Broadband and Older Americans

About SeniorNet

SeniorNet is the world's largest trainer of older adults on computer technology and the Internet with more than 240 hands-on Learning Centers in the United States, as well as affiliates in Japan, Sweden, Britain and New Zealand. A nonprofit organization, founded in 1986, SeniorNet is dedicated to providing education about and access to computers and the Internet to adults over 50 so that they can share their wisdom and knowledge with the world.

SeniorNet also has the largest web site for older adults, at www.seniornet.org, with more than 600 discussion topics, as well as educational and research material. The site provides seniors with up to date information, interactive opportunities, and valuable resources for specific areas of interest to the 50+ population. The web site has won every major Internet Award including "Best Senior Site" for 2001, 2000, and 1999 from Yahoo! Internet Life Magazine, and the 1999 Webby Award (considered "The Oscar" of the Internet).

SeniorNet also does a wide range of research related to older adults and technology, including groundbreaking 1998 research on networked communities funded by the National Science Foundation done in collaboration with Xerox Parc and Institute for Research Learning. Currently, SeniorNet is collaborating with the Sarasota (FL) Medical Center on a National Institute of Health grant to study the usefulness of the SeniorNet program in the rehabilitation of heart attack and stroke victims. SeniorNet is also collaborating with IBM to develop a Web Accessibility Gateway that will allow people with multiple disabilities to easily access the web.

SeniorNet has also developed a uniquely effective curriculum designed specifically for the older adult learner that is used in our 240 Learning Centers. All of SeniorNet's classes are taught by older adult volunteers. Currently more than 5,000 older adult volunteers teach SeniorNet classes in the United States.

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The Age Wave Meets the Technology Wave: Broadband and Older Americans

Table of Contents

Tables and Figures

The Age Wave Meets the Technology Wave: Broadband and Older Americans

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Executive Summary

Two "mega-trends" – the ***technology wave*** and the ***age wave*** – have had enormous impact on American society in the 20th century, and they are likely to have even greater impact in the 21st century. In terms of technology, the introduction of the personal computer and the Internet have changed our daily lives in many ways. Looking forward, the combination of ever-more powerful computers and increasingly ubiquitous high-speed communications networks is likely to bring about even more far-reaching changes. At the same time, the continued aging of the population of the United States is creating an unprecedented set of challenges and opportunities.

The purpose of this paper is to explore the intersection of these two trends, and particularly the role that the widespread availability of broadband networks can play in supporting and enhancing the lives of older Americans.

High-speed broadband networks offer several important advantages over slower narrowband networks: First, they make it possible to add high-quality two-way video to today's voice and text communications. Second, they provide instant access to rich multimedia content. Third, broadband's "always on" feature makes communications more convenient and supports a broad range of continuous, unobtrusive monitoring services. Finally, once broadband networks, both wired and wireless, become ubiquitous, users will be able to access any content from anywhere at any time.

While broadband applications will be of value to many segments of society, some applications will be of special importance to seniors. Among the key benefits that ubiquitous broadband networks will offer to older adults are:

- **Enhancing communications with family and friends.** High-speed, always-on networks will dramatically enhance the ways in which people communicate and share their lives on an on-going basis. High quality video will be added to today's voice and text communications providing opportunities for richer interactions. As the physical bandwidth of networks grows, so will the "emotional bandwidth" that will allow families and friends to stay closely connected even if they are geographically separated. Further, as this bandwidth becomes increasingly ubiquitous, it will be possible to maintain these connections from virtually anywhere.

- **Expanding opportunities for lifelong learning.** "Continued learning," it has been observed, "is the real fountain of youth." Current experiments with "e-learning" are demonstrating the potential of online education for older adults, particularly for those with limited mobility. Broadband networks will vastly expand and enrich access to the world of learning for older adults. Online "classrooms without walls" will bring engaging educational experiences to seniors at home, and will help prolong the careers of older workers by providing instant access to continued training in the workplace.
- **Improving the delivery of health care services**. Broadband technology may have the greatest impact on the lives of seniors in the area of health. As people get older, the cost of the medical services they use increases, and as the population of the United States continues to age, our existing health care delivery system is coming under increasing strain. One promising approach to improving health care delivery is a greater use of "tele-medicine" services. Broadband networks make it possible to deliver high quality medical services to older adults, including remote diagnoses and continuous health monitoring, in ways that are convenient for both patients and providers.
- **Supporting independent living**. One of the most innovative uses of broadband networks will be to help people remain independent as they age and become more frail. Research is currently underway to develop an "aware home" that will unobtrusively track the behavior of residents, automatically provide needed services, and call for help when needed.
- **Creating new options for entertainment**. As broadband access grows, so will the range of entertainment options available to everyone, including older adults. Greater bandwidth will expand the opportunities to provide content designed for specific audiences and give individuals the ability to customize the programming available to them.

For these benefits to be realized, a number of barriers will have to be overcome. These include ensuring that new services are easy for older adults to learn and use, guaranteeing that online applications are private and secure, and creating a legal and regulatory environment favorable to the rapid deployment of broadband networks.

The Age Wave Meets the Technology Wave: Broadband and Older Americans

A Day in the Life of Madge – Living in a Broadband World

To get a sense of some of the ways in which ubiquitous broadband networks will enhance the daily lives of older adults, consider the following scenario.

It is the year 2012, and Madge Gunderson is preparing to celebrate her eighty-eighth birthday. As she thinks about this event, she finds it hard to believe that she has lived so long. She is grateful that she is able to continue to live a relatively active and independent life despite several chronic medical conditions, including arthritis, high blood pressure, and a thyroid problem. Madge is also recovering from a moderate stroke that limited her mobility, although she has been able to regain most of her strength with physical therapy.

Madge has lived alone since her husband passed away just over a year ago. After being together for nearly 60 years, she finds it hard to accept that he is no longer part of her life. Just a few years ago they had moved from their long-time home in the Washington, DC, area to this apartment in a senior housing complex in small town on the Eastern Shore of Maryland, an area that they both loved and had visited many times together. One of the chief attractions of the building in which she lives is that it has incorporated a variety of new technologies designed to make life easier for older residents.

As Madge watches the sun glinting on the Chesapeake Bay outside her window, she is glad that she had not gone along with her children's request that she move nearer to them. Although she loves her family, she decided that she did not want to live in Boston to be near her daughter (too cold), or in Seattle to be near her son (too wet). Maybe she'll move someday, she thinks, but not till she gets old.

Staying in Touch

Despite their physical separation, Madge is able to remain in close contact with her family thanks to a constant stream of communication back and forth. As she sits down to breakfast, she picks up a wireless tablet about the size of a pad of paper and scans a list of half a dozen messages that have arrived overnight. She sees that a "video e-mail" message has arrived from her 21-year old grandson who is teaching English in Japan. She could play the message on her handheld tablet, but she decides to watch it on a larger flat panel screen that hangs on the wall in her kitchen. The screen is in fact a normal digital television set containing some additional circuitry that allows it to connect to and interact with other systems through a wireless home network. Using her tablet as a remote control, Madge turns on the wall screen and calls up the message.

Madge is amused to see that her grandson wants to introduce one of his students named Toshio who wants to practice his English skills. His English is less than perfect,

but she is able to follow his description of a kite-flying festival he had participated in. The message then cuts to a few seconds of video of brilliantly colored kites flying in a clear blue sky. Madge likes the image of the kites so much that she replays this segment. She freezes the video on one frame of the kites and sends the image to an electronic picture frame that sits on the kitchen counter, replacing another picture that had been in the frame for the past few weeks.

At the end of the message, Toshio asks Madge if she would be kind enough to send him a message back. She considers using a digital video camera in the room to create a video response, but decides that she doesn't look good enough at this hour of the day to be seen, even in an online message. So she records a short audio message politely thanking Toshio for his message and telling him how much she enjoyed seeing the kites. When she is finished, she sends the message to her grandson for delivery to his student.

As she scans the rest of her message list on her tablet, she sees one from her physical therapist who explains that he has some new exercises that he'd like Madge to try and asks her to schedule an appointment. She links to a calendar showing the therapist's schedule and sees that he has an open slot at the end of the morning. She taps on that time on the tablet's touch sensitive screen, and her name is automatically entered (the system recognizes that it is Madge who is calling and knows that she is one of the therapist's patients).

After going through her messages, Madge shifts to a display of the front page of the Washington Post, which remains a daily habit, even though she rarely reads the printed version of the paper. She scans the headlines and reads a few stories, then calls up a calendar of her activities for the day. She sees that she is scheduled to meet a friend for tea in the afternoon, then tutor a group of second graders in a local after-school program which she does every week. (Madge is convinced that volunteering is good for her health and well being as well as helping the kids she works with.) Since Madge no longer drives a car, her calendar has automatically reserved a ride to her appointments through a local para-taxi company.

Working Together

Madge's calendar also reminds her that she is scheduled to link in a half-hour with her younger sister Jennie who lives in Minneapolis. For the past five years, the sisters have collaborated on doing research on their family history. In the course of carrying out this project, Madge feels that she had gotten to know the Swedish village where her family lived, even though she has never been able to visit in person.

Before connecting with her sister, Madge decides to look at the family tree that they have been constructing and consider where they should concentrate their current efforts. After calling up a display of the family tree on her tablet, she zooms in on the children of a great-great grandfather. She "parks" this image in a corner of her screen so she can share it with her sister during their call.

When the time arrives to visit with her sister, Madge activates her big screen, and then says, "Call Jennie." In a few moments, her sister appears on the screen. After some

small talk about family and friends, they spend the next hour working together on their genealogy project. By the end of the session, they have filled out one branch of the family tree, which both sisters can both see displayed on part of their screens. Madge sometimes forgets as they work together that she and her sister are over 1,000 miles apart.

After saying goodbye to her sister, Madge connects to her physical therapist. Madge occasionally meets in person with the therapist, who works in Baltimore, but they both usually prefer the convenience of "video visits." Thanks to the high quality video link, Madge can watch the therapist demonstrate a new exercise that he wants her to do, and the therapist can watch Madge try the exercise out so that he is sure she is doing it properly.

The reason that the therapist feels the new exercise is important is that he has gotten an indication that Madge hasn't been as physically active in the past week as she had been previously. Madge's apartment is equipped with a "smart floor" that contains sensors that monitor the amount of walking around that she does as well as the speed with which she walks. With her consent, the data recorded by the floor is made available to her doctor and her therapist. The most recent data have indicated that Madge hasn't been walking as much as the therapist would like.

Getting Out

After she eats lunch, Madge is ready to get out of her apartment. As she prepares to leave, she picks up a small paperback-sized device that combines the functions of a phone and a personal assistant. On her way out the door, Madge pushes a button that simultaneously arms an alarm system for her apartment, turns down the thermostat until she gets back and forwards any messages that arrive while she is out to her portable phone.

As Madge rides to town, she gets a call from her granddaughter in Boston who is eager to show her a drawing that she made that morning in school. Since Madge only has her handheld phone with a small video display, she tells her granddaughter that she will look at the picture when she gets home, where she'll be able to see it on her big screen.

As Madge arrives at the school to work with her students, she decides to turn off her pocket phone. All of this technology is helpful, she thinks, but sometimes it's a good idea <u>not</u> to be too connected.

The Technology Wave and the Age Wave

Although this scenario may seem futuristic, most of the applications and devices that Madge uses could theoretically be provided today. Virtually all of the technologies described in this story exist in at least prototype form.

The scenario illustrates the intersection of two great "mega-trends" – the technology wave and the age wave – that both have had an enormous impact on our society in the 20th century, and are likely to have even greater impact in the 21st century. The interplay between these two trends in the future will result in new opportunities for dealing creatively with the aging population of the United States. This report describes these trends and, in particular, the potential benefits that the widespread availability of broadband networks offers older Americans.

The Technology Wave

One of the most distinctive characteristics of the recent past is the rate at which a wide range of new technologies have been introduced and been adopted by a large portion of the population.

Of course, it is not the case that every new technology is eventually acquired and used by everyone. For example, phonographs that played vinyl disks were extremely popular for many years, but never reached 100 percent penetration before they were largely replaced by compact disk players. And while it is no longer unusual today to find a fax machine in a home, it seems unlikely that every home will someday be equipped with a fax machine (at least in its present form). Only a relatively few innovations – such as television, the telephone and the automobile – achieve virtually universal adoption.[1]

It is not always easy to tell which of the new technologies will turn out to be passing fads and which will become mainstays of our daily lives. But it is possible to identify a couple of key trends that are driving the overall evolution of technology and that can help us to foresee the general direction in which technology is going.

From Analog to Digital

The first big trend is the shift from analog to digital media. This trend is driven by the ever-increasing efficiency of digital devices to capture, store and reproduce content in digital form. The personal computer itself is perhaps the most visible example of a digitally-based device, but there are many other examples where the shift is taking place from the older analog media to the newer digital form – from vinyl phonograph records to digital CDs, from film-based to all-digital cameras, from analog to digital television.

The force driving this transition is the ever-increasing power of computer technology that is used to process digital content. Thanks to Moore's Law (that states that the computing power of microprocessors doubles every 18 months), raw computing power continues to

get cheaper and more powerful. These chips are the heart of personal computers that continue to get smaller, more powerful and more affordable,[2] and they are increasingly "embedded" in many other types of devices (e.g., cars, phones, cameras) where they add "intelligence" that makes the digital devices more versatile. As Moore's Law continues to operate over the next decade, computer power will increase more than 100–fold, giving an even greater edge to digital media.

Similarly, technologies for storing digital information continue to get more powerful and less expensive. In less than a decade, the storage capacity of hard disks has increased from a few megabytes (millions of bytes) to several gigabytes (billions of bytes) – a more than thousand-fold increase. Within a decade, storage devices that hold terabytes (trillions of bytes) of data will be common and inexpensive. Solid-state storage devices, such as "flash memory" cards, which are used to store such things as digital music and digital photographs, are also getting cheaper and more powerful. A memory card that is smaller than a pack of matches and can hold more than 100 megabytes of content currently costs less than $60, and the capacity of these devices continues to increase steadily.

The movement toward an all-digital world is also providing a strong impetus for the convergence of media that were previously separate. As one observer has pointed out, "bits is bits," no matter what type of content they encode. Voice, video, text and data can all be stored on the same media or transported over the same networks as long as they are in digital form. This convergence is, in turn, leading to the creation of new systems and services that integrate these media in new ways (e.g., devices that combine a phone and a personal digital assistant or systems that play back either music from CDs or movies from DVDs). Which device or network is used to access which digital content will increasingly be a matter of choice, based on the economics and performance characteristics of the available alternatives.

From Narrowband to Broadband

The second key technology trend – which is to a large extent driven by the first trend, the "digitization of everything" – is the transition of communications networks from slow, narrowband connections to high-speed, broadband links.

Today, virtually all households are connected to the traditional "narrowband" telephone network. The telephone system was originally designed to use just enough bandwidth to carry a person-to-person conversation with an acceptable level of sound quality. The march of technological progress has enhanced the traditional phone system in many ways – today's telephone sets are far more versatile and capable devices; long-distance service has become so inexpensive that distance has become almost irrelevant; an ordinary telephone now provides the ability not only to talk to other people, but to carry out an array of other tasks – making reservations, paying bills, obtaining information on many topics.

More recently, the telephone network has taken on new roles. For example, ordinary phone lines have provided the means for people to instantly exchange documents via fax

machines. Today, dial-up phone lines serve as the gateway to the Internet for millions of individuals. However, for the average consumer at home, the ability to communicate online has been limited to the relatively slow speeds that can be carried over their existing phone lines. Sending digital information over a standard telephone line requires the use of a modem that converts a computer's digital information into the analog signal required by the phone network. Over the past two decades, modems have gotten cheaper and their speeds have increased steadily from 300 bits per second to the current standard of 56,600 bits per second (56.6 kilobits per second or kbps) – an increase in speed of nearly 200 times.

But even 56.6 kbps is slow compared to the megabyte-speeds provided by broadband networks based on technologies such as DSL (that use all-digital phone lines) and cable modems. And the next generation of broadband services will use light to transmit information at ultra-high speeds through fiber optic lines. This technology will provide connections at speeds in excess of 100 mbps, which is more than 1700 times faster than a 56 kbps modem.

These higher speeds make an enormous difference in the convenience with which digital information can be sent and received (see Table 1). For example, a single high-resolution photograph that takes approximately 2 ½ minutes to transmit on a dial-up line can be sent in a few seconds on a broadband network, and in a fraction of a second on an ultra-high speed fiber optic line. An entire full length movie that would take nearly a full day to transmit over a dial-up connection could be delivered in less than 10 minutes over a current generation broadband network and in just a few seconds via a fiber optic line. As these examples illustrate, applications that are simply unfeasible over a narrowband network become relatively easy to provide in a broadband environment.

Table 1
Transfer Times for Different Transmission Technologies

Transmission Technology	50 pages text (250 KB)	High resolution photo (1 MB)	7-minute video (18 MB)
14.4 kbps modem (1996 standard)	2.5 min	10 min	3.0 hr
56.6 kbps modem (2000 standard)	38 sec	2.5 min	46 min
500 kbps xDSL connection	4 sec	17 sec	6 min
1 mbps cable modem	2 sec	8 sec	30 sec
100 mbps fiber optic line	0.02 sec	0.08 sec	< 0.3 sec

(kbps = thousands of bits per second; mbps = millions of bits per second)

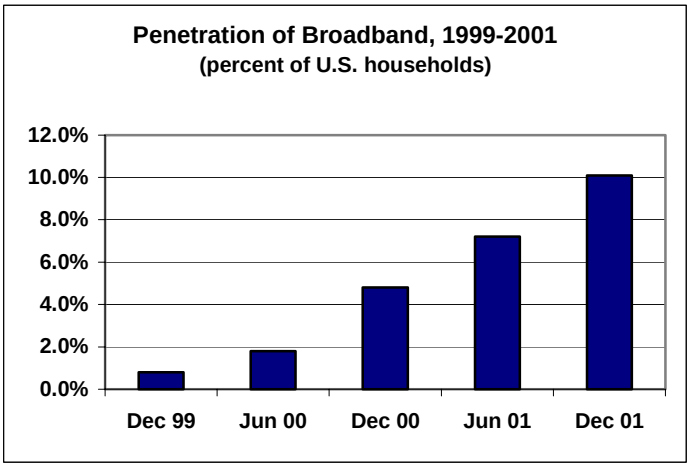
In addition to higher transmission speeds, all-digital networks have another important characteristic: they are "always on." Rather than having to place a call to send or receive a message or find some information, a broadband connection allows such communications to take place instantaneously. It also makes it possible for devices that are attached to a broadband network to continuously exchange information with a remote source, which is useful for all sorts of monitoring applications that can range from simple

security alarm systems to more elaborate systems that will monitor and regulate all aspects of a home.

Broadband Today and Tomorrow

By the end of last year, approximately 10 percent of U.S. households had broadband connections.[3] In December 2001, 3.7 million U.S. households were using high speed digital phone connections (DSL), while 6.7 million households were using cable modems, for a total of 10.4 million households, double the number one year earlier (see Figure 1).

Figure 1

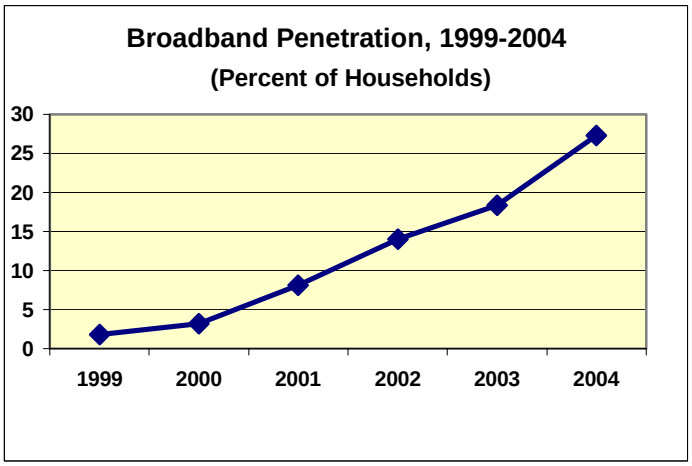


Source: *Fourth Quarter DSL and Cable Modem Update*, Credit Suisse First Boston, April 5, 2002.

Over the next decade, broadband links will become as widespread as narrowband dial-up connections are today. According to the FCC, the number of U.S. households with a broadband connection will increase from 10 percent in 2001 to more than 25 percent by 2004 (see Figure 2).

In the near term, most broadband access will be provided by current-generation technologies such as digital phone lines and coaxial cable. In the future, however, wireless broadband access will be increasingly common for both mobile applications and for communications between devices within locations such as homes. Already, the next generation of cellular phones, the so-called 3G ("third generation") devices, is capable of high-speed digital communications. New types of mobile devices will also have built-in communications capabilities that will support rich multi-media communications.

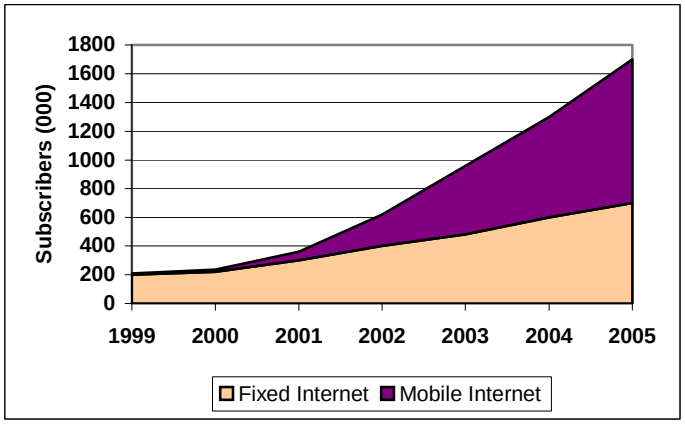
Figure 2



Source: FCC, *In the Matter of Inquiry of the Deployment of Advanced Telecommunications Capability to All Americans*, 2000.

It is risky to predict the exact form that these products will take since it is the marketplace that will ultimately determine which concepts succeed and which fail. But there will undoubtedly be a range of new "always-online" products available that include systems embedded in cars and other mobile platforms, hand-held devices and even devices that are wearable if not implantable. Within a few years, in fact, there may well be more wireless broadband connections to the Internet than wired ones. According to one projection, there will be some 750 million "fixed" Internet connections globally by 2005, but as many as a billion mobile connections to the Internet (see Figure 3).

Figure 3
Global Wired vs. Wireless Internet Connections, 1999-2005



Source: Larry Smarr, The 21st Century Internet, Ericsson

Wireless broadband networks will have an impact inside the home as well as outside of it. Technologies available today, such as the so-called 802.11b standard (also known as "Wi-Fi"), are being used to create low cost wireless home networks that can link personal computers to each other and to the Internet. The next generation of this standard, known as 802.11a, will be so fast that it will be possible to transmit broadband full-motion video

signals without wires or provide enough bandwidth to link together a whole host of devices within a home, including television sets, appliances, and home monitoring systems.

Eventually, today's broadband speeds will appear extremely slow when ultra-high speed fiber optic connections become more common. Only a few thousand homes have such access today, but within a decade, millions of homes will be connected at speeds of 100 mbps or higher.[4]

In this broadband world, communicating via full-motion video or exchanging very large files will be as routine as communicating by voice and text is today. As broadband becomes ubiquitous, people will be able to send a message or access multi-media content from any place they wish. And while person-to-person communication will be much richer and more convenient, much of the network's capacity will be used to support automated machine-to-machine communications that will enhance our daily lives in ways that we may not even notice. For a summary of related technologies that have the potential to bring about far-reaching changes in how we use computers and communication networks, see Appendix A.

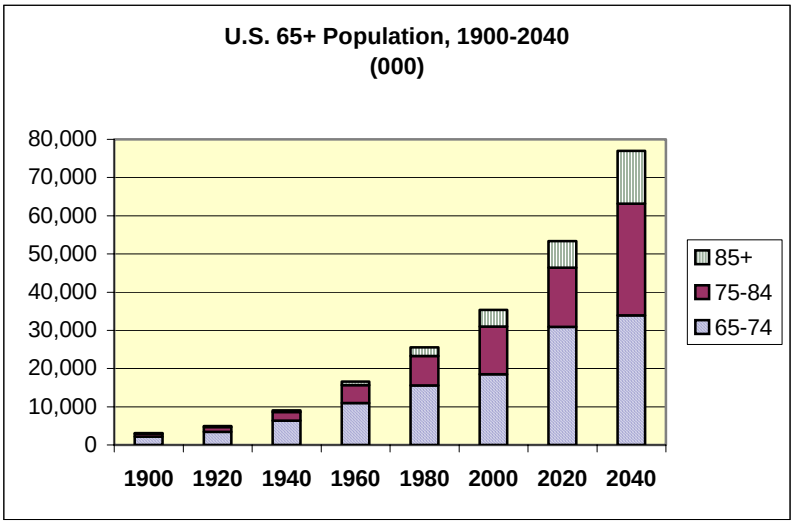
The Age Wave

Demographics are the most predictable of all trends. Someone who is 50 today will in ten years be 60 as long as they are still alive. There is no doubt that the older adult population, which has already grown substantially, will grow even more rapidly as the Baby Boomers reach later life. In many ways, we remain unprepared as a society for this major population shift.

The "age wave" of the past century has already brought about a substantial increase in the number of older Americans and has set the stage for even greater growth in the coming decades. Average life expectancy at birth increased by about 30 years over the past 100 years, more than in any other period of time in history. As a larger portion of the population of the United States enjoys longer lives, the very definition of "old age" is changing. For example, the notion that "retirement" at age 60 or 65 generally marks the end of an individual's productive life is rapidly becoming obsolete. Late life is no longer being seen as a time for "disengagement" from society but, increasingly, as a distinctive stage in life that offers its own challenges and opportunities for continued growth and social engagement.[5]

During the 20th century, the total U.S. population increased less than four times – from 75.9 million people in 1900 to some 280 million in 2000. In the same period of time, the number of Americans age 65 and older increased more than ten-fold, from just over 3 million to more than 35 million (see Figure 4). The "oldest old" population has increased even more, growing from 122,000 Americans over 85 at the beginning of the 20th century to more than 4.3 million at the end of the century – a 35-fold increase in 100 years.

Figure 4

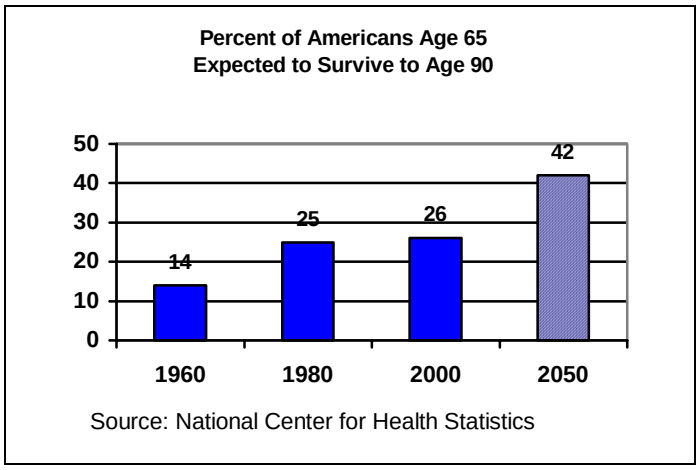


Source: U.S. Bureau of the Census/65+ in the U.S.

The number of older Americans will continue to grow steadily in the first half of the current century. Once the Baby Boomers begin reaching later life, the older population will begin increasing even more rapidly than it has in the past (the oldest Baby Boomers, who were born in 1946, will turn 65 in 2011). By 2020, there will be 53 million Americans over 65, and that number will rise to 77 million by 2040, more than double the number today. According to this projection, the number of Americans over age 85 will be greater (18.9 million) by the middle of this century than the entire U.S. population over age 65 in 1960 (16.6 million).

One of the key factors in the expansion of the older population is increased longevity, which is based on improvements in medical care as well as positive changes in lifestyle (e.g., diet and exercise). The likelihood that an American who reaches the age of 65 will survive to the age of 90 has nearly doubled over the past 40 years – from just 14 percent of 65 year olds in 1960 to 25 percent at present. By 2050, fully 40 percent of 65 year olds are expected to reach age 90 (see Figure 5).

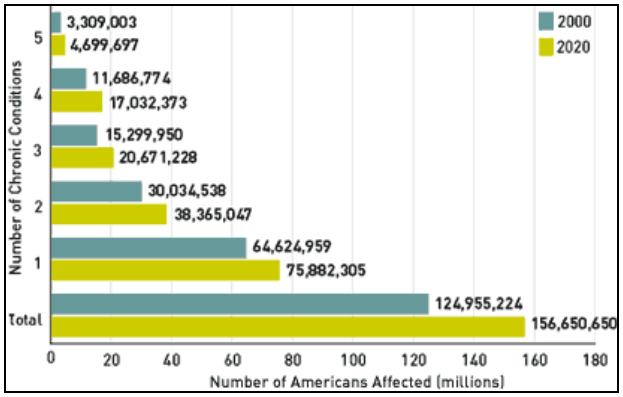
Figure 5



If this projection holds true, nearly 10 million Americans will be age 90 or older in the year 2050, compared to just one million in 1994. If medical breakthroughs occur that further reduce mortality levels, the number of Americans over age 90 could be even higher. It has also been suggested that research on the fundamental processes of aging may even result in a lengthening of the maximum lifespan well beyond age 100.

One of the unfortunate things that happens as people age is that they tend to develop chronic medical conditions and become increasingly frail. As a recent study noted, "because of the aging of the Baby Boom generation and advances in medicine that have enabled people to live longer with chronic illnesses, the number of people living with multiple chronic conditions is projected to increase to 81 million (25 percent of the population) by 2020," compared to 60.4 million in 2000.[6] The age group that is most prone to multiple chronic conditions are those over 85, which is the fastest growing group of any age (see Figure 6).

Figure 6
Americans with One or More Chronic Health Conditions

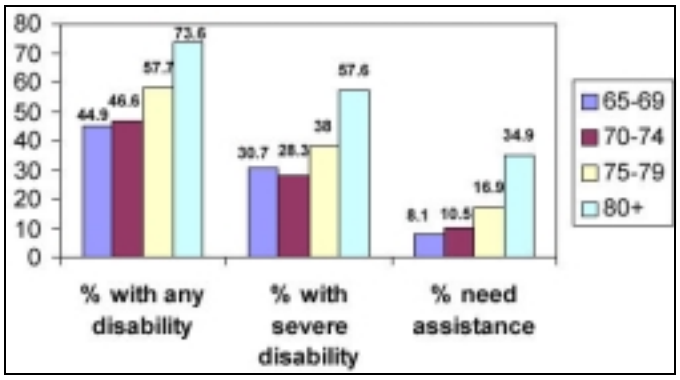


Source: Chronicnet.org

Some chronic conditions (e.g., high blood pressure, diabetes) need to be monitored and treated medically, but do not necessarily have a major impact on an individual's ability to remain active. However, as people age and become frailer, they tend to develop disabilities that can have a significant effect on their ability to remain independent. The most common way of measuring the prevalence of disabilities in the older population is by tracking the need for assistance with "Activities of Daily Living" (ADLs), defined as such common tasks as dressing, eating, bathing, grooming, and managing medications.

As shown in Figure 7, the proportion of the population that experiences some degree of disability grows steadily with age, generally because of illness, frailty, injuries from accidents, or dementia. Among those between the ages of 65 to 69, 44.5 percent have some disability, while 30.7 percent have a "severe disability" and 8.1 percent require ongoing assistance. Among those who are age 80 and older, nearly three-quarters (74.3 percent) have some disability, while more than half (57.6 percent) have a severe disability, and more than one-third require assistance in caring for themselves.

Figure 7
Prevalence of Disabilities by Age



Source: *A Profile of Older Americans, 2001,* Administration on Aging, U.S. Department of Health and Human Services, 2001.

The proportion of the population with disabilities severe enough to require ongoing assistance – provided either by family caregivers, by professional caregivers who make regular home visits, or by the staff of assisted living facilities – also increases with age, though not as quickly. If the relationship of disability with age remains constant, then by 2020, nearly four million Americans will require some form of long-term care, and by 2040, nearly ten million will require long-term care.

The health problems associated with age have significant financial costs, particularly when an individual must cope with multiple problems. Research has shown that "people who have functional limitations or a disability in addition to a chronic condition can face more than double the medical expenses of those with only a chronic illness."[7]

The picture that emerges from all this data has two distinctly different faces: on one hand, it is clear that the health problems that will arise from the aging of the population, and especially from the increasing number of the "oldest old," will pose a significant challenge to our ability to treat and care for them. On the other hand, the even larger number of Americans who are remaining healthy and active for many years past age 65 will pose a different kind of challenge to society – to help them remain independent and assist them in finding a meaningful, satisfying lifestyle that keeps them socially connected.

The Adoption of New Technologies by Older Adults

When a solution is proposed to address a problem of aging that involves the use of technology, the objection is often raised that seniors are "technophobic" and are resistant to adopting any new technology. It is true that older adults do not tend to be "innovators" or the "early adopters" of new technologies – that is, they rarely rush in to be "the first on their block" to try out the latest gadget. But once a technology reaches maturity and its benefits are well understood, seniors are as likely to use it as younger people. The key to the successful introduction of a technology for older adults is to make sure it is affordable, easy to use and delivers significant benefits. (For a more detailed discussion of this point, see Appendix B to this paper.)

The Missing Link: The Benefits of Ubiquitous Broadband

The missing ingredient that is required to deliver the full range of benefits to older adults, as illustrated in the story of Madge Gunderson, is the widespread availability of wired and wireless broadband connections, along with the hardware and software that will make use of high speed networks to deliver these valuable services. Once these technologies are available, an extensive range of applications will emerge to serve Americans of all ages. But older adults stand to benefit enormously from these developments.

It is difficult to forecast the precise applications of broadband that will prove most successful, but the main types of applications are relatively predictable. Work that is underway now also provides some useful clues about what life in a world of ubiquitous broadband might be like. As a result, it is possible to identify the main categories of benefits that the widespread availability of high-speed networks will provide to older Americans.

Enhancing Communications with Family and Friends

Probably the most compelling benefit of widespread availability of high-speed networks will be the increased convenience of staying in touch among family and friends and the greater richness of communications that broadband will make possible.

For older adults (as well as many younger people), the use of e-mail has been the most popular application of the Internet. For many seniors, getting access to e-mail has been the most compelling reason motivating them to begin using computers and the Internet. But the complexity of these technologies and the time and effort required to learn to use them remain barriers for many seniors.

High-speed broadband networks will dramatically expand the range of options for both personal communications as well as for access to a wide range of important services. If designed properly, these richer communications media should be as easy to use as today's telephones but more engaging and versatile.

The steady expansion of communications technologies has been a major factor in keeping people connected in an increasingly mobile, geographically diverse society. Just a few decades ago, telephone service for the great majority of households was provided by a black rotary-dial handset that could be used to dial other phone numbers. Today, cordless phones, smart programmable phones and cell phones have greatly expanded the ways in which people converse with one another. Answering machines and voice mail have made it possible to communicate with someone even if they do not answer a call.

The introduction of e-mail and instant messaging has provided an entirely new option for people to communicate with one another. And the newest generation of cell phones is

making it possible to send and receive text messages no matter where a user happens to be. (This application, which is already extremely popular in places like Japan and Scandinavia, is just beginning to appear in the United States.)

With the advent of the next generation of cell phones, richer forms of communication will also be available wirelessly. These so-called 3G technologies will make it possible to transmit "high-speed data anytime, anywhere, through a cell phone, a Personal Digital Assistant [PDA] or an information appliance, wirelessly and from any location. 3G means freedom from wires."[8] This technology will not only enhance person-to-person communications, but will be built in to cars and other vehicles and combined with such things as global positioning systems to make traveling easier and safer.

Eventually, the distinction between a wired and wireless phone will disappear, and each individual will be reachable through a single number no matter where he or she is. These new capabilities will be especially appealing for family members who are geographically separated but still want to share their lives frequently and intimately with each other, across distances and across generations. It is possible to envision a world where it will no longer be necessary to "reach out and touch someone" electronically. Thanks to always-on broadband connections, distant friends and family can "be there" for each other whenever they want.

Broadband networks will enable much richer forms of messaging that can increase the "emotional bandwidth" of online communications beyond what can be provided by text or even voice communications. Cell phones will incorporate visual displays for graphics and video messages. Always-on broadband networks will lead to the creation of "media spaces" in which continuous two-way video and audio links will create environments making informal "tele-visits" possible. Such applications can help to minimize the impact of separation between family members even if they are geographically distant from each other.

On the more distant horizon, an even more remarkable form of broadband-based communication is under development. Research is underway today on the development of "tele-immersion" – an application that will "enable users at geographically distributed sites to [communicate] in real time in a shared, simulated environment as if they were in the same physical room."[9] Tele-immersion combines 3D scanning and displays along with advanced tracking and audio technologies to capture and then recreate a three-dimensional image of an individual at a remote location. Because of the immense amount of data that must be transmitted, tele-immersion will require ultra high-speed communication networks based on fiber optics. The initial applications of this technology will be for such things as scientific and business collaboration; eventually it will be available to the general population.

Expanding Opportunities for Lifelong Learning

Remaining engaged in learning in later life has been identified as a key element in "successful aging." Just as keeping physically active is increasingly important for staying physically fit as one ages, so keeping mentally active is turning out to be critical to maintaining healthy cognitive functioning.

Current experiments with "e-learning" for older adults are demonstrating the enormous potential of this new approach to continuing education, particularly for seniors with limited mobility.

Broadband networks will vastly expand access to the world of learning for older adults by supporting richer, more engaging interactions than the current generation of classes delivered by narrowband dial-up networks. Broadband-based "classrooms without walls" can provide stimulating, engaging educational experiences that use video and voice as well as text. Ubiquitous broadband will also help prolong the careers of older workers by providing convenient access to continued training in the workplace.

Lifelong learning is also an area of rapidly growing interest among older adults. More than 33 million adults over age 45 – representing over one-third of this age group – are currently engaged in some form of adult education.

We are beginning to understand that lifelong learning is not just a "nice thing" to do as one gets older, but is a vital element in maintaining healthy cognitive function. The landmark MacArthur Foundation study of "Successful Aging" by John Rowe and Robert Kahn found that ongoing mental stimulation as well as physical activity are important elements in maintaining a "healthy mind."[10] And recent work by Paul David Nussbaum of the Pittsburgh Neuropsychology Associates indicates that ongoing involvement in learning contributes to "maintaining brain health and minimizing the risk for neurodegenerative diseases late in life."[11]

But access to ongoing education can be difficult for those who are not active and mobile. Several projects are underway to deliver educational programs directly to seniors at home. Perhaps the simplest of these is a project called the University Without Walls (UWW) that was launched in New York City in 1989. It has provided in-home education to students ranging in age up to 100 and living in places like Florida, Maryland, Utah and Israel. UWW's hour-long classes are delivered by telephone. When a class begins, each student is called and included on a conference line with the instructor and other students.

The program now offers a catalog of dozens of courses in the arts and humanities, legal and financial topics, and health. Students pay an $8 registration fee and tuition of $10 for each course which runs for 3-14 weeks.

Several organizations that serve older adults have begun to experiment with providing online education. In the past year, AARP has begun to offer online courses through its

web site. SeniorNet, an organization that operates a large online community for older adults, has also launched an e-learning initiative.

AARP's Online Courses. AARP has found that there is considerable interest in online learning among its 35 million members. Nearly one third of its members are now online, and of this group, 45 percent have indicated "high interest" in online learning, and 10-15 percent say that they are ready to try taking an online course. [12]

In the summer of 2001, AARP conducted a pilot that offered online classes developed by Fathom, an e-learning provider. The courses, developed by faculty members at leading colleges and universities in the United States and in Britain, were offered in four areas: technology and science, arts and humanities, history, and personal management. Course topics have ranged from "The Future of Computing Technology" and "Shakespeare and his World" to "W.E.B. DuBois and the Black Experience" and "Keeping Track of Your Diet."

With relatively little marketing or promotion, AARP's e-learning site attracted more than 8,000 visitors in a three-month period. Free courses were most popular, but members did sign up for courses that carried a fee of $10-50. The most popular courses turned out to be those on practical subjects – "anything related to technology" (e.g., Internet, digital cameras, building a web page), classes related to leisure and exercise (e.g., golf, yoga, health), and self-improvement classes (budgeting, diet, public speaking). Because of the positive response to the pilot, AARP is continuing to offer online courses to its members through its web site.

SeniorNet Online Courses. SeniorNet teaches older adults to use computers and the Internet through in-person classes at more than 200 learning centers around the country. It is also experimenting with online courses on the SeniorNet web site (www.seniornet.org). They offer a popular self-paced tutorial on "How to Search the Internet," and are exploring discussion-based courses on "How Literature Works" that will be taught by volunteer instructors. SeniorNet's online courses are currently offered at no charge.

Broadband E-learning. Today, the impact of online education is limited by the bandwidth available for delivering it. Online courses for older adults, who are dependent on dial-up connections, are mostly restricted to textual content.

E-learning will be greatly enhanced by the ability of broadband networks to deliver instruction via video and rich multimedia. Online learning in a broadband world will come closer to conveying the experience of actually being in the classroom, interacting with an instructor and other students. This will be particularly important for older learners for whom the social, interactive aspects of continuing education are often as important as the purely intellectual content.

In addition to delivering education for personal enrichment, broadband networks can also help older workers keep their knowledge and skills current by delivering "e-learning" to

them whenever and wherever they want. In today's information-intensive economy, on-the job training is rapidly becoming "a continual process [rather than] a distinct event."[13] Ubiquitous broadband will vastly expand access to this type of learning and improve the quality of education that can be delivered online.

Improving the Delivery of Health and Medical Services

Broadband technology may have its greatest impact on the lives of seniors in the area of health.

Health care expenditures in the United States are the highest in the world and are increasing at the highest rate of any country. As our population continues to age, new approaches will be required if we are to continue to provide high quality health care to all Americans without "breaking the bank."

Many projects have been conducted over the years demonstrating the promise of "tele-medicine" that makes it possible to deliver health services remotely. But we have not yet made the changes to our health care system that are required to make tele-medicine part of the mainstream. In addition, the quality of applications that can be delivered over low-speed networks is severely limited. The growth of high-speed networks will make it possible to deliver a much broader range of high-quality health services to patients at home or wherever they may be.

We know that as people get older, the cost of the health care services they use increases. This is particularly true as people develop chronic conditions and disabilities that require ongoing medical attention. According to a study by the Robert Wood Johnson Foundation, the direct medical costs for caring for people with chronic conditions is already in excess of $500 billion per year, and is projected to increase to $685 billion by 2020.[14] Total health expenditures in the United States exceed one trillion dollars, and are continuing to increase. As the U.S. population continues to age, our existing system for delivering health care is coming under increasing strain.[15]

One component of the solution will be "tele-health" and "tele-medicine" services that substitute online communications for in-person direct contact among health care providers and between the providers and their patients. A considerable amount of work has already been done to create and test these network-based services.[16] Among the most promising tele-medicine applications are home health monitoring and support for self-care, especially for individuals with chronic conditions such as diabetes or heart or lung disease.

A company called the Health Hero Network has developed a small device called the "Health Buddy" that enables health providers to interact on a regular basis with patients at home (see Figure 8). The device is easy for a patient to set up and use at home and can be used to deliver a series of "care dialogues" that include questions, tips and reminders. These dialogues are sent each day and the patient then interacts with the device to answer

questions and provide any data that is requested. The responses are used by health providers to track a patient's condition and determine his or her need for treatment. Studies conducted with patients suffering from congestive heart failure have shown that use of the Health Buddy to communicate with them can reduce the frequency of hospital stays and emergency room visits and lower overall medical costs by as much as $8,000 per year per patient.[17]

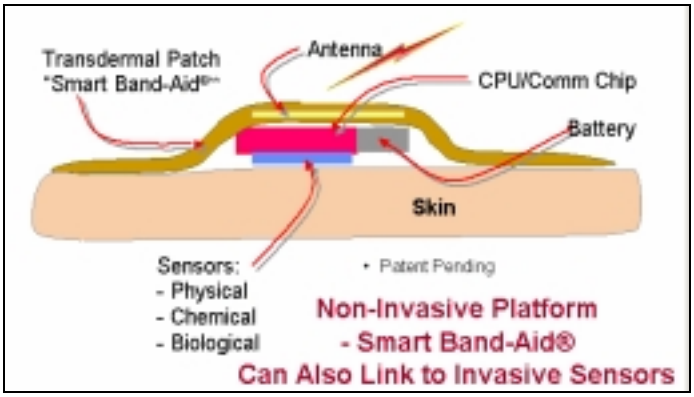
Figure 8
The Health Buddy Terminal

In Urbana, Illinois, Carle Home Care, a division of the nonprofit Carle Foundation, is using a "TeleHomeCare" system to monitor and communicate with patients in their homes. This system allows a registered nurse to make a "videovisit" that allows the patient and the nurse to see and hear each other. In addition, the nurse can use the system to monitor blood pressure and pulse, monitor medication compliance, observe wound healing process, listen to heart and lung sounds, or obtain other information such as blood glucose and temperature.[18]

Also under development are many types of small portable or "wearable" devices that automatically monitor the health of a patient and report the data to a health care provider. For example, PhiloMetron is a San Diego-based company that develops "distributed wireless human sensing technologies." It has designed a "smart Band-Aid" that can monitor the healing process of a wound or incision and automatically issue an alert if it detects any signs of infection (see Figure 9).[19] Other types of wearable sensors are being developed that will track and record other body functions.

Not all online health applications involve complicated technologies. At Stanford University's Patient Education Research Center, Dr. Kate Lorig is developing innovative methods to help individuals cope with chronic health conditions. She initially created printed guides and organized in-person support groups for patients with various chronic illnesses. But in the past few years, she has begun to experiment with providing support online. Dr. Lorig recently completed a randomized trial that enrolled a group of people suffering from chronic back pain in an online support group. The people who participated in the online group reported significant reductions in pain, physician visits and hospital stays compared to a control group.[20] She is currently testing the effectiveness of an interactive online course to teach skills for coping with a variety of chronic conditions.

Figure 9
PhiloMetron's Smart Band-Aid®



Source: Larry Smarr, The 21st Century Internet, PhiloMetron

While these tele-medicine and tele-health applications show promising results in a narrowband dial-up environment, they will be even more effective in a broadband world. The ability to communicate via video and voice should make online support groups more involving and emotionally compelling. The ability for patients at home to send as well as receive high-quality video will allow doctors to perform diagnoses and observe their patients remotely. And if wearable monitoring devices are to become common and convenient for patients, wireless broadband networks will be necessary to capture the data they generate and transmit the results to the right places.

Supporting Independent Living

One of the most important and innovative benefits of ubiquitous broadband networks will be to enable older adults to live independently by supporting their daily activities and keeping them closely connected to the outside world. A whole class of new applications and systems are being developed that combine advanced computing and communications technologies to create "aware" environments that will enhance independent living.

As people become increasingly frail and develop disabilities that interfere with their ability to manage their lives by themselves, the need for ongoing care becomes greater. Providing high-quality care on a long-term basis either puts tremendous strains on family members who act as caregivers or requires considerable expense to pay for professional home-health care or some form of assisted living.

The Broadband Institute Residential Laboratory at Georgia Tech University is creating an "Aware Home" to experiment with the integration of computing and communications technologies to enhance the ability of older adults to "age in place." The home will include a system of sensors that can monitor the environment and try to anticipate and

prevent problems. For example, the system could "alert the resident when the home is getting dangerously cold [and] ask, "Are you doing this on purpose?"[21]

The home will also have the ability to "sense the inhabitants by seeing, hearing and measuring contact through a variety of sensing technologies including video, audio, motion and load" to unobtrusively track residents' activities, provide them with needed services and, when necessary, identify potential crises and calls for help. For example, the Georgia Tech researchers have designed a "Smart Floor" (similar to that in the "Madge" scenario) that uses pressure-sensitive floor tiles to sense the movement of an occupant through the house. The system can distinguish between different individuals based on the pattern of their footsteps and keep track of their activity levels. It can be programmed to issue an alarm if the activity level of the resident unexpectedly changes or diminishes.

Yet another technology under development at Georgia Tech is designed to help older residents keep track of objects in their homes. This system will use "small radio-frequency tags attached to various objects (e.g., keys, wallets, glasses, remote controls) the user wants to track and an indoor positioning system to track these objects. . . the system will guide the user to a lost object using spatialized audio cues (e.g., 'your keys are in the bedroom')."[22]

There is no substitute for the companionship and care provided by a human being. These systems are not intended to replace a human caregiver, but rather to supplement and support them by automating the most mundane tasks of caregiving and providing convenient access to vital information about the person being cared for. These technologies can lighten a caregiver's burden or postpone the time when someone will need to make the move from living independently to assisted living or have ongoing in-home professional care.

Potential Cost Savings. Assisted living or in-home care can be quite expensive. Therefore, providing for even a few more months of longer independent life can make a significant financial difference.

Approximately one million people, with an average age of 83, currently live in some 28,000 assisted living facilities in the United States. This number is projected to double over the next twenty years as the older population increases.[23] Since assisted living typically costs at least $500 per month more than independent living, the overall savings that could be realized through the use of technology to support independent living could be substantial. If half a million Americans do find it necessary to move into an assisted living facility over the next decade, postponing that move by an average of just one month would result in a cumulative savings of $250 million. If such a move could be postponed for six months, the savings would be $1.5 billion.

Improving the efficiency of health care services for older adults holds the promise of even larger savings. As noted earlier, Americans currently spend some $500 billion each year on care for chronic conditions, and this amount is projected to increase to $685

billion by 2020. If the use of tele-medicine could reduce these expenditures by one-half of one percent, the savings in 2020 would amount to $3.4 billion annually.

Creating New Options for Entertainment

As broadband access grows, so will the range of entertainment options available to everyone, including older adults. Greater bandwidth will expand the opportunities to provide content designed for specific audiences and give individuals the ability to customize the programming available to them.

Based on past experience, the most important initial driver of adoption of broadband by home consumers is likely to be entertainment – including applications such as movies and music on demand and high definition television as well as various forms of interactive entertainment.

Older adults currently spend more time watching television than any other age group other than children. Men over age 65 watch approximately 36 hours per week, while women over 65 watch nearly 40 hours of television each week, compared to 25 hours and 27 hours per week for men and women aged 35-49 years old.[24] Older adults are also active consumers of other media such as radio, magazines, and newspapers.

It is an interesting paradox that despite the popularity of television among older viewers, the advertisers who pay for the programming on commercial television have tended to focus their attention on younger viewers and have been less interested in attracting viewers over age 59. The reasons for this go beyond the scope of this paper, but as the overall viewing audience continues to age, advertisers and programmers will inevitably pay more attention to the needs and interests of this audience.[25]

With the conversion of television from analog to all-digital format and the growth of interactive broadband networks, the variety of television programming will also increase. Intelligent digital recorders that today are still expensive stand-alone devices will be integrated into basic home entertainment centers. As a result, viewers will be able to pick from an ever-widening array of choices and create their own viewing schedule, enabling them to watch programs when it is convenient to them, not when they are transmitted.

Options for interactive entertainment will also expand. Today's videogames are largely focused on young people who enjoy the fast-paced action of "arcade-style" games. While this type of entertainment is of little interest to most adults, and particularly older adults, there will be opportunities to develop new types of content that appeal to this expanding audience. Interactive games, simulations, and quizzes that take advantage of the rich media capabilities of broadband networks will be developed that will be much more appealing to older adults. If properly designed, this type of content can also help provide valuable stimulation that can help seniors remain mentally active.

Challenges to the Deployment of Broadband to Older Adults

A new broadband environment has begun to emerge, and several million U.S. households now enjoy high-speed network connections. However, there are a number of challenges that will have to be overcome if the full benefits of broadband networks are to be enjoyed by a large number of older Americans. These include:

Moving Beyond the PC

Dr. Joel Birnbaum, the former director of HP Labs, once compared the process of bringing computers into the home to the domestication of wild animals. He pointed out that few people would take the risk of trying to make a lion or tiger into a household pet. But after generations of breeding, domestic cats were developed and safely brought into the home. Today's personal computers, Birnbaum observed, are still "half wild" – somewhere between the lion and the pussy cat.

The development of the so-called "WIMP" interface (Windows/Icons/Menus/Pointers) for interacting with a computer was a big step forward in domesticating the technology. But learning to use a PC still requires a substantial investment of time and energy.

A relatively small number of individuals have chosen to use so-called "Internet appliances" (such as Microsoft's WebTV, now known as MSN TV, or the EarthLink MailStation) to get online. These devices are simpler and less expensive than full-fledged personal computers, but they provide access to the same applications as PCs (which can be complicated), and they rely on the same slow dial-up connections as computers equipped with modems, which limit their value.

A much broader range of access options will begin to appear with the spread of high-speed, always-on broadband networks. As both wired and wireless devices continue to evolve, access will no longer be tethered to the personal computer. Wireless devices, in particular, may become the most popular method for accessing information and communicating with others. These new devices will utilize a good deal of computing power. In fact, they may well be more powerful than today's state-of-the-art PCs, but should be simpler to use. Some of tomorrow's devices (such as the portable tablet used by Madge Gunderson) will be descended from today's personal computers. Others may trace their origins to today's cell phones or handheld personal digital assistants (such as the Palm Pilot). In other cases (such as the smart floor tiles or smart Band-Aids), intelligence and communications capabilities will be added to existing "dumb" devices to increase their effectiveness.

Once this broader array of applications emerges, the value of broadband networks will expand beyond the universe of PC users to encompass a much larger portion of society. As described above, older adults represent one group that can benefit in many ways from these new applications.

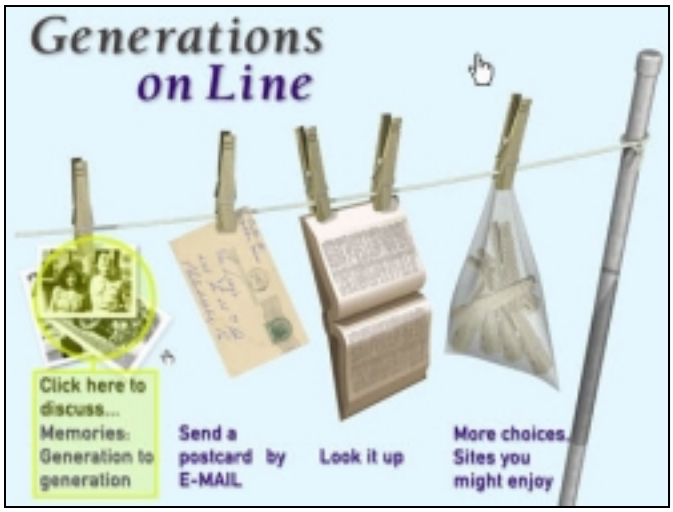
Ensuring Ease of Use

Older adults have not grown up with advanced technologies as part of their daily lives as younger people have. Therefore, it is not surprising that the adoption of new technologies by older adults has lagged behind that of the population as a whole (see Appendix B).

Research has shown that seniors tend to have more difficulty using computers and the Internet than younger people. A recent study by the Nielsen Norman Group found that a group of users over 65 has a success rate of just 52.9 percent in completing a series of assigned tasks (such as finding information and making a purchase online), compared to 78.2 percent success rate for a group of younger users. The seniors also made an average of 3.7 errors on each assigned task, compared to 0.6 errors for the younger group. Finally, it took the older users an average of 12.5 minutes to complete each task, compared to 7.2 minutes for the younger users.[26]

To deal with these problems, a number of innovative applications have been developed to aid older adults in going online. For example, the nonprofit organization Generations Online (GoL) has created a friendly Web-based interface specifically designed for seniors (see Figure 10). The GoL interface provides simplified access to e-mail, discussion groups, a search engine, and a set of links to other sites. The clothesline image is intended to serve as a "virtual bridge between new and old technologies."

Figure 10
Generations Online Internet Interface



A different approach to solving the same problem is being pursued by IBM, which recently announced development of software that allows online users to change the appearance of any web page to suit their individual needs or preferences. This new on-line "gateway" allows a user "to increase the size of the text on the web pages they access, quiet a distracting background, turn off flashing images, change the color for better contrast, adjust the keyboard to overlook typing errors and avoid other features that now make the Internet hostile territory for many seniors."[27]

Hopefully, the next generation of applications and devices will not require the same kinds of modifications to make them truly easy to use. Many single-purpose devices should have simpler interfaces than today's PCs, and many online monitoring systems should be capable of operating without the need for constant human intervention. However, the task of integrating multiple systems together to create useful, usable "intelligent environments" such as the Aware Home will be particularly difficult. As Georgia Tech's Dr. Gregory Abowd has observed, "the human challenge with this [new] technology is as much a challenge, if not more, than the technological challenge."[28] None of the promising new broadband applications will truly reach a mass audience until they are easy for everyone to use, young and old.

Ensuring Privacy and Security

Another crucial key to the widespread use of broadband applications by older adults is ensuring that they are private and secure. These issues will be even more critical in a broadband world in which many devices and applications will be "always on," and therefore potentially vulnerable to unauthorized access.[29]

Seniors are particularly sensitive to the importance of protecting their privacy. According to a survey conducted by the Pew Internet and American Life Project, "Fully 61 percent of those 65 and older say they are 'very concerned' about businesses and people they don't know getting personal information about them or their families, compared to 46 percent of Americans between 18 and 29."[30] Government and business have begun to address the problem of protecting privacy online, but more diligent efforts will be required to assure older adults that they can use these technologies with confidence.

Creating a More Positive Legal and Regulatory Environment

Although the number of residential broadband users in the United States has been growing, the availability of broadband remains fragmented. The FCC recently reported that high-speed networks are more available in urban areas than in rural areas and more available in affluent areas than in poorer areas of the country.[31]

Studies suggest that accelerating the deployment of broadband would have significant economic benefits for the country as a whole.[32] Yet, in contrast to a number of other countries, the United States has not made a national commitment to expanding availability of broadband networks or developing innovative broadband services.

Several U.S. organizations have recently called on the federal government to articulate a clear "vision" of a ubiquitous broadband infrastructure and to adopt policies that will promote its realization. For example, TechNet, a group of CEOs from major U.S. technology companies, has proposed that the federal government endorse an ambitious goal of providing high-speed network connections of 100 megabits per second to 100 million homes and small businesses by the end of this decade. TechNet recommends that the government act to "foster innovation and reduce regulation. . . [and] provide investment incentives, potentially including targeted tax incentives, to encourage

broadband deployment to underserved communities."[33] The Computer Systems Policy Project (CSPP), composed of the CEOs and chairmen of leading computer and information technology companies, has recently made similar recommendations. The CSPP has recommended that the federal government "make infrastructure development a priority." It has also called on industry to take greater responsibility for improving ease of use for new applications and strengthening network security as well as to "be responsive to government partnerships" that will speed broadband deployment.[34]

Many segments of society – including consumers and businesses – will benefit from the widespread availability of broadband. But, as this paper has attempted to demonstrate, older adults stand to benefit particularly from the services that broadband networks will deliver.

Endnotes

[1] The adoption of a new technology typically follows an "S" curve that plots the rate of penetration over time. A period of relatively slow initial growth generally follows the initial introduction of a new technology, which is followed by more rapid growth as it is adopted by the mainstream audience. At some point, the growth curve flattens out as penetration reaches a plateau. Different technologies reach different penetration levels before the curve flattens out.

[2] A San Francisco based company called OQO (www.oqo.com) has announced the development of an "Ultra-Personal Computer" that is small enough to fit in a shirt pocket. The device, which will run Windows XP, combines a microprocessor, 256 megabytes of memory, a 10 gigabyte hard disk and a battery in a package the size of a paperback book. It also has a small screen that will allow it to operate as a stand alone handheld computer, or it can be plugged into a regular keyboard and a monitor to replace a desktop PC. It is expected to cost $1,000-$1,400 at introduction.

[3] Daniel P. Rheingold, Julia Belladonna and Michael Winston, *Fourth Quarter DSL and Cable Modem Update*, New York, NY: Credit Suisse First Boston, April 5, 2001.

[4] A few thousand U.S. households already are connected to fiber optic networks. In Palo Alto, California, for example, a city-sponsored trial is underway that links homes in one neighborhood to the Internet via fiber optic connections. See Jeff Hecht, "Fiber Optics to the Home," *MIT Technology Review*, March/April 2000.

[5] See Marc Freedman, *Prime Time: How Baby Boomers Will Revolutionize Retirement and Transform America*. New York: Public Affairs, 1999.

[6] "Fact Sheet," Partnership for Solutions: Better Lives for People with Chronic Conditions, at www.chronicnet.org. The most common chronic conditions among older adults are (in terms of occurrence per 100 seniors): arthritis (49), hypertension (36), hearing impairments (30), heart disease (27), cataracts (17), orthopedic impairments (18), sinusitis (12), and diabetes (10).

[7] Cost of medical care for a person with one chronic condition = $6,032/year; cost of medical care for a person with one chronic condition + disability = $10,908/year; cost of medical care for a person with one chronic condition and functional limitations = $16,245/year. Partnership for Solutions Fact Sheet.

[8] Jim Thompson and Mike Woodward, "More than Mere Talk," *Bay Area Computer User*, April 2002, page 28.

[9] See "The National Tele-Immersion Initiative," at http://www.advanced.org/teleimmersion.html.

[10] John W. Rowe and Robert Kahn, *Successful Aging*. New York, Pantheon Books, 1998. Pages 125-142.

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[16] See W.R. Hersh, et al., *Telemedicine for the Medicare Population.* Rockville, MD: Agency for Healthcare Research and Quality (AHRQ), U.S. Department of Health and Human Services, 2001.

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[28] Ibid.

[29] See for example, John Schwarz, "Nanny-Cam May Leave a Home Exposed," *New York Times*, April 14, 2002

[30] Susannah Fox, *Wired Seniors*, Washington, DC: Pew Internet and American Life Project, September 2001.

[31] *High-Speed Services for Internet Access: Subscribership as of June 30, 2001*. Industry Analysis Division, Common Carrier Bureau, Federal Communications Commission, February 2002. According to the FCC, "high speed subscribers are reported to be present in 97 percent of the most densely populated ZIP codes and in 49 percent of the ZIP codes with the lowest population densities." Similarly, "in the top one-tenth of ZIP codes ranked by median family income, high speed subscribers are reported in 97 percent of ZIP codes. By contrast, high-speed subscribers are reported in 59 percent of ZIP codes with the lowest median family income."

[32] See, for example, Robert W. Crandall and Charles L. Jackson, *The $500 Billion Opportunity: the Potential Economic Benefit of Widespread Diffusion of Broadband Internet Access.* Washington, DC: Criterion Economics, July 2001. The report is available at www.criterioneconomics.com.

[33] "TechNet CEOs Call for National Broadband Policy," TechNet press release, January 15, 2002, at http://www.technet.org/news/newsreleases_/2002-01-15.62.html.

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Appendix A

Paradigm Shifts:
Ten Ways the Future Will Be Different From the Past

Most technology developments involve improvements to existing technologies – that is, making them more powerful, faster, smaller, more reliable, simpler, cheaper, etc. These are "incremental" changes.

However, some innovations make it possible for us to use technology in entirely new ways and to do entirely new things with technology. These developments are more revolutionary. They also happen less often and are harder to anticipate.

Both computers and communications have benefited from almost continuous incremental improvements over the past several decades. In a few cases, such as the advent of the Internet, the changes have been more fundamental.

Looking ahead, there are a number of new computer and communication developments that could be more revolutionary than evolutionary. Some of these are still just interesting concepts. Others are currently under development in R&D laboratories. Still others are on the brink of being introduced in the marketplace.

Here (in alphabetical order) are ten innovations that could have far-reaching consequences for everyone who uses technology, including older adults.

1. **3G Wireless Networks**. The first generation of wireless networks was built for "analog" cell phones that were limited to voice communications. The second generation of networks supported digital cell phones that could provide limited data services as well as voice. The third generation of networks is designed to carry high-speed digital applications such as Web browsing and multi-media messaging. These broadband networks will be used by a wide range of portable wireless devices that go well beyond today's cell phones. Currently available in Japan, 3G networks are just now being introduced in the United States.
2. **Affective computing**. Today's computers are cognitively smart but emotionally dumb. A computer can play champion-level chess or perform mind-boggling mathematical calculations. But even young children are more skilled than the most advanced computer in determining whether someone is happy or sad, angry or pleased. Researchers at MIT and elsewhere are working on developing computer systems capable of recognizing and responding appropriately to a range of human emotions. Whether we will be comfortable with such machines remains to be seen.
3. **Agents.** These are computer programs capable of operating automatically and independently on our behalf. One example of such a program would be an agent capable of planning a two-week vacation based on general instructions from the user regarding dates and destinations, or perhaps arranging a dinner party for six based on user preferences.

4. **Calm technology.** One unfortunate result of the continuing growth of media is the increasing fragmentation as they all seem to vie simultaneously for our attention. One antidote to this problem, first suggested by Xerox researchers Mark Weiser and John Seely Brown, is "calm technology" that is designed to operate continuously on the periphery of our awareness, and notify us only when something occurs that needs our full attention.

5. **Grid computing**. Even the simplest desktop computer on the market today has far more raw computing power than most users will ever need. For the most part, these computing resources are wasted. But work is underway in a number of places on systems that will allow an individual user to instantly tap into these unused resources to carry out computing applications that would tax the capabilities of even the largest "supercomputer." To demonstrate the potential of grid computing, projects have been launched that allow individuals to "donate" their unused computer resources to help identify new cancer-fighting drugs and to search for signs of extraterrestrial intelligence.

6. **Interactive television.** As television moves from analog to digital, new possibilities open up for viewers to interact with TV content. Past trials of "ITV" that offered relatively limited applications were not very successful. But in the future, the convergence of computers and TV sets will enable viewers to be their own programmers, and pick the programs they want to watch and when to watch them. The addition of TV-quality images to current interactive applications (like shopping) will enrich and extend them.

7. **Natural language interface.** Today, we work with computers mainly by issuing "commands" for them to do certain things. While "graphic interfaces" that involve icons and menus have simplified this process, it is still necessary to interact with computers in specific ways to get specific results. With a natural language interface, working with a computer will be more like talking to another person than typing commands or clicking on icons. For example, it will be possible to say to a computer, "Find that story about my family that I created last week," rather than searching for a particular file. In other words, we will be able to interact with computers using *our* language rather than theirs.

8. **Pliant computing**. According to computer scientists Austin Henderson and Jed Harris, current computer systems are rigid and unresponsive to individual needs and interests. The world of computers today is defined by and limited by the structure of their operating systems (e.g., Windows, Unix) and their applications (e.g., word processing, spreadsheet). In a "pliant" world, individual users will have much more control over how they interact with a computer.

9. **Ubiquitous computing.** As microprocessors continue to get smaller and cheaper, they will no longer be confined to relatively expensive "electronic" products, but will be integrated into all sorts of mundane devices that will make them much more versatile. For example, a suitcase could include a tiny chip to enable its owner to keep track of it no matter where it goes; a watch will have the ability to monitor the wearer's vital signs and warn of any environmental hazards; cars will have continuous access to current traffic and road conditions and be able to guide drivers to the best route to any destination. Ubiquitous

broadband networks will be needed to support ubiquitous computing applications.

10. **Web services.** The World Wide Web is currently made up of millions of separate, discrete "pages" accessed by individual users. Web services will make it possible to integrate content from different sources in ways that are customized and convenient for each user. For example, web services could give users the ability to keep track of and manage all of their financial resources from a single point of access, even if they are located in different banks, credit unions, mutual funds, etc. The technical standards and software tools necessary to create web services are now becoming available, and initial services will be available soon.

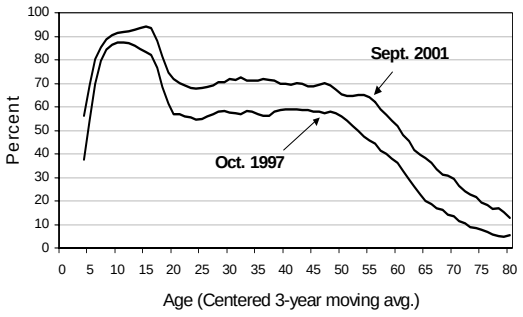
Appendix B

Adoption of New Technologies by Older Adults

Whenever the potential benefits of a new technology for older adults are discussed, someone is bound to raise the notion that seniors are "technophobic" – that is, as a group, seniors tend to be skeptical about and resistant to the use of new technologies. As a result of this reluctance, the theoretical benefits of a technology for older adults are not likely to be realized because the population for which they are intended will refuse to take advantage of them.

One of the most frequently cited examples of seniors' technophobia is their resistance to adopting personal computers. In fact, studies do show that older adults have been slower to make use of PCs than the general population. For example, a recent report from the U.S. Department of Commerce on use of computers and the Internet documented the fact that older adults continue to lag behind younger people in using PCs (see Figure B-1) which charts the use of computers by Americans age 5 to age 80). The data show that teenagers, more than 90 percent of whom now use computers, are the most avid group of PC users. Among all Americans from age 10 through 55, penetration of PCs is above 60 percent. But after age 55, the use of computers declines steadily and falls below 20 percent among those age 75 and older. Figure B-1 shows that use of PCs increased for Americans of all ages from October 1997 to September 2001, but that the overall shape of the curves remained roughly the same.[1]

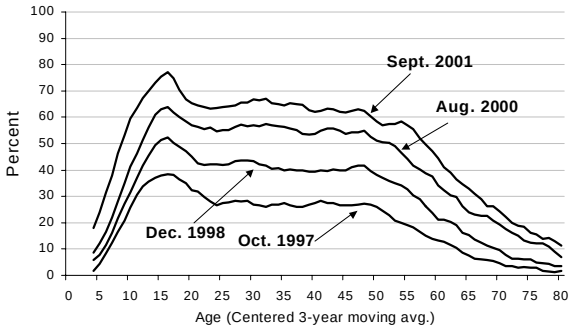
Figure B-1
Computer Use by Age, 1997-2001



Source: *A Nation Online: How Americans Are Expanding Their Use Of The Internet*, U.S. Department of Commerce, February 2002.

A similar pattern can be seen in the use of the Internet (see Figure B-2). These data indicate that more than half of all Americans between the ages of 10 and 55 now make use of the Internet, but that Internet use falls off steadily after age 55.

Figure B-2
Internet Use by Age, 1997-2001



Source: *A Nation Online: How Americans Are Expanding Their Use Of The Internet*, U.S. Department of Commerce, February 2002.

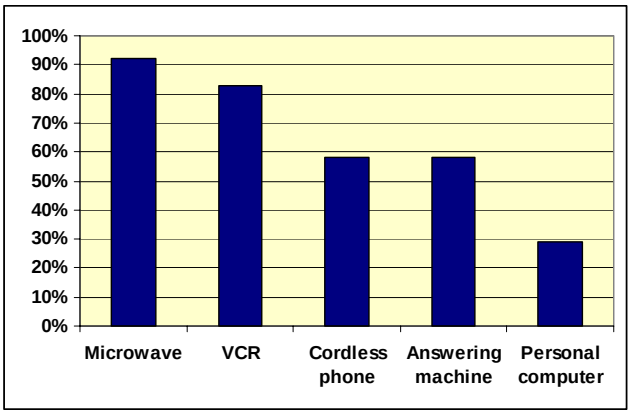
What accounts for this persistent "generational digital divide"? Part of the explanation has to do with access: virtually all children in this country now have access to computers and the Internet through their schools,[2] while working-age adults have access at their workplace. For an ever-increasing number of jobs, in fact, computer use is mandatory, not optional. By contrast, most of today's older adults completed their education and their working careers before computers were widespread, and they now live in environments where the technology is less available.

Evidence from other research suggests that the gap between younger and older people in making use of computers may not, in fact, be permanent. An early survey of computer use among older adults (conducted in 1996 by the author of this report) also examined the use of a range of other technology-based products by seniors (see Figure B-3)[3].

While the ownership of personal computers in 1996 averaged just 29 percent among those over 55, the penetration of other, somewhat older technology-based products was much higher. For example, more than 90 percent of the respondents owned a microwave oven, and more than 80 percent had VCRs. Even for cordless phones and answering machines, ownership was close to 60 percent. And since these data were collected six years ago, it is likely that the ownership of these products has increased from that time to the present.

These data suggest that, rather than being "technophobic" – that is, generally resistant to making use of technology – seniors are generally not "early adopters" of a new technology.[4] But once a technology becomes more mature and less expensive, more reliable and easier to use, and its benefits become more apparent and more compelling, seniors are as likely to use it as younger people.

Figure B-3
Ownership of Technology-Based Products
by Adults Over Age 55, 1996



Source: *Older Adults and Computers: Results of a National Survey*, SeniorNet, 1996.

Appendix B Endnotes

[1] *A Nation Online: How Americans Are Expanding Their Use Of The Internet*. Washington, DC: Economic and Statistics Administration and National Telecommunications and Information Agency, U.S. Department of Commerce, February 2002.

[2] There is now one computer in the public schools for every 5.4 students in the United States, up from one computer for every 10 students in 1995-96. Virtually all public schools (98 percent) are connected to the Internet, while more than three-quarters (77 percent) of all public school classrooms are equipped with an Internet connection. *The CEO Forum School Technology and Readiness Report.* Washington, DC: The CEO Forum on Education and Technology, June 2001.

[3] Richard Adler, *Older Adults and Computers: Results of a National Survey*. San Francisco, CA: SeniorNet, 1996.

[4] See Everett M. Rogers, *The Diffusion of Innovations.* (Fourth Edition) New York: The Free Press, 1983. According to this classic study, the adoption of any new innovation follows a predictable pattern. The first group of people to make use of the new technology are the "innovators," who will eagerly use a new technology precisely because it is new (these are the "gadget freaks"). This relatively small group is insensitive to price and willing to accept products that are not entirely reliable. This group is followed by the true mass market, which is made up of "early adopters" followed by the "middle adopters" (who represent the largest market segment) and, finally, by the "late adopters" and the "laggards." Evidence suggests that most older adults fall into the latter categories. For a useful marketing-oriented update of Rogers' theory, see Geoffrey A. Moore, *Crossing the Chasm: Marketing and Selling High-Tech Products to Mainstream Customers*. New York: Harper Business, 1991.