MIE 1404

# Mobile Computing for the Elderly and Disabled

Second Draft

**Literature Review**

Jade Rubick
jade@dgp

**Table of Contents**

Abstract ..... 3
Introduction ..... 3
Elderly and Disabled Users ..... 3
Benefits of Designing for (Elderly and) Disabled Users ..... 3
  Careful Design Helps all Users ..... 4
  The Elderly and Disabled are a Large Group ..... 4
  Many of us become temporarily disabled ..... 4
Seniors and Technology ..... 5
Mobile Computing for the Elderly and Disabled ..... 5
  Memory prosthetics ..... 6
    Several Kinds of Memory ..... 6
    Age's Effect on Memory ..... 6
    Research on Memory Prosthetics ..... 7
Design Recommendations ..... 8
  Seniors ..... 8
  Disabled ..... 8
  Memory Prosthetics ..... 8
Recommendations for Research ..... 8
Annotated Bibliography ..... 8
Expected Results/Contributions ..... 19
Challenges and Concerns ..... 19
Messy Notes That I Won't Dare Put in the Final Report ..... 20

## Abstract

## Introduction

Two populations that are often ignored by system designers is the elderly and the disabled. Their needs are considered to be secondary, and often something that can be addressed by people that fill niche markets.

This report reviews the research on design for senior and disabled users, and looks especially at the issues involved in designing mobile computing devices for these populations.

This article looks at the needs of senior and disabled users and offers guidelines for design for these populations. In addition, I will suggest directions for future research in this area.

## Elderly and Disabled Users

Before I venture into a review of the literature on this topic, I would like to clarify the scope of this report.

First of all, there is a common misconception that equates seniors with being disabled and not able to live life without assistance. Despite these stereotypes, most elderly people are not disabled, and carry out their lives without assistance (Novack 1995 and Kaplan 1997).

However, there are design issues that are unique to seniors. They come from a different generational culture, respond differently to technology, and receive their information about technology from different sources.

Disabled people also have their own share of design issues, such as interfaces that work for blind or deaf people, or alternative input devices.

The focus of this report is on both of these groups, because they are groups that have been often ignored in the design process. As this report shows, designers ignoring their needs are also ignoring the needs of average users as well, because designs that incorporate the needs of senior and disabled users are more flexible and easier to use for average users as well.

## Benefits of Designing for (Elderly and) Disabled Users

Designs that incorporate the needs of the disabled have demonstrated a wide range of benefits. First of all, designing for the disabled results in designs that are easier to use for all users. Second, careful design for the disabled allows them to use tools that they would not otherwise have access to. Third, many of us become temporarily disabled, and designs will be more flexible if they allow for this. Fourth, because mobile computing is becoming more common for the disabled, designs that don't take into account their needs will be less successful.

### *Careful Design Helps all Users*

Designs that considers the needs of elderly and disabled users often benefits other users as well. For example, in 1981 Whirpool Corporation tried to appeal to older customers by designing the dials on washing machines with large, legible labels. Although they targeted this product at the elderly, they found that it was very popular with younger families as well, who used them in dimly lit basements (Bowe 1988). Trunk designs are also easier to use than they used to be because of the influence of the disabled on car design. Disabled people had difficulty lifting heavy objects of out trunks, so car designers made trunks open up so that items could be slid out instead of lifted up to come out of the trunk. Passageways in buildings, modified to let wheelchairs through, are easier to navigate and less cluttered than hallways that aren't wheelchair accessible. Macintosh computers are well known for their ease of use, and they have always stressed making their computers easy to use for the disabled. All of these are benefits that have helped the general public while also making these products better for elderly and disabled users.

### *The Elderly and Disabled are a Large Group*

The disabled are a surprisingly large segment of the population. Approximately 15% of the population experienced activity limitations in 1994, which does not even include all types of disability (Kaplan 1994). This is up from 11.7% in 1970. Disability is more common among seniors. Kaplan (1997) cites a survey that found that that the elderly "experience disability at roughly twice the rate of those in the older working ages (45–64) and four times the rate of the younger working-age group (18–44)." She points out that "as the proportion of elderly people continues to rise, so will the overall incidence of disability."

Novack (1995) points out that the disability rates among the elderly are decreasing, and points out that technology is aiding many of these people. Novack cites research showing that 22.6% of seniors require the assistance of technology or other people to help them (1995).

Lazarro cites many forms of technology that have been helping seniors for years: "optical character recognition systems that output hardcopy text in synthetic speech, screen readers that output speech, software that displays very-large print, printers that output Braille, [...] Braille terminals, [...] voice-recognition software, adaptive keyboard designs, macro generators, and point-and shoot-devices." (1990). Brisbin (1997) describes a Powerbook that was designed for mobile computing for disabled users.

All of these designs help to make the computing world easier and more accessible for disabled people. Because of these technologies, people are often capable of having richer and more fulfilling lives. These

### *Many of us become temporarily disabled*

In *The Wealthy Barber*, by David Chilton (1998), the barber argues that all working people should insure themselves against disability, saying that as many as a quarter of all workers experience some form of disability during their working years.

A person with bad eyesight who loses their contacts or steps on their glasses could easily be considered temporarily disabled. After all, they are often not able to drive or use computers if they weren't using assistive technology (glasses or contacts). We can break limbs, damage organs, and lose our faculties, temporarily or permanently.

Besides physical accidents, circumstances can often make us temporarily disabled. A noisy street could be equivalent to being deaf, and fog or complete darkness can be like being blind.

Designing devices for the disabled also has the benefit of making our designs more flexible and usable under a wider range of conditions. For mobile computing devices, this is especially important, because it is hard to anticipate the environment under which mobile computing devices will be used.

## Seniors and Technology

There are many stereotypes that suggest that seniors are afraid of technology and reluctant to use computers. While this may be somewhat true, there is evidence that seniors are becoming a larger and larger part of the computer-using community. An article in Forbes suggested that only 1% of the Internet population are elderly, but said that the rate was growing about 15% a year since 1990 (Noer 1995). As a side note, the article said that elderly users who were given Internet and computer access were less depressed after six months. Peters (1997) said that people 65 years of age or older "constitute an estimated 5% of Internet users, and their numbers are expected to grow quickly" (Peters 1997). Another study found that 20% of households headed by someone aged 60 or older owned a PC by the end of 1995 (Flynn 1996). Dunman (1997) cites a poll that said that 19% of all Internet users are age 50 or over, and Dickerson (1995) talks about how many computer classes and services are being offered for seniors. An article in the Moscow News reports on a survey that shows computer ownership in the US to have grown 43% in the 16 months between July 1994 to 1995 (Moscow News 1996). All of these studies point to a surge in computer and online service use for senior citizens.

## Mobile Computing for the Elderly and Disabled

Mobile computing is becoming more and more common, and will likely sink into our culture the same way that cellular phone have. Evidence of this is found in the huge increase in laptop computer usage, and the success of PDAs such as the PalmPilot. Microsoft seems to be itching for a share of the action, and their Windows CE devices are designed to be put in devices ranging from Palm PC's to automobiles.

Given the rise in computer use among seniors, and the rise in mobile computing usage, it is likely that seniors will take advantage of mobile computing devices if they are designed for them. Disabled people have used computers for years, and the fact that a laptop computer was specifically developed and marketed towards their needs (Brisbin 1997) highlights that mobile computing is already in demand by disabled individuals.

There are many different applications for disabled and senior citizens. Besides what computers already do today, devices that act as position and safety devices that can call for help when needed, devices that serve as memory aids, devices to aid in communication and vision, and memory prosthetics could all be useful for these populations. I am not aware of any research that has been done in areas besides memory prosethetics, so this article will concentrate on memory aid devices.

### *Memory prosthetics*

Pre-agricultural societies worked 3 hours a day, and slept 9.5 hours a day. As the agricultural and industrial revolutions have come to influence our daily lives, our memories have proven to be unreliable. Time has become a commodity to be divided, sold, traded, and analyzed in a way it never was before. Simultaneously, our need to remember greater and greater amounts of information has become more important.

Humans have used memory aids for a long period of time. We've written notes to ourselves, used schedule books to keep track of what we're supposed to do, and used address and phone books to help us remember how to contact the people we interact with in our lives.

PDAs were a natural extension of new computer technology, and have become more and more ubiquitous each year. These are one form of memory prosthetic, but not necessarily the only type. Research has been looking at memory prosthetics for a while now. Many of this research is relevant for people designing memory aids for senior and disabled users.

#### Several Kinds of Memory

Before we look at the research that has been conducted on memory aids, we should first establish a clear understanding of how memory works, and the different types of memory within the human brain. Memory can be divided into episodic memory, prospective memory, and several other kinds of memory, such as semantic memory. The types of memory that concern us most with memory aids are episodic and prospective memory.

Episodic memory is memory containing information on events or episodes of our past. To remember these past events, we can use three different cues: who was involved, what objects were involved, and what places were involved. For more information on episodic memory, see Tulving (1983) or Loftus (1983).

Prospective memory is remembering something at a future time. For example, if I have to remember to make a phone call at 1:00 tomorrow afternoon, this requires my prospective memory. For this memory to work, it usually has to be cued by an event, a specific time of the day which happens before the item to be remembered.

#### Age's Effect on Memory

If we are to design memory prosthetics for seniors, we need to understand the effect age can have on memory, and understand the differences in the way that elderly people remember things. Fortunately, a great deal of research has been conducted on this topic.

Generally, however, age tends to decrease the speed of recall, and the accuracy of recall on memories. Bryan (1996) found that younger people process information quicker, have higher recall performance, and possess a higher backward word span than older adults. Older adults are also more sensitive to background interference than younger adulls (Einstein 1997). Older adults do not tend to perform well on prospective memory tasks, and it is even worse when memory load is also involved (Park 1997). Age correlates significantly with episodic memory performance, but not semantic memory performance (Nyberg 1996). One study, by Luszcz (1997) found only a modest amount of age-related variance in episodic memory, but found a significant difference in picture memory.

Fortunately, people are very adaptive. Bower (1997) found that "when allowed to collaborate, elderly couples who have been married for 40 years or more remember what they read better than young married couples or individuals." Also, Burack (1996) found that list-making significantly improves older adults' performance on recall tasks, narrowing the difference between older and younger adults. This is a promising finding for memory prosthetic design.

It is also interesting to note that older people tend to overexaggerate the effect of age on memory: "perceptions of decline did not correlate with actual changes" (McDonald-Miszczak 1995).

Older adults remember autobiographical events better if the event took place between the ages of 10-years-old and 30-years-old, and are less able to remember recent events than younger adults (Rubin 1997).

#### Research on Memory Prosthetics

Eldridge studied the value of adding video to aid in memory recall of work activities (1992). They found video to be helpful to remember the context of memories, but this might be less effective with older adults due to Luszcz's finding that picture memory decreased with age (1997). Because location is also an important cue for episodic memory, Harper's research on active badge systems, which give location information (1992), could be useful for the design on memory aids. For example, a system that tracked a person's movement through their house could help a person locate their car keys. In some ways, they are reminiscent of Star Trek's uniform emblems.

Newman's PEPYS system automatically created information on where a person went and the person they met, and aimed to see if their memories could be improved by doing so (1991). The results were somewhat mixed.

Mik Lamming and Mike Flynn developed a system called "Forget-Me-Not" which was designed with how episodic memory works in mind. This mobile computing device was supposed to help with common memory problems (Lamming 1994).

However, the most useful research I found was Mik Lamming (1994) "The Design of a Human Memory Prosthesis." In this article, Lamming describes how technology could augment human memory, and offers some design guidelines for the development of these devices.

## Design Recommendations

### *Seniors*

Yarnold found that touchscreens were the prefered method of input among older adults (1996) among the six varieties he tested. This may or may not be applicable for mobile computing, and probably ignored voice inputs. However, this form of input required the least training, was rated the most useful, and had the lowest completion time.

One common theme that ran through the literature on design for older adults was that these people do not like to be singled out as incapable. For example, many older adults "prefer to use a built-in soap holder for help getting in and out of the bathtub, rather than install a grab-bar" (Harper 1995). These issues go beyond simply designing effective interfaces. There are a broad range of physical, psychological, and sociological issues that affect whether technology is used, and as human factors engineers, we should not neglect the other aspects (such as the way the technology is presented) that will affect whether it is used or not.

### *Disabled*

### *Memory Prosthetics*

## Recommendations for Research

## Annotated Bibliography


ABLEDATA Web Site. www.abledata.com. "*An electronic database of information on assistive technology and rehabilitation equipment available in the United States. With more than 23,000 product listings, ABLEDATA covers everything from white canes and adaptive clothing to low-vision reading systems and voice output programs. Each product record provides a detailed description of the item, complete company contact information, and distributor listings (where applicable). In addition to commercially available products, the data-base also lists noncommercial proto-types, customized, and one-of-a-kind products.*"

Agency for Health Care Policy and Research
http://text.nlm.nih.gov/ftrs/pick?collect=abcpr&dbName=0&t=872374413 *Eighteen clinical practice guidelines are available from this US government agency site. Users can access full-text versions of the guidelines, quick reference versions, or patient guides in English or Spanish. **

Alliance for Technology Access. www.ataccess.org. "*A nationwide network of forty-two community-based technology resource centers and seventy technology vendors and developers working to increase access to technology by people with disabilities.*"

American Association of Retired Persons (AARP). (current) http://www.aarp.org *Has a useful guide to Internet resources.*

American Geriatrics Society http://www.americangeriatrics.org/ *The home page of this society has information on membership, faculty development opportunities, annual meeting information, professional publications, and a patient education forum (with questions and answers).**

Anonymous. (1995, October 28). Rescuing Memories With Age (although some memory loss comes with old age, studies indicate that older people may devise memory strategies that will overcome some of the effects of aging on memory). Science News, 18: 283. *Discusses what part of mental facilities degrade with age, and finds that some of these declines can be overcome by certain type of mental activity: "Because professors must frequently integrate new information into an existing knowledge base, [older professors] may devise memory strategies that overcome some of the biological glitches of the aging brain, the investigators propose in the September Psychological Science."*

Anonymous. (1996, March 7). Computers: Who Buys Them? (Market For Personal Computer Grows in the US And Russia) Moscow News, 9: 9. *"A survey conducted by the SeniorNet, which teaches computer literacy to elders, reveals that ownership of a computer in the 55-74 age group has grown by 43% in 16 months from July 1994 to 1995. The finding goes against the established notion that elderly people ignore technological advancements."* •••••

Anonymous. (Unknown). Special Needs Services: a First Overview http://www.fen.bris.ac.uk/elec/UMPTIDUMPTI/DOCUMENTS/d12_v1.html. *This web page details the issues for senior and disabled users of mobile phones and computing devices.*

Appleby, Chuck. (1995, March 5). Retro Tech. Hospitals & Health Networks, 5: 40-42. *Abstract: "More powerful personal computers and integrated health care systems have made some high technology innovations introduced in the 1980s obsolete before even becoming popular. Some of the ill-fated ideas include picture archiving and communications systems, smart cards storing personal health histories, bedside computers, use of bar codes and computerization of all patient information. Providers and practitioners have learned that solutions to health care problems are more complex than the latest gadget." Might provide examples of previous technologies that didn't work, and give insight into some design principles that should be encorporated into mobile devices for seniors.*

Baran, Nick. (1996, March). Get Smart - Wear a PC. Byte, 3: 36. *Has some information for visually impaired applications.*

Barber, Paul. (1988). Applied Cognitive Psychology: an Information-Processing Framework. London: Methuen. *Includes several pages about car phones and cognitive load.*

Bergman, Eric, and Earl Johnson. (1995). Towards Accessible Human-Computer Interaction. http://www.sun.com/tech/access/updt.HCI.advance.html. *Defines and discusses accessibility, accessibility design issues, and the capabilities and needs of users with various disabilities. It then presents guidelines for increasing application accessibility, and discuss future directions for improving accessibility.*

Bowe, Frank. (1988, August-September). Why Seniors Don't Use Technology. Technology Review, 6: 34-40. *Talks about the reasons seniors don't use technology. Asserts the largest reason is because seniors don't want to act like they need help or assistance, and talks about the implications of this.* •••••

Bower, Bruce. (1997, September 13). Partners in Recall: Elderly Spouses Build Better Memories Through Collaboration. Science News, 11: 174-5. I *thought this article might give insight into different ways of using memory. Perhaps computers can act like collaborative devices. "when permitted to collaborate, elderly couples who have been married for 40 years or more remember what they read better than young married couples or individuals."* •••••

Brandenburg, Sara and Gregg Vanderheiden. (year unknown). "Communication, Control, and Computer Access for Disabled and Elderly Individuals". *The book is ten years old, and probably doesn't have any information on mobile devices, but may be useful nonetheless.*

Brink, Satya. (1997, Fall). The Twin Challenges of Information Technology and Population Aging. Generations, 3: 7-10. *Talks about interface issues, older people's effect on designs, designs effect on older people, and explores the possibilities of technology for the elderly. Well written and a good overview of the ways technology could be helpful for seniors, but also shows how seniors could be excluded from the benefits of these technologies.*

Brisbin, Shelly. (1997, February). Powerbook for the Disabled: Customized Powerbook 5300s with Multiple Controls Find New Life as Innovative Laptops for the Disabled. MacUser, 2: 24. *Provides examples of how mobile computing devices are being designed for disabled users.* •••••

Bryan, Janet, and Mary A. Luszc. (1996, March). Speed of Information Processing as a Mediator Between Age and Free-Recall Performance. Psychology and Aging, 1: 3-9. *Abstract: "The task-independent speed of information processing as measured by the Digit Symbol*

*Substitution Test acts as an intermediary between age and free-recall performance. The recall performance of younger adults is better than that of older adults. Increasing the number of rehearsals improves recall in younger adults but not in older adults. Younger adults are faster on all speed-of-processing measures and possess a higher backward word span."* •••••

Burack, Orah R., and Margie E. Lachmanource. (1996, July). The Effects of List-Making on Recall in Young and Elderly Adults. The Journals of Gerontology, Series B, n4: P226-233. *Found that list-making significantly improved older adults' performance on recall tasks. Additionally, found that differences in recall were narrowed between age groups when the participants made lists beforehand (they were not allowed to see the list when doing the recall).* •••••

CHI '97, Making computers easier for older adults to use: area cursors and sticky icons. 266-271. *Looks at input for the elderly.*

Chilton, David. (1998). The Wealthy Barber. Updated 3rd edition. Prima Publishing. •••••

de Klerk, Mirjam M.Y., Robbert Huijsman, and Joseph McDonnell. (1997, June). The Use of Technical Aids by Elderly Persons in the Netherlands: An Application of the Andersen and Newman Model. The Gerontologist, 3: 365-373. *Studied which segments of the elderly population use technical aids most, and what the determining factors were: "Whether or not elderly people use mobility aids or technical aids for basic activities of daily living (ADLs) is mainly predicted by need (functional status, chronic illnesses) and predisposing (gender, housing) variables. The number of used technical aids can be explained by predisposing (age, housing, education), enabling (income, receiving help), and need (functional status, chronic illness) variables. As opposed to others, in this study elderly people with a high income were less likely to use many mobility aids than people with an average income. We could not offer a plausible explanation for the nonlinear relationship between income and the number of technical aids used."*

Dickerson, John F. (1995, Spring) Never Too Old; Millions of Senior Citizens are Getting Connected to the Net. Time, 12: 41. *Abstract: "Millions of senior citizens are using computers, networks and online services. Computer classes for seniors are springing up across the US. Seniors communicate with each other and make lasting friendships on forums such as SeniorNet on America Online."* •••••

Dominguez, Joe, and Vicki Robin. (1992) Your Money Or Your Life. New York: Penguin Books.

Dunman, Susan. (1997, October 1). Webwatch (World Wide Web Sites on Aging). Library Journal, 16: 33-34. *"Look closely, and the gradual graying of the Internet becomes undeniable. A recent poll indicates that 19 percent of all Internet users are age 50 or over."* •••••

Einstein, Gilles O., Rebekah E. Smith, Mark A. McDaniel and Pat Shaw. (1997, September). Aging and Prospective Memory: the Influence of Increased Task Demands At Encoding And Retrieval. Psychology and Aging, 3: 479-488. *Background activities can have a significant impact in impairing the performance of prospective memory tasks. Age differences are apparent when background activities are demanding. Prospective memory performance is affected in younger adults as well as the aged when background activities are increased.* •••••

Eldridge, Margery, Michael Lamming, and Mike Flynn. (1992). Does a Video Diary Help Recall? People and Computers VII, A. Monk, D. Diaper, and M.D. Harrison (eds), Cambridge University Press, Cambridge, 257-269. *Studies the value of video recording in aiding the recall of work activities. Has implications for memory prosthetics.* •••••

Encyclopedia Brittanica *had some information on memory and aging that I thought was useful*. For example: http://www.eb.com:180/cgi-bin/g?DocF=macro/5004/57/184.html and http://www.eb.com:180/cgi-bin/g?DocF=micro/537/30.html.

Erlich, Reese. (1993, March 29). Mac Technology Aids Disabled Users: Conference Features Range of Interfaces (Vendors Introduce Products At 1993 Technology and Persons With Disabilities Conference). MacWEEK, 13: 7. *Discusses technologies available for disabled users, such as voice interfaces for the blind.*

Essex, David. (1995, June). Rewriting Handwriting Recognition. Byte, 6: 150-151. *Overview of research and design issues for handwriting recognition.*

Flynn, Mary Kathleen. (1996, June 10). Plugged-in Seniors (Seniors on the Internet). U.S. News & World Report, 23: 94-5. *"Some 20 percent of households headed by people age 60 or older owned a PC by the end of last year--a jump of 31 percent in a year, says Computer Intelligence, a market-research firm in La Jolla, Calif. They're using PCs to make friends, research concerns from Alzheimer's disease to estate planning, run home businesses and E-mail distant relatives for the price of a local call."* •••••

Gerontological Society of America http://www.geron.org/ *Contains links to publications (journals and newsletters) sponsored by the society and more.*

Gilly, Mary C., and Valarie A. Zeithaml. (1985, December). 1985 The Elderly Consumer And Adoption Of Technologies.: Journal of Consumer Research, v12 n3 p353(5). *Abstract: "Adoption of a number of key consumer-related technologies by the elderly are*

*examined, particularly the use of scanner-equipped grocery stores, electronic funds transfer, automated teller machines, and custom telephone calling services. The adoption of each technology by an elderly and non-elderly sample are compared, with the results indicating that lower percentages of elderly consumers were in the process of trying and adopting most of the innovations. The study also indicated that the elderly are most likely to use electronic funds transfer, and that they rely on sources of information at different levels than non-elderly do to learn about the innovations."*

Harper, Doug. (1995, Spring) Ease and Independence Without Stigma: Three New Products that Work. Generations, 1: 58-62. *Talks about physical, psychological, and sociological factors behind an elderly person's willingness to use technology. Gives the example that "many, for example, prefer to use a built-in soap holder for help getting in and out of the bathtub, rather than install a grab-bar." These type of issues have reprocussions for mobile computing design.* •••••

Harper, R.H.R., M. G. Lamming, and W. M. Newman. (1992). Locating System at Work: Implications for the Development of Active Badge Applications. Interacting with Computers, 3: 343-363. *Discusses location information systems.* •••••

Kaplan, Deborah. (1997, Fall). Access to Technology: Unique Challenges for People with Disabilities. Generations, 3: 24-37. *"[The survey] shows that the elderly experience disability at roughly twice the rate of those in the older working ages (45-64) and four times the rate of the younger working-age group (18-44).* •••••

Lamming, Michael G. (1994, February 2-4). Towards Future Personalised Information Environments. Proceedings of FRIEND21, '94 International Symposium on Next Generational Human Interface. *I think the 1404 class should all read this article. Lamming talks about future directions that PDAs may go, and calls them intimate computers.*

Lamming, Michael G., and William M. Newman. (1992). Activity-based Information Retrieval: Technology in Support of Personal Memory. Personal Computers and Intelligent Systems (Proceedings of Information Processing '92) F.H. Vogt (ed), Elsevier Science Publishers B.V., Amsterdam, The Netherlands, 68-81. *Abstract: "Much information is hard to retrieve because the need to do so was not foreseen at the time the information was stored. This problem appears hard to solve with the aid of computers. however, research in the area of autobiographical memory suggests the useof retrieval cues relating to the kinds of activities in which the user was engaged at the time of storage. These are highly correlated with the time at which the event took palce, and thus can be used for indeing, taking advantage of the accurate time-stamps that computers usually apply automatically when information is stored. In the proposed activity-based retrieval system, data on the user's activity are gathered automatically to support retrieval by, for example, browing through an 'autobiography' of work episodes. The paper discusses some of the difficulties with this approach,a nd presents the results of three experiments in which autobiographical episodes were reconstructed by means of automatically collected activity data. It conlcudes with some comments on the technical feasibility and social acceptability of such an approach to information retrieval."*

Lamming, Mik, et. al. (1994). The Design of a Human Memory Prosthesis. The Computer Journal, 3: 153-163. *This is the most useful article I've found on memory aids. This article describes the different types of human memory, and explores ways that technological aids can augment that memory. It also explores in detail the design aspects of memory prostheses, and gives some design guidelines.* •••••

Lamming, Mik., and Mike Flynn. (1994). "Forget-Me-Not" Intimate Computing in Support of Human Memory. Proceedings of FRIEND21, '94 International Symposium on Next Generational Human Interface. *Talks about using mobile computing devices to aid with everyday memory problems, such as finding a lost documents, remembering someone's name, or remembering how to use a piece of machinery. It does this by taking advantage of how human episodic memory works.* •••••

Lansdale, M. and Edmonds, E. (1992), Using Memory for Events in the Design of Personal Filing Systems, International Journal of Man-Machine Studies. 36: 97-126.

Lazzaro, Joseph J. (1990, August). Opening Doors for the Disabled: Adaptive Technology Lets Blind, Deaf, And Motor-Disabled Personal Computer Users Lead More Productive Lives. Byte, 8: 258-265. *Abstract: "Adaptive microcomputer technology enables people with sensory or physical disabilities to lead more productive lives by though facilitating the use of personal computers (PCs) to explore employment, educational and social opportunities. Adaptive hardware and software for the visually impaired include optical character recognition systems that output hardcopy text in synthetic speech, screen readers that output speech, software that displays very-large print, printers that output Braille, and Braille terminals. Adaptive computer products for the deaf include a modem that handles ASCII and Baudot communications, the latter for the TDD telecommunications used by the hearing impaired. Individuals with motor disabilities can be assisted with voice-recognition hardware, adaptive keyboard designs, macro generators, and point-and-shoot devices. A variety of adaptive products are described."* •••••

Littler, Martin. (1994, October 28). A Special Kind of Help. Times Educational Supplement, 4087: A24. *Abstract: "The 'Closing the*

*Gap' seminar program, held in Minneapolis every year, helps teachers, therapists and technologists discuss how technology can be used to overcome physical, communication and sensory barriers to learning. These innovations include Berkeley Systems's software 'outSPOKEN' to enhance blind people's access to desktop computers and Don Johnston's IntelliTools, which provides information for switch users."*

Loftus, E.F. and Marburger, W. (1983). Since the Eruption of Mount St. Helens, Has Anyone Beaten You Up? Improving The Accuracy Of Retrospective Reports With Landmark Events. Memory and Cognition, 11: 114-120. *Elizabeth Loftus has many articles based on peoples ability to accurately recall previous events. These may be useful for understanding memory better for memory prosthetics.*

Lunzer, Francesca Z. (1989, March 6). Small Gadgets That Can Change Lives: Aging - Handy Technology Lets Older People Who Need Help Reclaim Their Independence. U.S. News & World Report, 9: 58-60. Discusses design issues for the elderly, and how to design products that benefit the elderly, but are also useful for other people.

Luszcz, Mary A., Janet Bryan and Patricia Kent Source. (1997, June). Predicting Episodic Memory Performance of Very Old Men and Women: Contributions from Age, Depression, Activity, Cognitive Ability, and Speed. Psychology and Aging, 2: 340-351. *Studied the effects of age on episodic memory. Found only a modest amount of age-related variance. Picture memory varied most according to age. General processing speed was important in mediating memory variance related to age.* •••••

McDonald-Miszczak, Leslie, Anita M. Hubley, and David F. Hultsch. (1996, March). Age Differences in Recall and Predicting Recall of Action Events and Words. The Journals of Gerontology, Series B, 2: P81-90. *Found that among women, age differences in global prediction and recall performances are higher with verbal materials than with subject performance tasks (SPTs). Global predictions are more accurate and higher for SPTs than with verbal materials.*

McDonald-Miszczak, Leslie, David F. Hultsch and Christopher Hertzog. (1995, December). Stability and Accuracy of Metamemory in Adulthood and Aging: a Longitudinal Analysis. Psychology and Aging, Dec 1995 v10 n4 p553(12). *Abstract: "Adults were more likely to report memory decline as they age because they believe that memory decline is an inevitable aspect of aging. Adults whose memories were monitored for a period of two years and another group whose memories were tested in a period of six years reported that their memories were failing, showing how perceptions of decline did not correlate with actual changes. This finding questions the accuracy of tests for self-reporting memory function in aging." Interesting because it shows that memory failure is partially explained by the expectation of memory failure.* •••••

McGuire, Francia A. (year unknown). Computer Technology and the Aged. *This is not a current book, but may be useful.*

Memory http://alethea.ukc.ac.uk/Dept/Computing/Seminars/postgrad/951214

NACDA Data Archive http://www.icpsr.umich.edu/NACDA/archive.html *The National Archive of Computerized Data on Aging, maintained by the Inter-university Consortium for Political and Social Research at the University of Michigan, Ann Arbor, is a database searchable by topic or researcher. Data on demographics, social characteristics, economics, psychological characteristics, and health care needs of older adults in the United States are available. Results are displayed in an abstract format, but users can also view the actual data sets.* *

National Institute on Aging http://www.nih.gov/nia/ *On this site maintained by the National Institute on Aging, a division of the National Institutes of Health, users can read about research and funding opportunities. One section offers news releases about issues pertaining to aging research. The Health Information section features several online publications and pamphlets for professionals and patients. Topics covered include Alzheimer disease, menopause, cardiovascular disease, and urinary incontinence.* *

Newman, William M., Margery A. Eldrige, and Michael G. Lamming (1991, September 25-27). PEPYS: Generating Autobiographies by Automatic Tracking. Proceedings of ECSCW '91, Amsterdam, The Netherlands, 175-188. *A memory prosthetes project at EuroPARC that aims to see if human memory can be improved by automatically capturing contextual data about human activities.* •••••

Noer, Michael. (1995, September 25). Senior Cybernauts (Internet Access Benefits for Elderly). Forbes, 7: 240-241. *Says: "elderly users [are] at 1% of the Internet population, but computer use in that population segment has grown an estimated 15% annually since 1990." Also, a study showed that elderly users who were given access to computers and the Internet were less depressed after six months.* •••••

Novack, Janet. (1995, January 16). Making the golden years golden. (technology and elderly independence). Forbes, 2: 98. *Discusses many areas in which technology has helped elderly people, and areas where it may in the future. "Duke University demographer Kenneth Manton and associates analyzed three national surveys done from 1982 to 1989. They found that in 1989, 22.6% of the elderly in the survey needed either devices or other folks to help them with the basics."* •••••

Nyberg, Lars, Lars Backman, Karin Erngrund, Ulrich Olofsson, and Lars-Goran Nilsson. (1996, July). Age Differences in Episodic Memory, Semantic Memory, and Priming: Relationships to Demographic, Intellectual, Biological Factors. The Journals of Gerontology, Series B, 4: P234-240. *Abstract: "This study examined age differences in episodic memory, semantic memory, and priming using a random sample of 1,000 men and women from 10 age groups (35, 40, 45, . . . 80 years). The main purpose was to determine whether an age effect existed after differences on various demographic, intellectual, and biological factors had been controlled for. The simple correlations of age with episodic and semantic memory performance were found to be significant, whereas no relationship was found between age and levels of priming. After controlling for differences on the background factors, age predicted episodic but not semantic memory performance. It is proposed that the failure to account for the age effect on episodic memory is because it is caused by age-related neuronal changes."*

Park, Denise C., Christopher Hertzog, Daniel P. Kidder, Roger W. Morrell and Christopher B. Mayhorn. (1997, June). Effect of Age on Event-Based and Time-Based Prospective Memory. Psychology and Aging, 2: 314-327. *Abstract: "Prospective memory relates to retrieval of intentions from long-term memory needed to carry out plans like taking medicine or meeting people. Older adults tend not to perform well on time-based prospective memory tasks, and this is especially true when memory load is also involved. This indicates that the difference cannot just be attributed to poor time monitoring. Age differences are also apparent with event-based prospective memory and event-based responding appears to need a major input in terms of attention."* •••••

Peters, Richard, and Robert Sikorski. (1997, October 22). Vintage care: geriatrics resources on the Net. The Journal of the American Medical Association, 16: 1299-1300. *"People 65 years of age and older already constitute an estimated 5% of Internet users, and their numbers are expected to grow quickly. (footnote: Cortese AA. Census in cyberspace. Business Week. May 5, 1997:84.)"* •••••

Pirkl, J. J. (1994). Transgenerational Design: Products for an Aging Population. New York: Van Nostrand Reinhold. *I haven't looked at this, but it looks promising.*

Post, Joyce A. (1997, February). Internet Resources on Aging: Increasing Options and Human Factors. The Gerontologist, 1: 125-129. *May have human factors information, but may also just be a coincidence.*

Rubin, David C., and Matthew D. Schulkind. (1997, September). Distribution of Important and Word-Cued Autobiographical Memories in 20-, 35-, and 70-year-old Adults. Psychology and Aging, 3: 524-535. *Abstract: "The ability of older adults to recall autobiographical events is greatest for those events that occurred between ages 10-years-old and 30-years-old, described as a bump. Memories can be triggered by word cues. All adults have fewer memories from childhood than from other years. Older adults aged 70-years-old and 73-years-old are less likely to recall recent events than are younger adults. Memories from the bump period only differ from other memories in being more frequent."* •••••

Rule, Jane. (year unknown). Memory Board. *Apparently, this book talks about how a senior used a "memory board" to maintain her relationship with her grandchildren. It is fiction.*

Seniors Computer Information Project. (1998). http://www.crm.mb.ca/scip/ *This website has web conversations and services for seniors. It is interesting not only for the information there, but it shows what is drawing seniors' interest.*

Trace Research and Development Center. http://trace.wisc.edu. *Contains design and usability guidelines for designing technology for disabled people.*

Tulving, E. (1983), Elements Of Episodic Memory, Oxford University Press. *Episodic memory is the type of memory most important for memory prosthetics, and this book was recommended to me for understanding episodic memory.* •••••

U.S. Department of Health and Human Services. (current). Administration on Aging (AOA). http://www.aoa.dhhs.gov *Contains a section for researchers.*

Van Hees, Maartje M.W. (1996, Fall). User Instructions for the Elderly: What the Literature Tells Us. Journal of Technical Writing and Communication. 4: 521-536. *Contains an investigation of the gerontological research literature to find out what is already known about age deficiencies in cognitive processes which might adversely influence instructional text processing. Offers some guidelines on how to design manuals for the elderly.*

Verbrugge, Lois M., Catherine Rennert, and Jennifer H. Madans. (1997, March) The Great Efficacy of Personal and Equipment Assistance in Reducing Disability. The American Journal of Public Health, 3: 384-392. *Abstract: "Objective: Personal and equipment assistance are common strategies to reduce disability. This study sought to determine how often assistance reduces or even completely resolves health-related difficulties in everyday tasks. Results: Most people use assistance for the 12 tasks; "personal assistance only" is the principal type used for upper-extremity and body transfer tasks; "equipment only" ranks first for lower-extremity tasks. Assistance reduces difficulty for the great majority of persons (75% to 85%) and completely resolves difficulty for about 25%. Equipment only proves to be the most efficacious strategy for reducing and resolving limitations. Conclusions: Equipment's*

*success may be due to greater perceived gains when people accomplish the assistance by themselves."*

Waldrop, M. Mitchel (1985). Machinations of Thought, Science, 85: 38-45. *This article was recommended to me.*

Yarnold, Paul R., Michael J. Stewart, F. Conrad Stille and Gary J. Martin. (1996, April). Assessing functional status of elderly adults via microcomputer. Perceptual and Motor Skills, 2: 689-690. *Tested six different forms of computer-based interactive methods on adults 65 years or older. Touchscreen input required the least training, was rated most useful, and had the lowest completion time.*•••••

## Expected Results/Contributions

I expect that this project will lead to the following contributions:

* recommendations and categorizations of the types of problems that seniors face with mobile computing devices. This will be helpful because it will give future designers an understanding of the issues that they're facing.
* description of where the research is directed. This will provide a road map of where the technology and design focus is going, and identify areas that could be fruitful for future research.
* description of likely applications for seniors that would be useful and successful, given the limitations and possibilities of mobile computing devices.

## Challenges and Concerns

This project is challenging because it may be fairly new. Although this is an issue many companies may be looking at, their research is not publicly available. My very cursory research over this last weekend did not reveal very many sources of information on the topic. However, I believe the information is available somewhere, but just hard to locate. Thus, my first challenge will be to locate useful information on this topic. I anticipate there will be a fair amount of information on seniors and computers, but little on mobile computing for seniors.

Another challenge I anticipate is my review of the literature on memory. I believe it is important to study how memory works, and to understand Alzheimer's Disease so that I can assess memory aids and the needs of seniors more effectively. However, this is a well-developed field of psychology, and, in this case, the amount of information is too abundant. I will need to locate some excellent sources that are also understandable to someone without a degree in psychology. I will have to be efficient in my overview of this section, so that it doesn't consume too much of my energy, because it's not my main focus of this report.

A third problem I am facing is the definition of the topic. I see two topics here: memory prosthetics and designing mobile computing devices for the elderly and disabled. I think I will concentrate on the second, but also look at memory prosthetics as they apply to elderly and disabled people. The problem here is that I am finding these topics to be very large, but also not very well covered. Thus, I have to sift through a lot of data to get any useful information.

## Messy Notes That I Won't Dare Put in the Final Report

The Rehabilitation Engineering and Assistive Technology Society of North America (RESNA), an interdisciplinary association for the advancement of rehabilitation and assistive technologies, operates a technical assistance program for the state assistive technology projects and maintains a database with contact information for each state. Its main telephone number is 703-524-6686, its fax is 703-524-6630, and TTY is 703-524-6639. Its mailing address is RESNA, 1700 North Moore Street, Suite 1540, Arlington, VA 22209-1903. General e-mail for RESNA is: natloffice @resna.org. General e-mail for the technology assistance project is resnata @resna.org.

Czaja, Sara. She has a chapter (Chapter 34, Computer technology and the older adult) in the second edition of the handbook of HCI which is a must read for you. Can you get a copy of this chapter? If it is difficult then we can make a copy of it from our source in the lab.

Memory Prostheses and PDA's to Date (Apple Newton, PARC Tab, Pepys, Video Diary, NoTime, Philips Nino