

Robert Kraut, William Scherlis,
Tridas Mukhopadhyay, Jane Manning,
and Sara Kiesler

The HomeNet Field Trial *of Residential Internet Services*

*What compels ordinary citizens to log onto the Internet?
What social factors predict their Net behavior?
Teens are the heaviest users, and communication
keeps them coming back for more.*

HOMENET IS AN EMPIRICAL FIELD TRIAL OF residential Internet use whose goal is to increase our knowledge about the use and impact of residential electronic services. It uses longitudinal data collection techniques to study families' online behavior over time. This article is an early attempt to describe how ordinary citizens use the Internet and explore their motivations for doing so.

OUR PURPOSE HERE IS TO DESCRIBE HOW AN initial sample of nearly 50 families with teenagers behaved in the first year of the trial and the variables that predicted their Internet use. A major finding is that, in this group, social demographics—generation, race, and gender—rather than socioeconomic factors—income and education—and psychological factors—like social extraversion and attitudes toward computing—were major influences on use. Despite improvements in usability, participants still need computer skills and help to use the Internet. Interpersonal communication (email), rather than broadcast information (the Web), is the main motivation of further use.

The results have implications for design (e.g., provide more help for adults getting started), for marketing (e.g., realize lower-income people have as much desire for online services as upper-income people), and for research (e.g., understand why teenagers lead family computing). For example, “I really want to move to Antarctica. I’d want my cat and Internet access and I’d be happy.”—16-year-old HomeNet participant.

Into the Home

Computers are moving into homes. By 1995, computers for the home represented more than 50% of PC sales; by 1996, approximately 37% of U.S. households had computers. The Internet and online services (e.g., America Online) continue their vigorous growth. Yet we lack an understanding of the changes taking place. In particular, we know little about which electronic services are valuable to people across incomes in diverse communities. Our knowledge of electronic services in general and the Internet in particular is based mainly on the behavior of predominantly upper-income, white male professionals who bought and used computers and electronic services in the past (e.g., [15]).

Our research presumes that as computers become cheaper and online services easier to use, future users of these services may well be unlike current users.

Therefore, we set out to investigate how a broad sample of people would use and value electronic services.

The HomeNet project is based on a service model with low barriers to entry. Starting in March 1995, we lent families a computer, or if they preferred, sold it to them at half price. Each family also received a 14.4-Kbps modem and an extra telephone line as well as full Internet accounts for each family member above age eight who wanted one. We simplified Internet access; all computers included a turnkey system—for access to the entire Internet, including newsgroups, the Web, email, multiuser domains (MUDs), and special HomeNet newsgroups. Our software configuration allowed family members to use Internet services without learning the details of any operating system. Their Internet services were individualized by, for

example, providing each family with a Web starting page that pointed through links to information sources tailored to its members' identified interests. They received approximately three hours of training. We also offered online support through a help newsgroup, email, and an evening telephone help desk staffed by college students.

We recruited the first sample of 48 families through the public high schools of four demographically diverse neighborhoods in Pittsburgh, Pa. In each school, we recruited students working on the school newspaper and their families, as well as at least one journalism teacher and the teacher's family. The common bond of journalism gave students from different schools something to discuss as we put the project online. Whereas the HomeNet sample was not intended to be representative of the U.S. population, it is more diverse than existing Internet demographics (see Table 1).

Data Sources

The HomeNet project uses five sources of data:

- Computer-generated use records of electronic traffic, newsgroups read and posted to, Web

Table 1. HomeNet sample characteristics

Variable	Sample Description
Number of families	48
Number of family members	133
Generation	42% under 18 years old
Gender	57% female
Race	24% minority
Family income	25% under \$35,000/year

Major influences on Internet use: social demographics—

generation, race, and gender—rather than socioeconomic factors—income

and education—or psychological factors—like social extraversion

and attitudes toward computing.

sites visited, and time on the Internet

- Pretrial, bimonthly, and posttrial questionnaires
- An archive of HomeNet newsgroup messages
- A log of help requests
- Home interviews

The analyses reported here rely mainly on the computer-generated use data, in-depth interviews with 14 families, and the pretest questionnaire completed by 133 people.

Hard to Start

Even the easiest-to-use computers and applications pose significant barriers to the use of online services. Nearly 20% of the HomeNet sample had never used a computer. (At the other end of the spectrum, 20% were using a home computer at least once a day.) Getting started was a major problem for many families. Even with help and our simplified procedure, HomeNet participants had trouble connecting to the Internet for a variety of reasons, including bad telephone lines and busy signals, passwords forgotten, misunderstood user interfaces, depressed shift-lock keys on keyboards, erased login scripts, and buggy software.

Many participants lacked clear models of how components of the overall system operated and could not diagnose problems. Some participants blamed themselves for problems caused by software bugs or over-taxed servers. Their problems were more likely to be solved quickly if other family members or friends were more sophisticated than they or if they felt comfortable revealing their ignorance to the strangers on a help desk. (Giving up was associated with *not* calling the help desk.) Teens typically became the most skilled computer users in their families, but they were sometimes reluctant to share their expertise with their parents. Almost 70% of the families needed consultation with our telephone help desk before they got online. The frequency of help requests declined as families got started (or gave up) and as participants became more skillful at navigating the Internet.

Aggregate Use Strong, But Varies Widely

Of the 133 individuals who received Internet accounts and filled out pretrial questionnaires, 92% logged into the Internet, that is, dialed in to the HomeNet server, from home at least once during the first 55 weeks of the trial; participants logged in during an average of 28 weeks. Internet use was initially strong but fluctuated with time. During the first 18

weeks of the trial, approximately 59% of the participants logged in at least weekly. Use declined to about 44% during school vacation but rose again to 49% when the school year resumed.

Figure 1 shows the mean hours per week that teenagers and adults logged on to the Internet. Use differed by both generation and gender. It was also highly skewed, with many people showing moderate use and a small number of individuals using the Inter-

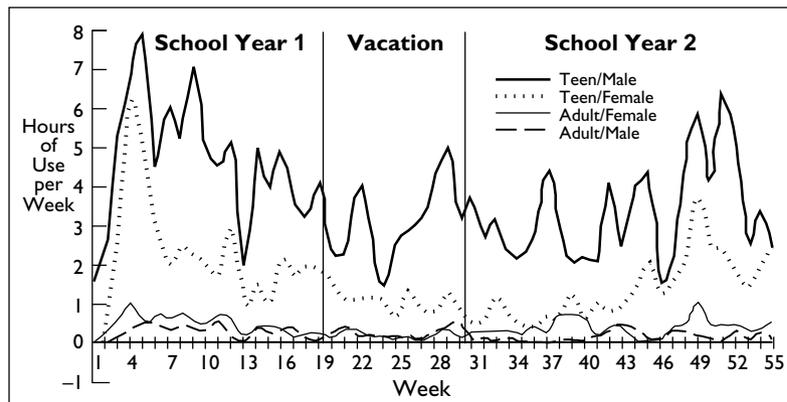


Figure 1. Mean hours per week connected to the Internet (by gender and generation). (Note: To compensate for skewed data, entries are Winsorized means of data from the middle 80% of the sample.)

net extensively. For example, the median teenage boy used the Internet at least once per week during 43 of the first 55 weeks of the trial and accumulated more than 320 hours of connect time, while the median adult male accessed the Internet during only 20 weeks and accumulated less than 32 hours. Some participants, mainly teenagers, logged in multiple times per day, and about 10% of the sample averaged more than 7.5 hours per week. The heaviest user averaged 35 hours of use per week. Among the teenagers, males were much heavier users than females; among adults, the sexes differed little.

Teens Lead

There was a significant correlation ($r = 0.54$, $n = 48$, $p < 0.01$) between the use of the heaviest user in the family and the average use by other family members. In 41 of the 48 families, the heaviest user was a child, and such use predicted use by both siblings ($r = 0.43$) and parents ($r = 0.42$). Our interviews suggest that in these families, teenagers' enthusiasm motivated other family members to use the Internet, and their skill helped them overcome barriers. Because so few adults were heavy users, we cannot tell if their use also influenced that of their spouses or children. (Next year, we will report comparative results from a new sample of families with adults motivated to use the Internet for community organizing purposes.)

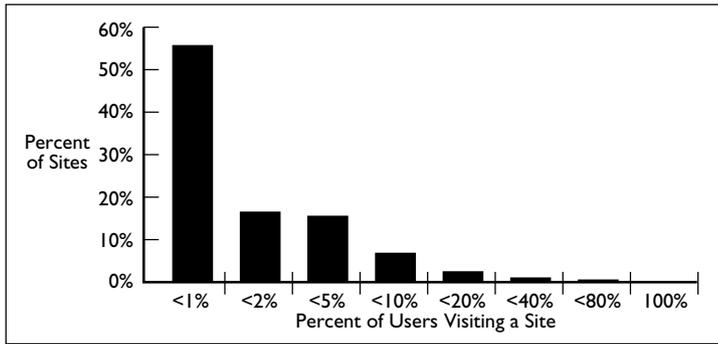


Figure 2. Popularity of various Web sites

Appeal of Niche and Mass Markets. Discussion of the Internet tends to emphasize either broadcast information services, especially the Web, or interpersonal communications services, especially email [13]. However, changes in software and people's behavior blur this distinction. People learn to be their own broadcasters using the Web. They post information to newsgroups in response to something they saw on a Web page or look up a Web site someone told them about through email.

Table 2. Measures of weekly Internet use and their correlations

Measure	Mean	Standard Deviation	Correlation with Logins	Correlation with Connect Hours	Correlation with Messages Sent	Correlation with Messages Received
Number of different occasions per week an individual logged on the HomeNet server to access the Internet (logins)	1.5	1.2	0.75	0.65	0.55	0.45
Total hours connected to the Internet (connect hours)	1.5	1.2	0.65	0.75	0.55	0.45
Number of electronic messages sent to individuals (email sent)	1.5	1.2	0.55	0.55	0.75	0.65
Number of electronic messages received that included the participant in the to-field (email received)	1.5	1.2	0.45	0.45	0.65	0.75
Number of electronic messages received that did not include the participant in the to-field (listserv messages read)	1.5	1.2	0.45	0.45	0.45	0.65
Number of Usenet messages accessed (newsgroup messages read)	1.5	1.2	0.45	0.45	0.45	0.65
Number of Web IP addresses visited (Web sites visited)	1.5	1.2	0.45	0.45	0.45	0.65

We find that these conceptually distinct services are complementary. HomeNetters using interpersonal communications services were also likely to use information services and vice versa; both kinds of use predicted the number of logins to the Internet and the number of hours spent there. Table 2 shows descriptive statistics for various measures of weekly Internet use (averaged over 55 weeks) and their correlations. These measures include the number of different occasions per week an individual logged on the HomeNet server to access the Internet (logins); the total hours connected to the Internet (connect hours); the number of electronic messages sent to individuals (email sent); the number of electronic

messages received that included the participant in the to-field (email received); the number of electronic messages received that did not include the participant in the to-field (listserv messages read); the number of Usenet messages accessed (newsgroup messages read); and the number of Web IP addresses visited (Web sites visited). Because use was skewed, these counts were converted to logarithms before the correlations were calculated. The average correlation is high, indicating that HomeNet participants who used any Internet service used most of them—email, listservs, newsgroups, and the Web.

HomeNetters visited nearly 10,000 Web sites, but the modal Web site appealed to only one participant in the sample, implying that beyond a few highly popular services, people look for (and find) specific, or niche, services matching their idiosyncratic interests. Figure 2 shows the distribution of Web sites visited by different proportions of the sample during the year. Of the 9,912 unique IP addresses visited, 55%

were accessed by only a single individual and less than 2% were visited by 20% of the sample. Usenet groups show a similar distribution. Of the 2,664 different newsgroups that HomeNet participants read during the year, 629 were “followed”—accessed at least three or more times by at least one user. When this subset of newsgroups is

ranked by number of followers, 76% were followed by just one user and only 9% were followed by three or more users. HomeNet participants posted to 202 different newsgroups.

The niche services appealing to one or two people reflected the people's personal interests and were extremely varied. Newsgroups ranged from those associated with hobbies (e.g., needlepoint) to religion (e.g., Jewish culture) to professions (e.g., tax preparation).

A few Web sites and newsgroups were popular with nearly everyone. The most frequently accessed Web services were directories and indices, including Yahoo and Lycos, that allow users to search and

browse the Web. Sites providing information about popular culture, such as sports and entertainment, were also broadly popular. Men visited sites that provided information about Pittsburgh's sports teams—Penguins, Pirates, and Steelers—and teens downloaded cartoons and songs from rock groups. A few Usenet groups were very popular. One mother and her teenage daughter regularly participated in a newsgroup to keep up with the soap operas they missed. Participants looked at sexually oriented newsgroups, such as the alt.sex.* hierarchy and the Web sites published by *Penthouse* and *Playboy*. Asked about their children's access to pornography on the Net, parents said they trusted their children to avoid inappropriate content. Some said the sexually oriented materials they personally checked out were no worse than the material available to their children at the corner drugstore.

The Internet is global, but local Pittsburgh and neighborhood information and communication services have special appeal to participants in the trial for two reasons:

- Movie times, bus schedules, scores of local teams' games, and information about social services and community development are typically useful only when local. For example, HomeNet teens from different high schools shared information about which Department of Motor Vehicle testing station gave the easiest parallel parking test.
- Local information services can also appeal to people's social identities. People want to participate in and be part of groups, and geography provides one basis for group formation. For example, teenagers preferred communication forums limited to their own high schools. They complained when their communication areas were "invaded" by interlopers from other schools and asked for controlled-access forums for their own groups.

BESIDES BEING A SOURCE OF INFORMATION, THE Internet allowed participants to broadcast information to others. Six trial participants created their own Web homepages, one touting his high school, another showing off her creative writing. Others exercised their skills and interests through Usenet newsgroups, which were posted to by adults and teens alike. Many teenagers became regular members of virtual groups. Teens who became relatively sophisticated computer users gave advice in the HomeNet help group to strangers in the trial who were having trouble. Several adults shared their pro-

fessional expertise on newsgroups (e.g., an accountant his tax knowledge and a doctor his knowledge of arthritis). Others offered advice on their hobbies (e.g., a woman on raising exotic pets).

Discovering Communication

According to pretrial questionnaires, participants didn't view computers as particularly useful for interpersonal communication. They initially thought their computers would be valuable for such activities as doing schoolwork, supporting jobs, and performing household chores, but not for keeping in touch with friends, coworkers, and family. Yet, as when people discovered the telephone at the turn of the century, chatting quickly became a dominant use of the Internet, especially for teenagers. Moreover, participants' use of email influenced whether they used other services.

Some of the teens discovered communication services allowing them to exchange messages with friends and strangers in real time, including Internet Relay Chat and various MUDs. One girl who had never dated started seeing a boy she met through a chat service. Because of what seemed to be almost addictive behavior among some of the teenagers using the real-time communication services, several parents imposed limits on their children's computer use.

Predictors of Internet Use

We used linear regression analyses to identify the characteristics of HomeNet participants that predict differences in Internet use. Because different use measures are highly correlated, our dependent variable in this analysis is a composite, defined as the average of the standardized use scores for number of logins, connect hours, email messages sent and received, messages to Usenet newsgroups sent and received, and Web sites visited (all in the log scale) during the first 55 weeks of the study.

The predictor variables were measured on the pretrial questionnaires—before participants had Internet access. These variables are grouped into five categories for purposes of analysis:

- Economic and demographic factors
- Psychological or personality dispositions
- Computer skill and experience
- Social environment
- Use of other media

We briefly describe this analysis in the following para-

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—16-year-old HomeNet participant.

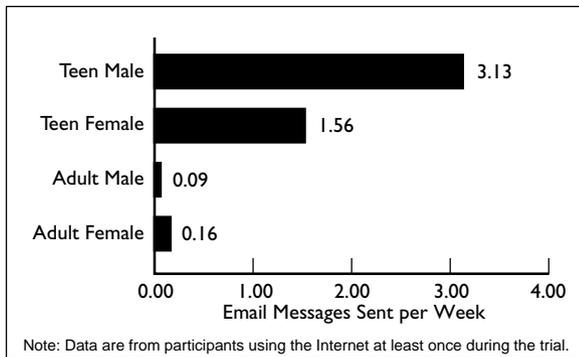


Figure 3. Median weekly email messages sent (by gender and generation)

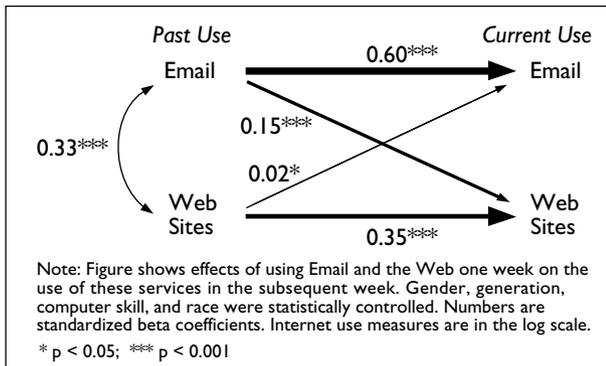


Figure 4. Influence of email and Web access on each other

graphs. (More detail can be found in [9].)

Demographics. Previous research shows that the poor, the less educated, minorities, women, and older people are less likely to use the Internet [1, 14]. In the HomeNet trial, we gave potential users training, a subsidized computer, and free Internet access, allowing us to determine whether past patterns resulted from the availability of financial, technical, and educational resources (e.g., the poor are less likely to have a personal computer, and the poorly educated are less able to master the arcane commands for accessing the Internet). Also considered was whether failure to own a computer resulted from these demographic groups' lack of interest.

We included two measures of social class—household income and household education (average years of schooling of the adults in the household). We also measured race (whites vs. other), gender, and generation (adults 19 years or older vs. other). Finally, we tested whether the effects of gender differ for teenagers and adults by including the gender-by-generation interaction (a variable constructed by multiplying gender by generation).

Neither household income nor education predicted Internet use, strongly suggesting that if economic

barriers were removed, people across socioeconomic lines would use the Internet. By contrast, race, gender, generation, and the gender-by-generation interaction were all strong predictors of Internet use in our sample. For example, whites, males, and teens were more likely to use the Internet than minorities, females, and adults, respectively. Among the teenagers, males were heavier users than females, but this finding was reversed for adults. These effects all speak to strong cultural and social forces influencing Internet use. Of all the variables, generation—the difference between teens and their parents—was the strongest demographic predictor and turned out to be the strongest predictor across all analyses.

Figure 3 illustrates the gender-by-generation interaction, showing the median number of personal email messages sent per week, broken down by generation and gender. (We use the median—half the people above the median, half below—because a few heavy senders seriously skew mean email figures.) As the figure shows, teens were much heavier communicators than their parents. However, the generational difference was much greater for males than for females. Teenage boys sent almost twice as many messages as teenage girls. In cases in which messages were exchanged within the HomeNet sample, almost all of the teenagers' messages went to other teens, whereas the adults communicated approximately equally often to teens (their own children and others) and to other adults.

Psychological dispositions. We measured three psychological dispositions that could be related to people's willingness and ability to use the Internet:

- Innovativeness, [10]
- Depression [11]
- Social extroversion [2]

When these variables are examined by themselves, people who are more innovative ($p < 0.07$) and people who are more depressed ($p < 0.05$) use the Internet more. However, when we control statistically for demographics, the statistical significance of these psychological dispositions disappears. That is, demographic differences among people who are innovative and depressed can account for the association of these personality characteristics and Internet use.

Social environment. Since people spend a lot of time on the Internet communicating, we reasoned they might use the Internet more if they had a more socially supportive environment [6]; bigger social circles, including friends and relatives they talked with; and more friends and relatives using email before the study started. Also, since learning to use a computer

and exploring the Internet consumes time and energy, we reasoned that people would use the Internet less if they were under time pressure [3] or experienced more daily life hassles [7], ranging from the family car breaking down to a child getting sick at school. An analysis of the variables measuring the social environment shows that people with more hassles use the Internet less. However, once we control statistically for demographic characteristics, the statistical significance of hassles disappears.

Computer experience and attitudes. The literature on individual differences in computer performance strongly suggests that people with better computer skills, more computer experience (or years of using a computer), more positive attitudes toward computers and more positive attitudes toward computer applications would use the Internet more. We constructed measures of all four variables. The measure of computer skills was the average of several self-report statements (e.g., “I am very skilled at using computers.”). The computer attitude measures asked respondents to rate the usefulness of home computers across several domains, and the computer application measure had them rate the value of standalone computer

Internet. The text-based nature of most services on the Internet may appeal to people who read for information and entertainment. However, as with most other individual characteristics, the statistical significance of this relationship disappears once we control statistically for demographic characteristics.

Combined model. We constructed a combined model predicting Internet use in our sample, including only the variables from the previous analyses that significantly predicted Internet use. This analysis shows that in the HomeNet sample, the demographics of generation, race, gender, and gender-by-generation interaction were the major predictors of Internet use. Once these factors were controlled for, computer skill was the only individual difference that independently increased our ability to predict an individual’s Internet use. Some of the personality, environment, and interest differences among participants—particularly their innovativeness, depressiveness, freedom from hassles, and reading of books—partly mediate the link between demographics and Internet use, but they do not explain all differences among demographic groups.

Whereas knowing that demographics predict

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applications (e.g., word processing, spreadsheets, and games) and networked applications (e.g., email, newsgroups, and file downloading).

People with more pretrial skill use the Internet more, an effect that remains even after controlling statistically for demographic differences ($p < 0.07$). Holding skill constant, neither years of computing experience nor perception of usefulness of computers or applications were related significantly to participants’ use of the Internet.

Use of other media. The Internet may compete with such media as books, telephones, newspapers, and television. To examine the possibility that pretrial reading or television watching predicted Internet use, we measured the times per week participants used a home telephone, read a newspaper, read a book, listened to music, and watched television.

People who read books are more likely to use the

Internet use might be sufficient for marketing purposes, it is unsatisfying from a scientific perspective. What is it about teenagers in general—white teenage boys in particular—that makes the Internet so appealing to them? One possibility is that our sample, selected to target teenagers’ families, might have wanted Internet services mainly to give their college-bound children a step up (many of the seniors did, in fact, go to college). That goal could have affected family use, especially that of the adults. Or it might be that Internet content, which was mainly constructed voluntarily by young white males, is mainly attuned to the interests of young white males. Or is it that young white males can get more of the necessary skills and technical support from their peers? We expect future analyses of changes over time (and of a second sample of mainly adult families) will help us choose among these possible explanations of strong demographic effects. For example, we will be able to track

in periodic questionnaires how skills have changed and thus test how competency changes affect use.

Developing the Internet Habit

The best predictor of people's behavior is often their past behavior. In the case of the Internet, it is very likely that people's experiences influence their subsequent use. Successful or enjoyable experiences could cause them to return to the Internet; disappointments could drive them away. We set out to learn if the HomeNetters' use of the Internet at a particular time would predict their use of the Internet at a later time. The goals in this analysis were to assess the stability of email and Web use and to determine their generality—whether use of one drives use of the other. These are important issues if we want to establish whether a particular type of service hooks people into stable or frequent Internet use.

Time series analyses allowed us to examine the stability of Internet use. We asked whether using email and the Web one week caused people to return to them in the subsequent week. In a regression equation, we examined how well each week's Internet use predicted use during the next week, summed over all weeks of the trial. We conducted these analyses separately for email (defined as number of personally addressed email messages sent and received) and Web use (defined as number of unique IP Web addresses visited).

We also examined the generality of Internet services by testing whether email led to Web use or vice versa. If experiences with particular services generalize, the quality of a person's experiences on the Internet in any week could cause him or her to return to the Internet or abandon it, not only for the service that generated the experience but for other services as well. For example, poor Web experiences can spill over to taint email use, or failure to receive email one week can depress use of the Web. Using a time series analysis, we tested how well each week's email use predicted the next week's Web use and how well each week's Web use predicted the next week's email use. All time series analysis controlled statistically for demographic and individual characteristics influencing the overall level of use.¹

Our results show that email use is the experience that kept trial participants returning to the Internet (see Figure 4). The arrows in the figure (thickness indicates statistical weight) show that email use is self-reinforcing and particularly stable; that is, a particu-

lar week's usage predicted the following week's usage. Moreover, one week's email use significantly predicted the following week's Web use, even when the previous week's Web use was statistically controlled. Web use was moderately stable, but reliably less so than email use. More surprisingly, heavy Web use one week barely predicted email use the following week.

We speculate that email brings people back to the Internet more consistently than Web use for several reasons. First, the messages people send and receive by email constitute dialogues. Unlike visits to the Web, the dialogues carried on by email are integral to social relationships—with friends, family, distant relatives, acquaintances, and coworkers. Relationships are generally more stable than school or work tasks, games, curiosity about a particular hypertext link, or even personal interests that cause people to use the Web. Since people usually wish to sustain relationships, they also want to continue dialogues. Even in the absence of long-term personal relationships, dialogues have an obligatory character that helps make them self-perpetuating. It is rude to fail to respond to the messages one receives.

Coming back to check one's email also satisfies curiosity and, in the language of psychology, is a powerful intermittent reinforcer, and hence resistant to extinction. People keep coming back to the Internet to check their email because email is rewarding, but not always present. In contrast to Web pages, email is directed toward them and almost always contains something relevant and personally interesting when it arrives. The content of one's email also usually changes more frequently than the content of a favorite Web site. When email does not arrive, people may send messages themselves and later look again (following the rule that hope springs eternal).

We speculate that email brings people to the Web (but not vice versa) because once a person is using email, using the Web is something one can do at the same sitting. That is, the incremental costs of connecting to the Web after an email session are low. But for many people, the attractions of the Web alone do not warrant the costs of connecting to the Internet.

Conclusion

For 12 months, when ordinary individuals were given access to the Internet from home, 50% of them used it regularly. Teenagers in our sample were central to Internet use at home, often providing the motivation for their parents to try the Internet. Teenagers were often also the heaviest users in their families while becoming sources of expertise within the household and catalyzing Internet use by other family members. If these findings are generally true, the family dynamics that characterize teenagers' interactions within

¹We used the Time Series Cross Sectional (TSCS) package for panel designs from the SAS Institute to carry out these analyses. The sample consists of 54 weeks of data from 129 individuals. Three participants were dropped from the analysis because their data were too invariant. The analyses controlled for individual differences of gender, generation, race, and computer skill, as well as vacation and school year.

families influence the diffusion of home computing.

Although national surveys show that high-income, educated white males dominate the Internet, the HomeNet study shows that once financial barriers are lowered, lower-income, less-educated people are as likely to become enthusiasts. However, race and gender remain associated with Internet use; males (especially teens) and whites are the heaviest users. Unclear is whether these differences result from males' and minorities' attitudes toward the Internet and its services per se or because the Internet's mainly white male users have created a resource environment most attractive to them. (One HomeNet woman complained that there was too much football and too little fashion on the Web.) The bias in Internet resources might change if more women and minorities log on.

HomeNet participants communicated heavily and used a range of information services. Only a few of these services were broadly popular, and the typical Web site visited was visited by less than 1% of the sample. People gravitated toward services addressing their idiosyncratic interests. Communication seemed to drive Internet use, perhaps because email is so personal that it is also central to Internet use in this sample.

The HomeNet project is limited to describing the behavior of a small sample of households and, like most studies on technological change, is being conducted during a period of rapid technological change. As a result, readers should be cautious in generalizing our results to other populations and other times. On the other hand, the HomeNet study is one of the first detailed accounts of Internet use, providing information not available elsewhere. This article is preliminary; later, we will include another sample focusing on family interactions, on dynamic processes, on use over time of different electronic services, and on the impact of Internet use on individuals, groups, and families.

Additional documents about HomeNet are at <http://homenet.andrew.cmu.edu/Progress/>. 

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ROBERT KRAUT (robert.kraut@cmu.edu) is a professor in the Human Computer Interaction Institute and the Department of Social and Decision Sciences at Carnegie Mellon University.

WILLIAM SCHERLIS (scherlis@cs.cmu.edu) is a senior research scientist in the Computer Science Department at Carnegie Mellon University.

TRIDAS MUKHOPADHYAY (tridas@andrew.cmu.edu) is an assistant professor in the School of Industrial Administration at Carnegie Mellon University.

JANE MANNING (jmann@mail.usyd.edu.au) is a database designer at the University of Sydney. She was previously project manager for HomeNet.

SARA KIESLER (kiesler+@andrew.cmu.edu) is a professor in the Department of Social and Decision Sciences at Carnegie Mellon University.

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