). The history of e-mail in many ways mirrors that of the telephone. In the early years of the residential telephone (Fischer 1992), entrepreneurs and technologists building these systems underestimated the extent to which people would value interpersonal communication. It is hard to imagine, but to attract his investors in 1876, Alexander Graham Bell demonstrated the telephone as a medium for broadcasting music, news, and drama over long distances, and he even invented a triple mouthpiece so that several performers could simultaneously sing into the device (Aronson 1977). By the 1890s, the telephone broadcast news, baseball games, sermons, and concerts (Marvin 1988, p. 223). However, social communication dominated telephone use from the early days of residential telephone service at the turn of the century (Fischer 1992). Telephone experts criticized women who used the telephone for "purely idle gossip," and they sought economic and technological mechanisms to curtail this "unnecessary use" (Fischer 1992, p. 79). It took 50 years for telephone companies, such as AT&T, to advertise the telephone for purely social conversation (Fischer 1992, Chapter 3). Household communication by telephone has steadily undercut first class postal mail since the invention of the telephone in 1876 (U.S. Department of Commerce, 1975).

Today, social communication remains the dominant use of the residential telephone (Dimmick et al. 1994). Among residential subscribers, the modal telephone call is a pairwise conversation between friends or family who are located geographically close to each other and who call each other to stay in touch. Dordick and LaRose (1992) had a national sample of households record whom they talked to and why. About two-thirds of residential calls were to family and friends.

The Internet's value for conversation, like the telephone, also was underpredicted (see King 1997, Leiner et al., 1997). The Internet began as a robust data network that would survive nuclear attack. Scientists and engineers would use it for remote access to scarce computing resources (Quarterman 1990). Nonetheless, e-mail quickly became the network's most popular service, used by workers to collaborate on projects and to trade notes and gossip, and just to chat (Leiner et al. 1997, Sproull and Kiesler 1991, Sterling 1993).

Earlier underestimates of people's demand for conversation may be replayed today. The press, politicians, and industry pundits tout the World Wide Web as the driving force behind the public's fascination with the Internet. Most government and industrial research, most government policy initiatives and most attempts to commercialize the Internet focus on improving and deploying its information distribution and entertainment potential. Despite the hoopla surrounding the Web, it is possible that interpersonal communication will drive most people's use of the Internet.

Hypotheses

If either interpersonal communication or information and entertainment dominate people's use of the Internet, one would expect this preference to be reflected in several measures of usage—popularity of one type over the other, priority within sessions, consistent use over time, generalization to other uses, and continuation of usage rather than dropping service. Because we believe people have a primary preference for interpersonal communication, we make the following predictions:

1. *Popularity*. People will use e-mail more frequently than the World Wide Web.
2. *Priority*. People will access e-mail early in any session in which they are using the Internet at all.

3. *Stability.* People's use of e-mail will be more stable than their use of World Wide Web (i.e., those who use the service in one time period will be likely to use it in subsequent time periods and their use will be sustained over time).

4. *Generalization.* People who use e-mail in one time period will use other Internet services in subsequent periods.

5. *Survival.* People who heavily use electronic mail relative to their use of the World Wide Web will be likely to continue using the Internet.

6. *Loyalty.* People will be more likely to exchange mail with the same correspondents over time than they will be to revisit the same websites over time.

7. *Individual Differences.* We also tested predictions about variation among family members and about the influence of family members on one another. Adult woman and teenagers of both genders are the heaviest users of the residential telephone (Brandon 1980). Women, as part of their sex-role obligations, often take responsibility for maintaining the family's social networks; women also say they enjoy talking on the phone and think the phone is especially helpful for socializing (Dimmick et al. 1994). Teenagers are at a life stage when they are developing their personal social networks and have substantial free time. These same factors—the value placed on sociability and the availability of free time—may lead women and teenagers, in contrast to adult men, to be heavy users of the Internet for interpersonal communication.

We hypothesized the importance of e-mail over the Web will be greater among teenagers as compared with adults, among women as compared with men, and among more sociable people as compared with less sociable people.

8. *Social Influence.* Like other new consumer products, the Internet is an "experience good" that consumers must experience to value (Nelson 1970). But by contrast with such devices as the electric tooth brush and the VCR, the Internet, with its many possible uses, is far more ambiguous about the value that the user will find on using it. Many people cannot accurately predict how they will use their first home computer (Kraut et al. 1996). Research in organizations suggests that the exploration period is relatively short lived, and that social influence affects usage (e.g., Eveland and Bikson 1987, Tyre and Orlikowski 1994). We posited that family members' early explorations using the Internet would quickly determine their later use and that of others in the family.

We hypothesized people's use of e-mail or the Web will be predicted in part by other family members use of e-mail or the Web, respectively.

Method

The data analyzed here come from HomeNet, a field trial of residential Internet use, in which a sample of 110 households (229 individuals) were given Internet access from 1995 through 1996 in exchange for making themselves available as a source of information about how they used Internet.[1] When these analyses were conducted, all participants had had access to the Internet for at least a year.

Sample Characteristics

We recruited the sample of 110 households through four high schools and four community development organizations in Pittsburgh, Pennsylvania. In each high school, we recruited students who worked on the school newspaper and their families, as well as at least one journalism teacher and his or her family. Most of these households were contacted in 1994 and gained access to the Internet in early 1995 (n = 48); we added more households that included a high school student in early 1996 (n = 18). In each neighborhood development organization, we recruited adults who were members of the board of directors and their families. These households were first contacted in 1995 and gained access to the Internet in early 1996 (n = 44). Over 90% of the households contacted agreed to participate. We did not recruit households already connected to the Internet. Thus our data represent the first experience of home Internet use for this sample.

Our sample (see Table 1), while richer and better

[1]The 110 households contained 386 individuals, but only 258 were over 10 years old, requested an Internet account, and agreed to participate in the data collection. Of these, only 229 actually filled out the pretest questionnaire and used the Internet at any time during the trial. The number of respondents fluctuates with analyses because people moved into and out of households (e.g., students who went away to college) and sometimes failed to complete questionnaires.

educated than the population at large, was demographically more diverse than was the population of Internet users in 1995, who were predominantly white professional males (Anderson et al. 1996).

Resources and Support

We loaned each family a Macintosh computer with a 14.4 kbps modem connected to a dedicated telephone line and gave every interested family member a full Internet account. The computers had a turnkey system for access to the Internet and software for using electronic mail, newsgroups, the World Wide Web, MUDs and chat rooms, and special HomeNet newsgroups. The computers came with a customized homepage that contained links to topics for which family members had previously indicated interest on pretest questionnaires. The software for electronic mail was MacMail II, a proprietary program used at Carnegie Mellon University with an easy-to-use graphical user interface. Families also used Netscape Navigator 2.0 to browse the World Wide Web (although later in the trial most families upgraded this browser).

We offered a training session that 80% of the families attended; they were shown how to use the computer, how to send electronic mail, and how to search and navigate on the World Wide Web. During the trial, families had access to a help newsgroup, a telephone help desk staffed by college students, and staff who made occasional home visits to repair or replace hardware or software.

Data Collection

All family members participating in the trial signed detailed consent forms allowing researchers to collect the data reported in this article.

Computer Generated Usage Records. Households received access to the Internet on a staggered schedule; most began in March 1995 (high schools) or March 1996 (community groups). Custom-designed logging programs tracked each participant's actual use of the Internet. To permit comparisons across the entire sample, the data reported here encompass the first 52 weeks after a HomeNet family's Internet account was first operational. From the usage records, we derived the following metrics:

Table 1 The HomeNet Sample

Characteristic	Individuals	Households
N	229	110
Adult (>19 years old)	66%	37% adult-only households
Female	57%	22% female-only households
White	72%	64% White-only households
Years of school (of adults)	15.5	46% households with at least one college degree
Median household income	NA	$39,500

Note. Of those 19 years and under, three were under age 13 and 72 were teenagers 13–19. For simplicity, we refer to this group as teenagers.

Sessions and Session Length. Number of discrete sessions per week each participant logged into the Internet, and number of minutes in a session.[2]

Internet Hours. Total hours per week the participant was logged into the Internet.

E-mail Use. Number of e-mail messages sent and received per week. (We did not examine the content of participants' e-mail.) The e-mail application allowed participants to check whether they had received new electronic mail without actually logging into their e-mail account. As a result, our measure of e-mail sessions excludes Internet sessions in which participants only checked for new e-mail.

To compare interpersonal communication with information and entertainment, our count of e-mail messages excluded messages from listservs, Usenet newsgroups, and other sources where the recipient's address was not explicitly included in the address field. We reasoned that Internet advertising, broadcast newsgroups, computer bulletin boards, and listserv messages reflect a fuzzier mix of interpersonal communication and information or entertainment goals than does private e-mail to named individuals, which we assume is mainly interpersonal communication.

[2]A comparison of Internet and electronic mail logins suggests that in approximately 13.5% of the sessions, participants used the Internet under another family member's account. Interviews suggest that this behavior typically occurred when one member of the family had already logged in, and a second member checked his or her e-mail or used another Internet service without explicitly logging out and logging in again.

To assess participants' loyalty to specific e-mail correspondents, we recorded e-mail addresses to which a participant sent mail, excluding posts to computer bulletin boards or newsgroups. This measure underestimates loyalty because recipients can change e-mail addresses.

World Wide Web Use. The number of unique World Wide Web domains or sites visited each week and the addresses of particular html pages participants accessed within those domains. (A domain or site is an Internet protocol address, such as www.disney.com.) The average number of weekly domains visited and the average number of weekly html pages visited were very highly correlated ($r = 0.96$).

To assess participants' loyalty to specific information sources, we recorded the Web addresses they visited. In this article, we report repetitions at the domain level (www.disney.com). We also conducted analyses at the level of the domain plus one directory (www.disney.com/Hercules) and at the level of the full path (www.disney.com/Hercules/hercules/index.html).[3] We came to similar conclusions about the comparative loyalty of people to e-mail and Web addresses from all these analyses.

Individual Differences. Each participant at least 10 years of age completed a pretest questionnaire assessing their computer experience, skill, and attitudes; their use of household information technologies; their allocation of time; a check list of life hassles; a measure of health; measures of their social support and social networks; family communication; demographic characteristics; hobbies and interests and personality measures of innovativeness, sociability, and depression. We have previously reported, for the first 48 households, that males, teens, whites, and those with more computer skill used the Internet most in their first year (Kraut et al. 1996). We also have reported, for the households in this larger sample, that greater overall Internet use in the first year, especially by teens, predicted some negative social outcomes (Kraut et al. 1998).

To test our predictions of the individual differences we expected to be associated with participants' preference for interpersonal communication (Hypothesis 7), we used participants' gender (male = 0; female = 1) and generation (under age 19 = 0; 19 and over = 1) in our models. We also included the gender by generation interaction to test whether the effects of gender might differ for teenagers and adults. (Teenage boys and adult women = 1; teenage girls and adult men = 0.) Our measure of sociability was several items from Bendig's Pittsburgh Social Extroversion Scale (1962; Alpha = 0.74).

We also included three other individual difference variables as control variables in our models because earlier analyses had indicated these variables predicted overall Internet use. These variables were race, computer skill (measured by a five-item, self-report scale on the pretest, e.g., "I am very skilled at using computers"; Alpha = 0.86), and sample (high school or community organization).

Social Influences on Use. We included two factors that could indicate whether individual preferences for e-mail or the Web are influenced by others' behavior.

Other Household Members' Usage. These include the number of hours they were connected, amount of e-mail they sent and received, and the number of websites they accessed. For a particular user, these variables are the weekly Internet hours, e-mail and website measures, averaged over all other participants in the household.

School Days. The school year schedule has a large impact on how students and their parents spend their time, so we included a measure of the percentage of weekdays school was in session each week. Since business holidays are often geared to school vacations, this measure also can serve as a proxy for nonschool household vacations. This measure was 0 for weeks during summer vacation and ranged from 0 to 100 during the academic year.

Period. To examine whether preferences changed

[3]Apparent loyalty to World Wide Web addresses is influenced by the level of analysis. Web pages are named by a domain, representing the Internet address of the computer on which the page resides, and a path, representing the directory and file name of the page. One will see more repetition at the level of the domain than at the level of the page, because the domain is a substring of the full address for a page. At the level of the domain, www.disney.com/DisneyWorld/index.html, www.disney.com/Hercules/hercules/index.html and www.disney.com/investors/—index.html are identical, whereas at the level of the page they are different.

after participants got used to the Internet, we compared the first 26 weeks of the trial with weeks 27 through 52.

Results

We first examined the amount and variability of participants' total Internet usage over time; then we examined our hypotheses about participants' comparative use of the Internet for interpersonal communication or information and entertainment. The correlations among usage measures suggest these comparisons are sensible. Weekly Internet hours were correlated highly with e-mail use ($r = 0.81$) and with Web use ($r = 0.73$), but the amount of e-mail was correlated only moderately with the number of websites visited ($r = 0.53$).

Amount and Variability of Internet Use

Usage data were highly skewed in that a few individuals exhibited very high levels of usage and a sizable minority never used each service. Table 2 presents average weekly usage statistics for the middle 80% of the sample (to compensate for skewness). As the table indicates, teenagers used the Internet a great deal more than adults, and boys used it more than girls.

Figure 1 shows demographic differences in Internet usage and an overall decline in weekly use after the first weeks. (The growth of use in the early weeks reflects getting-started delays that occurred with the installation of new telephone connections, debugging of login scripts, and learning to use the computer.)

We used the Mixed Model Regression package available from the SAS Institute (Littell et al. 1996) to carry out a panel design analysis, in which both participant and week were repeated factors modeled as random effects; week was a repeated variable with an autoregressive component of order one. Individual difference variables (e.g., gender) and period were modeled as fixed effects. This analysis is equivalent to a random effects model for an unbalanced panel. Results did not differ substantially when we used a generalized linear model for unbalanced panel data (Greene 1995). Because of their nonnormal distribution, all usage variables were converted to the log scale prior to analysis. To allow comparisons of the size of effects, all variables were also standardized to a mean of zero and a standard deviation of one.

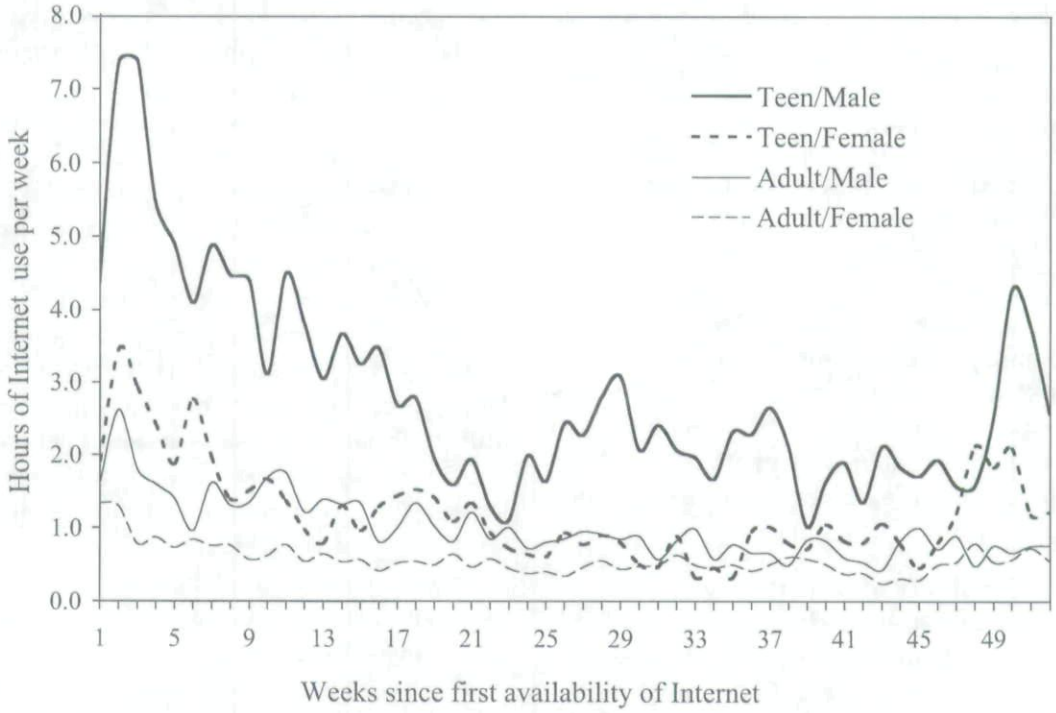
We used time series regression analyses to examine how a participant's Internet usage each week influenced that participant's usage during the next week. The coefficient for lagged hours of Internet use represents a stability coefficient, which summarizes the week-to-week predictability over participants' first 52 weeks. To examine whether stability increased with

Table 2 Internet Use by Participants in the HomeNet Sample

		Subgroups			
	All	Teenage boys	Teenage girls	Adult men	Adult women
Percent of weeks logged in at least once	52%	60%	54%	51%	48%
Mean hours connected to the Internet per week	1.0	3.1	1.2	.5	.9
Mean Internet sessions per week	2.1	4.8	2.6	1.6	1.5
Mean session length (minutes per week)	28.2	38.9	26.8	38.3	34.3
Mean e-mail messages sent per week	.6	2.4	1.7	.3	.2
Mean e-mail messages received per week	.4	2.0	1.5	.2	.1
Mean unique World Wide Web sites visited per week	3.4	9.6	2.8	4.5	4.4
Total N	229	35	44	66	84
Winsorized N	183	28	35	53	67

Note. Because the data are highly skewed, entries shown are Winsorized means from the middle 80% of the sample. The percent logged in per week was not Winsorized. Analyses were performed on the entire sample, not on the truncated distributions.

Figure 1 **Weekly Hours of Internet Use by Demographic Subgroup.**



Note. To compensate for skewed data, entries are Winsorized means from the middle 80% of the sample data.

time, we included the interaction of the lagged hours of use with the early-late period variable. We expected that the stability coefficient would be larger in the second half of the year than the first.

Table 3 shows factors predicting the hours that a participant was connected to the Internet during the week. Teens used the Internet for more hours per week than did adults, whites did so more than minorities, and males tended to do so more than females ($p = 0.12$). The generation and gender effects may be less surprising than the race difference. Possibly, minority (mostly African-American) families in this sample had fewer relatives and friends with Internet connections, and thus would have fewer people to communicate with online and less social pressure to use the Internet. Our analyses also suggest that social influence can affect Internet usage. Participants tended to use the Internet more during weeks when other family members were using it ($p = 0.07$). These social influences did not decline with time, as shown by the nonsignificant interactions of period by other family member use.

Participants reporting more computer skill on the pretest were heavier users of the Internet throughout the trial. Surprisingly, this effect did not decline with time or experience. In fact, the positive coefficient for the period by skill interaction, although not significant, suggests that the difference in weekly usage of the Internet between more and less skillful users was slightly larger in the second half of the trial than it was initially.

The coefficient for period shows that, on average, participants dropped their use during the course of the year. However, heavy Internet use was habitual. By far the strongest predictor of week-to-week variation in the numbers of hours a participant devoted to the Internet was the number of hours that the participants spent on the Internet the preceding week. The absence of a significant interaction between period and lagged connect hours suggests that it did not take long for people to acquire a stable amount of Internet use.[4] Their use was as stable in the first half of the trial as it was later.

[4]The period by lagged Internet hours interaction was also nonsignificant when we used a finer granularity for time—one week rather than 26 weeks.

Table 3 Results of a Time Series Analysis Predicting Weekly Hours Using the Internet

Predictor	Beta
Intercept	−0.031
School Days Percent of Week	0.043***
Race (minority = 0; white = 1)	0.034**
Gender (male = 0; female = 1)	−0.010
Generation (19 yrs or fewer = 0; adult = 1)	−0.052***
Gender X Generation	0.019
Sociability	−0.011
Computer Skill	0.052***
Period (weeks 2–26 = 0, weeks 27–52 = 1)	−0.017***
Sample (0 = high school; 1 = community org.)	0.014
Other Family Members' Internet Hours	0.011
Internet Hours in the Previous Week (Lagged)	0.710***
Period X Computer Skill	0.000
Period X Other Family Members' Use of E-mail	0.000
Period X Other Family Members' Use of the Web	0.003

$^{*}p \leq 0.05$, $^{**}p \leq 0.01$, $^{***}p \leq 0.001$

Note. N = 221 participants who had Internet access for 52 weeks. Entries are standardized beta coefficients from the mixed model regressions. An index for participant and the autocorrelation for week were held constant in the analysis. Internet hours were measured in the log scale and then standardized.

Table 4 Type of Internet Use within Sessions

Type of Internet use	Total sessions	Percent sessions of given type	Average session length (minutes)
No e-mail or Web	19,916	30.0%	18.4
E-mail only	21,080	31.8%	34.3
E-mail before Web	8,485	12.8%	74.1
Web before e-mail	2,842	4.3%	96.0
Web only	14,060	21.2%	40.0
N (individuals)	229		
N (sessions)	66,383		

Note. Only 2.3% of sessions were more than three hours long. Some long sessions might have occurred when participants forgot to disconnect. We truncated long sessions to 181 minutes when computing means.

Popularity and Priority of E-mail and the Web

Table 4 shows the results of analyses comparing participants' e-mail and Web use. Data logs show no use of either electronic mail or the Web in 30% of Internet sessions. These sessions included those in which participants' network connections failed, those in which participants logged on only to discover they had no new e-mail, and those in which participants used an Internet service other than e-mail or the Web, such as FTP.[5,6] Overall, participants strongly preferred using e-mail to the Web. They used e-mail in 44% of their sessions, whereas they used the Web in only 25%. Among sessions involving both services, participants accessed their e-mail before they accessed the Web 75% of the time. These analyses support Hypothesis 1, that e-mail would be more popular than the Web in households, and Hypothesis 2, that e-mail would receive priority in Internet sessions. In only one respect did indicators favor the Web: Sessions involving the Web (including downloading) were substantially longer than sessions involving e-mail.

Stability of E-mail and Web Use

To examine predictions about the stability of e-mail and Web use, we conducted two separate time series analyses using the log of e-mail messages sent, and the log of websites visited as dependent variables. (These analyses are analogous to those reported in Table 3. We dropped time-period interactions from the analysis for simplicity since they added no predictive power in earlier analysis.) For each analysis, as an independent variable, we included the log of e-mail messages and Web sites, respectively, lagged at a one week interval. Columns 1 and 2 in Table 5 present the results from the time series analysis, predicting the amount of e-mail and Web use during each week.

This analysis shows that both the number of e-mail messages participants sent and the websites they visited declined from their first six months to the next. The decline, however, was reliably larger for the Web than for e-mail ($\beta_{\text{e-mail}} = -0.017$ versus $\beta_{\text{web}} = -0.038$; difference $t = 2.4$, $p < 0.05$). In addition, the

[5]Approximately 7% of sessions had no e-mail or Web browser recorded and lasted less than a minute. We think most of these sessions resulted from technical difficulties.

[6]Our probes recorded e-mail use only if participants opened their mailbox to read or send a message. The e-mail program allowed users to connect to the Internet to find out if they had new e-mail waiting. If participants did so and then disconnected, the probes would not record use of e-mail in that session.

Table 5 Time Series Analysis Predicting Participants' Use of E-mail and the Web

	E-mail ± [a] Beta	Web[a] Beta	Internet hours[a] Beta
Intercept	−0.033**	−0.025	−0.024
School days percent of week	0.047***	0.047***	0.031**
Race (minority = 0; white = 1)	0.039***	0.040†	0.023
Gender (male = 0; female = 1)	0.020†	−0.047**	−0.023
Generation (teen = 0; adult = 1)	−0.082***	−0.069**	−0.031†
Gender X Generation	0.014	0.016	0.015
Sociability	−0.004	−0.013	−0.009
Computer Skill	0.039***	0.057**	0.049***
Period (weeks 2–26 = 0, weeks 27–52 = 1)	−0.017***	−0.038***	−0.012***
Sample (0 = high school; 1 = community org.)	0.003	0.046*	0.020
Other family members' e-mail use	0.009†		
Other family members' Web use		0.036***	
Other family members' Internet hours			0.012†
Email use in the previous week (lagged)	0.743***		0.102***
Web use in the previous week (lagged)		0.557***	−0.044***
Internet hours in the previous week (lagged)			0.674***

†$p \leq 0.10$, *$p \leq 0.05$, **$p \leq 0.01$, ***$p \leq 0.001$

Note. N = 221 participants who had Internet access for 52 weeks. Entries are standardized regression weights. An index for participant and the auto correlation for week were held constant in the analysis. E-mail, Web, and total Internet hours were measured in the log scale and then standardized.

stability coefficient (i.e., whether use in one week predicted use in a subsequent week) was reliably larger for e-mail than for the Web. E-mail use and Web use were both stable week to week, but e-mail use was substantially more stable than Web use (Hypothesis 3). That is, one can predict a participant's current e-mail use from his or her use in the prior week much better than one can predict a participant's current Web use from his or her prior Web use ($\beta_{\text{e-mail}} = 0.73$ versus $\beta_{\text{web}} = 0.56$; difference t = 13.0, $p < 0.001$).

Generalization of E-mail and Web Use

To examine generalizability—whether use of e-mail or the Web leads to greater overall use of the Internet—we added e-mail and Web usage measures lagged at a one week interval to the model predicting weekly hours of Internet use (see Column 3 in Table 5). Controlling for hours using the Internet in the prior week and other control variables, this analysis estimates whether exceptionally heavy or light e-mail or Web use in a prior week changed the total number of hours participants used the Internet in the subsequent week. The results here show that when participants sent or received more e-mail than their average during one week, they logged into the Internet for more time than was usual for them during the next week. By contrast, following weeks in which they used the Web more than average, participants reduced their subsequent hours of Internet use ($\beta_{\text{e-mail}} = 0.10$ versus $\beta_{\text{Web}} = -0.04$; difference t = 2.8, $p < 0.05$).

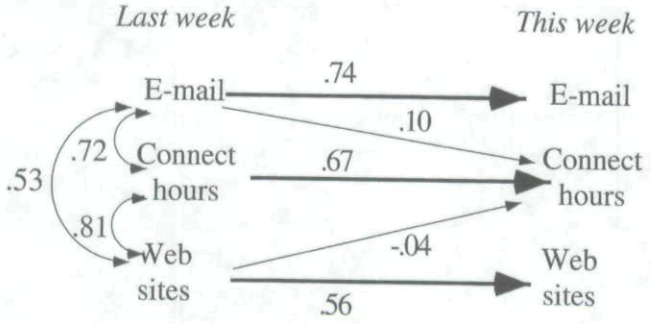
Figure 4 summarizes the relevant coefficients from Table 5, showing the relatively stability of e-mail and Web use and their influence on subsequent hours using the Internet.

Survival of Internet Use

We conducted a survival analysis to test our hypothesis that people who heavily use e-mail will be more likely to continue using the Internet than those who use the Web heavily. This analysis uses data from 179 individuals—all respondents who filled out a pretest questionnaire, who used the Internet at least once, and who remained in the field trial for at least 52 weeks with a HomeNet computer in the household.[7] The dependent variable in this analysis is duration of Internet

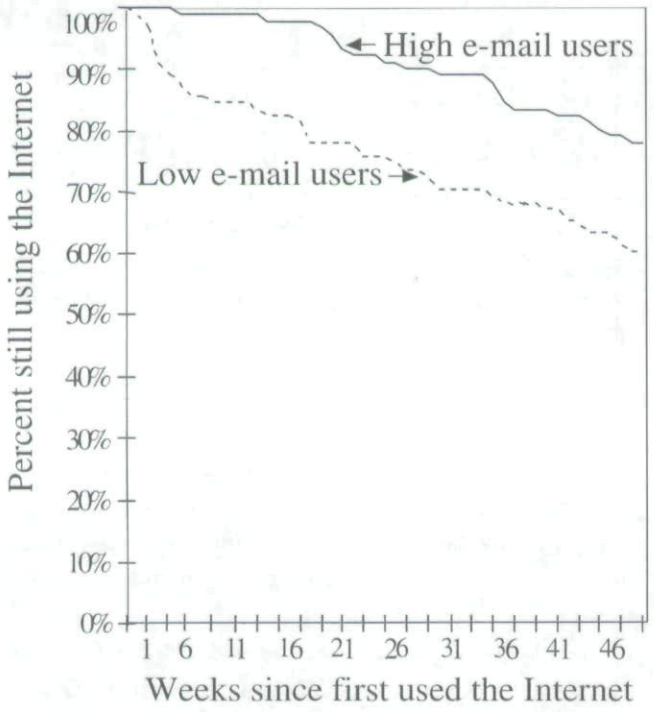
[7]We cannot test for survival on the Internet among participants who never used the Internet. Other participants were dropped from this

Figure 2 **The Influence of E-Mail Use and World Wide Web Use on Subsequent Internet Use**



Note. Numbers are standardized beta weights.

Figure 3 **Survival on the Internet by Use of Electronic Mail**



Note. The sample was divided by median split into those for whom e-mail was a comparatively high or low percentage of all their Internet use. N = 179.

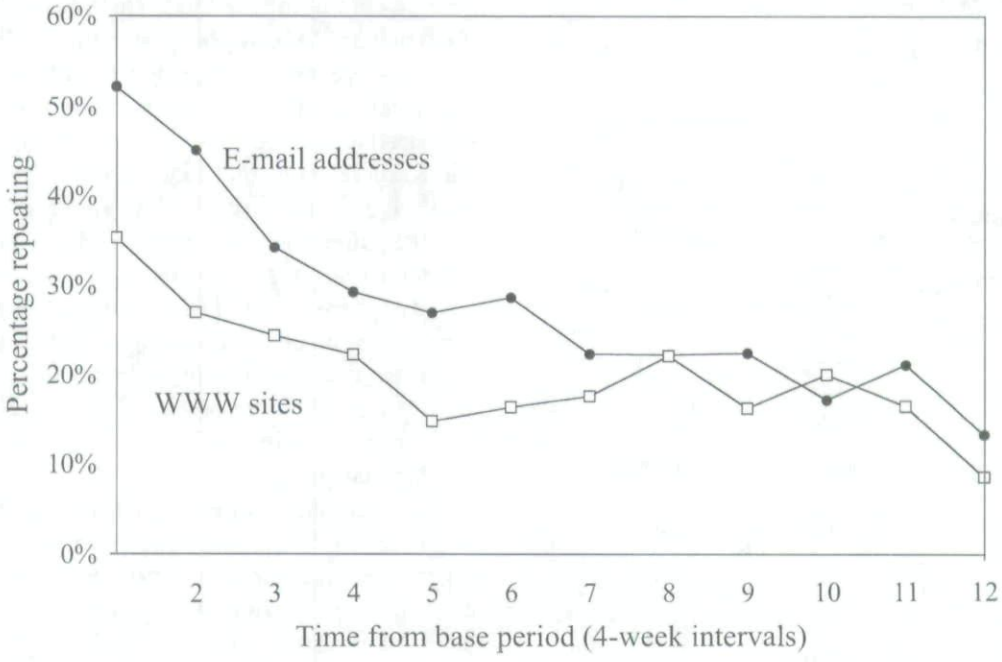
analysis because they left their household (e.g., through marital separation or leaving for college) or because the household computer left the household (e.g., a student took the computer to college).

use, that is, the number of weeks from a participant's first use of the Internet to their last use. We considered a participant to have stopped using the Internet during their first year if we recorded no Internet activity during weeks 49 through 52. Because the data are right censored at 52 weeks, we used a survival analysis with the Kaplan-Meier method to examine whether greater relative e-mail use (vs. Web use) led to longer survival on the Internet and whether these effects differed among different subgroups. We created an e-mail ratio as a measure of relative e-mail use. We standardized e-mail use (number of messages sent and received) and Web use (the number of websites visited), divided e-mail use by the sum of e-mail and Web use, and then separated participants into low and high e-mail users on the basis of a median split.

The main analysis examined the effects on survival of low or high relative e-mail use, gender, generation, sociability, and the interaction of the e-mail ratio with the other individual differences. We included computer skill as a covariate. Preliminary examination of the survival distribution suggested that an exponential distribution best modeled the survival data; that is, the hazard rate (or instantaneous drop-out rate) for the total sample was constant over the year we examined. Figure 3 shows a plot of the proportion of high and low ratio e-mail users who continued to use the Internet during their first year on the Internet. The ratio of e-mail use had a large effect on survival (Hypothesis 5). Seventy-eight percent of the high ratio e-mail users were continuing to log on to the Internet after a year, compared with only 60% of low ratio e-mail users (Log-rank chi-square = 8.6, $df = 1$, $p = 0.003$). The high ratio e-mail users had an average duration on the Internet of 44.5 weeks, compared with 37.8 weeks for the low ratio e-mail users. A disproportionate number of low e-mail users dropped out early, within two or three months of trying the Internet. After four months, the gap between low and high e-mail users did not grow.

A linear regression analysis of the survival data, taking into account the exponential survival distribution and right censoring, allows us to test whether individual differences interacted with the relative e-mail index to influence duration of Internet use. We ran models using an exponential distribution and included participant's pre-Internet computer skill as a covariate. Results again show that participants who used e-mail

Figure 4 **The Probability of Returning to an E-Mail Address or Url in Subsequent 4-Week Periods**



relatively more than the Web survived longer on the Internet, even after controlling for relevant individual differences (Estimate = 0.445, $\chi^2 = 9.32$, $p < 0.01$), that those with more initial computer skill also survived longer on the Internet (Estimate = 0.252, $\chi^2 = 3.66$, $p = 0.055$), and that compared to teenagers, adults survived longer on the Internet (Estimate = 0.31, $\chi^2 = 3.98$, $p < 0.05$). However, the effects of high e-mail use did not differ for teens versus adults, women versus men, and more sociable versus the less sociable people (for the interactions, all ps > 0.30).

Loyalty

One reason that electronic mail use may be more popular and stable than Web use and may lead to longer survival on the Internet is that the messages people send and receive by e-mail sustain dialogues and ongoing relationships with family, friends, and coworkers. These dialogues and relationships tend to be unbounded; that is, they often extend beyond the electronic medium and have no a priori stopping time. Participants described a variety of people with whom they had relationships: grandparents, members of the soccer team, teachers, people they met in chat groups. Even in the absence of standing relationships, dialogues have an obligatory character that helps to make them self-perpetuating. It is considered rude to fail to respond to a message. By contrast, using the Web often satisfies a bounded goal, such as searching for product information prior to a purchase. Completing the task may even exert negative incentives for revisits, as with a game already downloaded, a weather report already obtained, or homework already done. We tested this idea by examining participants' loyalty to e-mail addresses and websites over time.

For this loyalty analysis, we divided the 52-week data into 4-week intervals. We examined the probability that each e-mail address to which participants sent a message or each Web domain or site they visited during any interval would be repeated in following intervals, for up to 12 intervals following the first period. Figure 4 plots the loyalty rate—the number of e-mail addresses or Web domains in common in an earlier and subsequent period, divided by the total number of e-mail addresses or Web domains in the two periods. Participants were three to five times more likely to repeat e-mail addresses than website domains. At

each interval, the loyalty rate for e-mail was significantly higher than the loyalty rate for Web domains (*t*s range between 2.71 to 7.33; all *p*s < 0.01). These results lends indirect support to our argument that e-mail sustains dialogues and relationships, hence brings people back to it (Hypothesis 6).

It is possible that people are more loyal to e-mail addresses than to websites only because World Wide Web addresses go out of date more rapidly than electronic mail addresses. We believe this explanation to be implausible because we found that e-mail addresses were more stable than Web addresses, even when we defined a Web address to be its most permanent attribute—the domain, which is the computer on which the resource is located. However, we have not explicitly tested this explanation, which would require tracking samples of addresses of both kinds over time.

Individual Differences and Social Influence

Many of the individual differences that predicted overall hours of Internet use (see Table 3) also predicted use of e-mail and the Web separately (see Table 4). Here we highlight the exceptions. First, as compared with males, females used e-mail more and the Web less and the difference was significant (Hypothesis 7). There was a tendency for this same relative preference of e-mail over the Web to be greater for teenagers than adults ($p < 0.10$). More sociable people (as measured by the personality measure we used) did not show a particular preference for e-mail compared to the Web.

Participants used the World Wide Web more during weeks when other family members were using it; presumably use within the family spread as family members communicated with each other about the interesting sites they found (Hypothesis 8). However, there was no family influence on the amount of e-mail participants exchanged. The personal nature of e-mail communication may partly account for this effect. The difference between the family-influence coefficients for e-mail and the Web was not statistically significant.

Discussion

HomeNet participants, in the 1995–1997 period of the evolution of the Internet, showed a strong preference for interpersonal communication to information and entertainment in their first year of using the Internet at home. They used e-mail in more Internet sessions and used e-mail first in sessions where they used both e-mail and the Web.While their use of both e-mail and the Web decline with time, the decline was sharper for the Web. Their use of e-mail was more stable from week to week than was their Web use. Their use of e-mail at one time led to their increased Internet use later, whereas their use of the Web reduced their subsequent use of the Internet. Furthermore, those who used e-mail more heavily were less likely to discontinue using the Internet.

We found only weak support for our hypothesis that e-mail would be especially popular with subgroups that value interpersonal communication traditionally. Those who were measured as especially sociable did not prefer e-mail more than others. Teenagers were heavier users of e-mail than adults, but they were also heavier users of the Web. Only in the case of gender were our expectations met. Females were heavier e-mail users than males, even though they were lighter users of the Web. The survival analysis did not show that any of these subgroups gained more than others by virtue of their high relative e-mail use. One unexpected finding was that people's self-reported computer skill before they ever began the trial was a major predictor of their use of the Internet and their survival on it. The need for others' guidance may explain why use of the Web by other family members predicted Web use. E-mail also helped people persevere, we think, shown in the gap of Internet survival between relatively high and low e-mail users.

Although our analyses point to strong conclusions for this sample, they should be examined further before generalizing to the population of future computer purchasers. We did not select participants randomly, but instead invited groups with existing ties. Furthermore, we gave participating households computers and access to the Internet to overcome initial economic barriers to trying them. One way our participants' behavior differed from that of existing computer purchasers is that their income and education did not predict their Internet use (see Kraut et al. 1996).

The HomeNet trial for this sample also was conducted during a period of technological ferment on the Internet. The Web now offers greatly enhanced facilities for online shopping, which may encourage more

time using the Web. Also, recent technical advances in Internet telephony and real-time interactive gaming suggest that new forms of synchronous interpersonal communications on the Internet might take place through these facilities. Based on the historical elasticity of communication, which stems from its support of reciprocal, ongoing relationships, we suspect people will add these communication services to their asynchronous communication using e-mail. A 1998 national sample poll of Internet users (America Online 1998) cited 87% of respondents as saying they communicated online with friends and family; 67% said they would choose an Internet connection over a television or telephone if stranded on a desert island; over half said they preferred using e-mail to communicate with business associates to using the phone or postal mail. Future studies like this one that provide detailed accounts of Internet use over time will help us anticipate these trends and understand why they are taking place.

We argued that one reason people have greater loyalty (i.e., higher return rates) to e-mail addresses than to Web domains is that e-mail sustains ongoing dialogues and relationships, whereas Web information has more bounded properties, in which the goal is satisfied with one or a few visits. In the abstract sense, this is an argument that the Internet is a social and emotional technology (Sproull and Faraj 1997), and that it sustains social networks (Wellman 1997).

Interviews with participants in our study suggest that most (but not all) of the time, the relationship preceded use of the Internet, and e-mail was just one mechanism people used to maintain it. Adults bought their parents computers so that they could add them to their set of electronic correspondents; people put their e-mail addresses on their Christmas greetings to prompt more communication with infrequent partners. Our quantitative findings, showing heavier use of electronic mail (but not the World Wide Web) when school was in session, suggests that seeing potential correspondents prompts e-mail exchanges. This behavior suggests that e-mail can create what economists call "network externalities," where additional users of a product or service increases it value to others, and eventually the snowballing of value makes the product or service universal (Shapiro and Varian 1998). Network externalities may cause e-mail to become an embedded and virtually necessary household technology for communication. As such, it might not only sustain many existing relationships, but rekindle old ones, start new ones, and support group communication that telephones do not support well.

Our analyses did not explicitly examine group communication through listservs, newsgroups, chat services, MUDs, or IRCs (Internet Relay Chat). Our interviews, however, suggest that electronic groups may be the primary mechanism by which people start new relationships online. In most (but not all) cases, the new relationships we learned about in our interviews were maintained exclusively through the Internet. A movement from public group communication to private e-mail communication was common in our interviews. One woman in the sample received and offered advice about the care of her rabbits over a newsgroup about exotic pets that she called "the bunny line." She struck up an e-mail correspondence with a school teacher from Texas, with whom she discussed her family and problems at work. Another woman struck up a casual friendship with a woman she met in a mitten exchange on a knitting newsgroup. One teenager boy met his high school prom date on a chat service on America Online, and a teenage girl, who had never dated, started dating a boy she met over a chat service.

Researchers could explore, perhaps in a laboratory setting, a more cognitively-oriented hypothesis for people's preference for, and loyalty to, e-mail. It is possible that, relationships aside, e-mail is psychologically interesting because it contains partial information and personally-relevant reinforcement that people are curious to explore further. Each message is incomplete by itself and, like a soap opera, is "continued in the next episode." Stimuli like these can be powerfully motivating. E-mail, like other conversation, is highly dynamic and changes with every message. It is also a partial reinforcer across time, because new messages don't always show up when people look for them. As such, e-mail would be highly resistant to extinction, to use the terms from psychological learning theory. When e-mail does not arrive, people may send new messages ("Where are you?") and later look again.

Our analyses should not be read as meaning that

interpersonal communication was the only resource of value on the Internet for participants in this trial. Some participants continued to use the Internet for over a year while sending or receiving virtually no electronic mail. The Internet is a portal through which people have access to a rich array of other people, information, and experience; interpersonal communication is a primary goal, we think, but not the only one and not for everyone.

Implications for Social Impact, Technology Design, and Policy

The diffusion of the Internet has the potential to further open up the household to influences from the larger society and bind the household to it. Many scholars treat the household as a relatively encapsulated unit of production of children, household labor, and socialization. Although household members participate in other institutions in society, such as the educational system and the employment system, in contemporary America, they often travel from their homes to do so. In contrast to earlier times and to other cultures in which households were the location of an extended family, in twentieth-century American society households typically represent a single nuclear family or even a single person. Indeed, the average household size in the United States has been declining over the past century (U.S. Bureau of the Census 1975, 1996). Given the encapsulated nature of the household, mechanisms that bind it to the large society are especially important. The Internet adds a new entry in the list of older mechanisms such as the telephone, postal mail, TV, radio, and newspapers, all of which import communication and information into the household.

Our analyses suggest that people in households will use the Internet for interpersonal communication. If this proves to be the case, the eventual social impact of the Internet may well be more important in the domains of work, school, and family interactions than in the commercial domains that are so much emphasized in the press today. Medical, library, and government applications that will be most popular may be those that provide ways for patients and clients to talk with one another and with providers, although interactive, dynamic, automated services may be popular too.

One of the most important issues concerns whether people's interests and commitments will become more global. A traditional question about distance-spanning technologies like the radio, telephone, car, and now the Internet is how they change people's commitment to the local geographic community. Today, this commitment in part will depend on the extent to which people use the Internet to communicate with friends and family within their local communities or with relative strangers who are geographically distant. Our data say that both are happening, although the balance may change with time (see Kraut et al. 1996 for a preliminary analysis of this issue).

Computer scientists and entrepreneurs see the challenges and opportunities in the Internet in the burgeoning amount of multimedia data that the Internet makes available to its users and the Internet's use as a vehicle for retail sales. Services for finding people are far less common, sophisticated or accurate than services for finding information and products. Online directories of e-mail addresses are far less comprehensive than online directories of telephone numbers. Search services on the Internet, like Yahoo, Alta Vista, InfoSeek, and Lycos grew from sophisticated industrial and government-funded research programs in information retrieval; they are well known and heavily used. The initiative on digital libraries funded by the National Science Foundation and DARPA has a goal of making pictures, graphs, and video images as easy to search and retrieve as text. Comparable search capabilities for finding people based on their attributes are far less well supported. (See the research on collaborative filtering, e.g., Resnick and Varian 1997, for an interesting exception.) Our data suggest that current design initiatives are imbalanced with respect to what people really want.

Information and entertainment perspectives also have dominated policy debates. For example, the Federal Communications Decency Act of 1996, struck down by the U.S. Supreme Court (1997), was concerned with children's exposure to pornography over the Internet. The massive investment in Internet connectivity for libraries and schools by private foundations and by local and federal governments gives privileged status to the information facet of the Internet. In contrast, public policy discussion about issues relevant

to interpersonal communication has been scant. For example, consider the issue of universal access. In the first half of the twentieth century both the industry and the federal government instituted policies to foster universal access to telephone service through subsidies of residential phone subscribers or rural phone subscribers by urban ones. One goal was to make the telephone network more useful for the nation as a whole by capitalizing on network externalities (Katz and Shapiro 1994). We do not prejudge whether universal electronic mail is critical, but it should be discussed because it may have benefits to the nation comparable to those of universal phone service. We believe that public debate about the desirability of universal access to electronic mail and policy to achieve it would be very useful. Anderson et al. (1996) represents one of the few policy analyses of this issue of which we are aware.

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