How Can Technology Contribute to the Quality of Life of Older Adults?

Wendy A. Rogers & Elizabeth D. Mynatt
Georgia Institute of Technology

Rogers, W.A., and Mynatt, E.D. (2003). How can technology contribute to the quality of life of older adults? In M.E. Mitchell (Ed.), *The technology of humanity: Can technology contribute to the quality of life?* (pp. 22-30). Chicago, IL: Illinois Institute of Technology.

How can technology contribute to the quality of life of older adults?

Independence...quality of life...and remaining in familiar, comfortable surroundings — these are goals of many older adults. Through the application of science and technology these goals may be achieved. An innovative research program at Georgia Institute of Technology has focused on developing computer technology to support the independence and quality of life of older adults by enabling them to remain in their own homes. This Aware Home Research Initiative consists of an interdisciplinary team of computer scientists, engineers, and psychologists (http://www.cc.gatech.edu/fce/ahri/index.html). Their research and development activities are carried out in a residential laboratory (i.e., a high-tech home) on the Georgia Tech campus (see Figure 1). The theme of their work is "aging-in-place." In this paper we will review some of their current activities and the issues that must be addressed to successfully answer the question, "How can technology contribute to the quality of life of older adults?" (For additional details see: Essa, 2000; Kidd et. al., 1999; Mynatt, Essa & Rogers, 2000; Mynatt & Rogers, 2002).

Background

Technology has the potential to change lives — generally for better, but sometimes for worse. Obviously, technological developments in the past century have made fundamental improvements in many areas of our lives: transportation, work, communication, health care, and leisure activities. However, with such improvements has come a reliance on technology, and technological failures can have dire consequences. In addition, rapid changes in technology may leave segments of the population ill-prepared to interact with some of these complex systems, due to inexperience, lack of training, or poor system design.

There are currently more than 30 million Americans over the age of 65 (http://www.census.gov/population/www/socdemo/age.html). Imagine the technology changes they have observed in their lifetime. Since the 1930s, there has been mass-market dissemination of major technological developments such as television, microwave ovens, videocassette recorders, compact disk players, electric cars, answering machines, cellular telephones, and of course, desk-top, lap-top, and hand-held computers. For older adults to benefit from the advances that technology brings, but not be harmed by the potential for technological failures, we must ensure that: systems are designed with the capabilities and limitations of the older user in mind; proper training is provided; and the needs of older users are considered in the development of future technologies.

New technologies are only as successful as they are easy to use by all members of the user population. Efforts to reach older consumers are often hampered by lack of understanding of the abilities, requirements, and preferences of this population. Many computer-based systems have been designed with little regard for the potential older adult users. The demands of designing technology for older adults are clearly pointing the way for the human factors researchers and practitioners to take a more active lead in developing design specifications for everyday and advanced technology. Our current research efforts are designed to contribute to the design of and training for technologies that are usable, effective, and safe for use by older adults.

Home-based, environmental interventions, which

include assistive technologies, home modifications (i.e., physical changes in the home), and monitoring and communication technologies, can be effective strategies to compensate for functional limitations of older adults. These interventions can reduce difficulty in activities of daily living, enhance independence, safety, and security for older adults, and reduce the burden of care for caregivers (Connell & Sanford, 1997). In the long run, environmental interventions can be cost effective if they allow elders to remain in their own homes (Lanspery, Callahan, Miller, & Hyde, 1997).

The Aware Home

The Aware Home Residential Laboratory is a fully furnished, state-of-the-art, 5,040 square foot, two-story residence (see Figure 1). The two floors are identical apartments, each consisting of a full kitchen, dining area and living room, two bedrooms, two bathrooms, an office, laundry room. The apartments facilitate conducting advanced research on one floor while simultaneously being able to support experimentation on another floor. The basement contains a conference room with full multimedia presentation capabilities as well as a machine room, storage rooms, and two large project areas. The facility was constructed to look as much like a normal house as possible, with some concessions to facilitate research. There is a drop ceiling with hidden cable trays to permit rewiring and sensor installation. To facilitate computational perception research, indirect lighting was provided, high-gloss paints and chrome finishes were avoided, and the floor is bleached hardwood.

The Residential Laboratory has a 2GB connection to the campus Internet backbone, expandable to 12GB; and four independent ADSL points, with independent satellite feeds to digital TC through EchoStar and the DishNetwork, and over five miles of bundled network cabling, Category 5e Ethernet, and fiber. Network outlets provide access to 100Mbit Ethernet, analog video and fiber. All networking and video feeds are terminated at a FutureSmart patch panel in the basement for easy reconfiguring of network feeds to various rooms within the house. Reception (through ceiling-mounted microphones and worn wireless lapel microphones) and delivery (through speakers in the ceiling) of high-quality analog audio (soon to be digital) are located throughout the house. An array of 20 ceiling mounted NTSC analog video cameras are embedded in the first floor ceiling. Audio and video signals are sent to the basement for control and processing. Each video feed is separately digitized in an array of computers in the basement.

The Aware Home serves as the focus of research and development efforts to support aging-in-place. State-of-the-art measurement of physical and cognitive impairments will provide critical information to guide development of appropriate and usable technologies for older adults. Most importantly, understanding the housing needs of older adults will drive the research and development efforts. Evaluation studies of monitoring, communication, and smart environment interfaces and technologies will lead to the development of useful and usable interventions. Training efforts are being designed to ensure that service providers as well as the older users themselves will be able to use the technology.

The Aware Home Research Initiative is certainly not the only effort to develop ubiquitous computing in the home. Other efforts, worldwide, are referred to as "smart" homes, or domotics, and discussions of some of the prototypes are available: www.smart-homes.nl; http://www.sentha.tu-berlin.de/; www.stakes.fi/cost219/smarthousing.htm; http://www.gdewsbury.ukideas.com/; http://www.cc.gatech.edu/fce/ahri/index.html.

In brief, existing efforts have focused on areas of safety (fire, smoke, intrusion), comfort (heat, lights, shades), communication (telephones, videophones, teleshopping, telehealth, telework), entertainmemt (device control, VCR programming), and remote management. In fact, a smart home is defined as "A home or working environment, which includes the technology to allow for devices and systems to be controlled auto-

matically (van Berlo, 1999, p. 6).

The Aware Home Research Initiative is meant to go beyond the "control" of home systems. The ubiquitous computing applications will augment the activities of the people living in the home — supporting their activities, providing interactive information to the home dwellers and selected individuals outside of the home, and enabling the development of predictive models of changes in capabilities based on trending information.

Successful independent living requires older adults to be capable of performing activities of daily living (ADLs) (bathing, toileting, eating), and independent activities of daily living (IADLs) (managing a medication regimen, maintaining the household, preparing nutritious meals; Lawton, 1990). Existence as an independently living, active older adult may also require willingness to accept new challenges and to engage in lifelong learning, referred to as enhanced activities of daily living (EADLs; Rogers, Meyer, Walker, & Fisk, 1998). All of the activities can potentially be aided by augmented environments; for example ADL supports during bathing such as temperature regulation, and monitoring the vital signs of the bather for signs of problems; IADL supports such as external cues to enhance medication-taking behavior, nutritional information and support for meal-preparation; and EADL supports such as supports for social communication and leisure activities.

Support for Communication

Communication technologies are a critical means to ensure safety and independence of older adults with disabilities through providing access to health care providers and caregivers. Coincident with the health care needs of older adults are their needs for social support. Awareness of an older adult's well being is crucial to family members and caregivers who must make decisions about an older adult's ability to function safely in their own home. Moreover, from the perspective of the older adults, communication with family and friends can reduce feelings of isolation and loneliness and lead to a better quality of life.

Isolation and depression are significant problems with some older adults, especially older adults with disabilities (Mynatt, Adler, Ito, Linde, & O'Day, 1999). Although appreciative of their independence, or unable to afford a long-term assistive care setting, increasing health problems, lack of transportation, and lack of motivation can collude to feelings of isolation. Moreover, communication and awareness between older adults and their extended family members is often key to an older adult's safety and independence.

A holistic perspective on aging in place requires communicating information to extended family members and caregivers who are involved in decisions (e.g., making modifications to the home or health care needs). In-home monitoring systems have the potential to inform family members about daily activities, health status, and potential problems. One prototype we have developed is the Digital Family Portrait (Mynatt & Rogers, 2002; Mynatt, Rowan, Craighill, & Jacobs, 2001). This device provides a qualitative view of the well-being of a family member over a period of 28 days (see Figure 2 — left panel).

The Digital Family Portrait is an in-home monitoring system to inform family members about an older relative's daily activities, health status, and potential problems, as well as information about patterns of activities over a period of time (see Figure 2 — right panel). The Digital Family Portrait creates a visualization of the older person's day at home from available sensor information and displays the information to a family member in a different location. This Digital Family Portrait is created by framing a flat panel display and connecting it to a standard personal computer. Various sensing technologies (e.g. radio frequency badge tracking and computer vision) can be integrated into the interface. The goal of this project is to integrate the digital family portrait with different levels of sensing technologies in home environments to evaluate its effectiveness in augmenting communication and awareness between family members.

Potential future projects with this system involve the development on next-generation systems based on the results of research that identifies specific barriers to the use of current communication technologies. Such systems might employ new technologies and interfaces that would facilitate unrestricted communication as the person moves throughout the home, persistent displays that support on-going awareness of a remote individual or place, automatic transmission of awareness information to remote caregivers, new forms of expression amenable to young children staying in touch with their grandparents, and light-weight interaction for casual communication to peers and neighbors.

New communication technologies must be designed to meet the needs of aging adults and their extended families. Future systems should enable communication practices unsupported by traditional communication technologies. Devices might also be designed to foster other critical forms of communication such as peer-to-peer awareness for older adults.

Supporting Home Health Care

Medical devices are designed to improve the health of an individual. Advances in the technology of medical devices may enable individuals to take an active role in their own health maintenance. One example is the use of hand-held, battery-operated meters that are used by patients with diabetes to check their blood glucose levels. The development of home-based blood glucose meters in the 1970s allowed diabetics to self-monitor their blood glucose levels (Fleming, 1994). Self-monitoring of blood glucose levels allows diabetes patients to determine blood sugar levels and adjust diet, insulin, or exercise to effectively manage their diabetes (National Diabetes Information Clearinghouse, 1999).

The advent of self-care, unfortunately, has some negative consequences as well. If the patient takes responsibility for monitoring blood glucose levels, there is no longer a health care professional involved in the process (except, of course, during doctor's visits). Accordingly, there may be an increase in the occurrence of errors in the use of blood glucose meters. Such errors can have serious consequences for the short- and long-term health of the individual, particularly because treatment is often determined from glucose level readings.

Support for the use of medical devices is a potential domain in which an aware home could contribute tremendously. In our previous work, we have found that blood glucose monitors are not trivially easy to use and the instructions provided by the manufacturer are ineffective (Rogers, Mykityshyn, Campbell, & Fisk, 2001). In addition, it has been reported that even experienced users make errors (Colagiuri, Colagiuri, Jones, & Moses, 1990).

Successful use of many medical devices involves completing a series of sequential steps — one error in the process may invalidate the entire sequence. Even with well-designed training programs, both younger and older adults make errors in the process of using and calibrating the device (Mykityshyn, Fisk, & Rogers, in press). Planning how and when to complete the various components can be working memory intensive, and it may be especially difficult for older adults to maintain their monitoring of where they are in a sequence of actions if they are interrupted in some way. Future research in the Aware Home will include the development of environmental supports for the use of medical devices.

Technology Use by Older Adults

Acceptance. Older adults are willing to use new technologies, contrary to some stereotyped views. Older adults are more accepting if they are provided with adequate training (Rogers, Cabrera, Walker, Gilbert, & Fisk, 1996) and if the benefits of the technology are clear to them (Melenhorst, Rogers, & Caylor, 2001). Moreover, field trials of intelligent home monitoring systems have been implemented successfully with adults aged 60-85 (see e.g., Sixsmith, 2000).

Within the home environment, one strategy for increasing acceptance of ubiquitous computing is to

introduce it gradually, to older adults who are still high functioning (e.g., in their 50s and 60s) and to increase the supports provided by the technologies as the individual's abilities decline (e.g., in their 70s and 80s). An important research question is to determine how to identify these transition points — such decisions could be based on trending data from computational perception applications.

Older User Capabilities and Limitations. Understanding age-related changes in motor movement, sensory processing, and cognitive functioning will be critical for the design of effective systems and home modifications. As people age, motor behaviors change such that older adults take longer to make movements, ability to maintain continuous movements declines, coordination is disrupted, and movements are more variable (Vercruyssen, 1997). Age is associated with reductions in all sensory abilities: including vision, audition, taste, smell, and tactile sensitivity (Schneider & Pichora-Fuller, 2000). In addition, there are cognitive changes that accompany the normal aging process (Craik & Salthouse, 2000). Aspects of memory (e.g., keeping information active in working memory), online reasoning ability, and aspects of attention such as attending to more than one source of information all show age-related declines. Abilities that tend to remain intact into old age include some aspects of memory (e.g., recalling well-learned information), verbal abilities such as vocabulary and reading, and some aspect of attention (e.g., focusing on a single source of information). Designers must recognize and accommodate those abilities that do decline while at the same time capitalize on the abilities that remain intact.

Design must be based on user needs assessment and partnered with a commitment to training users to effectively interact with the systems — then older users will be willing to embrace and use the systems. In addition, by making environmental supports part of the home, usable, and of relevance to individuals before they begin to experience age-related declines in motor, perceptual, and cognitive capabilities, acceptance will be smoother and more natural. The best assistive technologies are those that have become invisible to the user — tools that people use to accomplish a goal without thinking about the technology itself, such as the telephone or a radio (King, 1999).

Conclusions

This paper is based on a presentation made at the conference on "The Technology of Humanity," sponsored by the Institute for Science, Law, and Technology and the Institute of Psychology, Illinois Institute of Technology, Chicago, IL (April 2002). The organizers of the conference invited the presenters to consider a set of questions. Our answers to those questions provide a useful framework for our concluding remarks.

What does your research and experience suggest for future research? Future research in advanced computing technologies must explore how computational capabilities can enhance day-to-day activities. The computer should not be thought of as a tool to be picked up, used, and then set aside — it can be a constant partner in daily activities. The computer could notice when you are interrupted and help you regain your task. It could monitor your environment, and inform you of useful information. It could help you schedule your day to coordinate virtual visits from health care personnel and actual visits from family and friends. The challenge is to design interfaces that reflect and support on-going activity of daily life but not be inappropriately intrusive. Some of the issues are specific to the aging individual, such as what activities need to be supported, how the level of support should change to accommodate the changing needs of the individual, and how to develop interfaces that will be usable by the older persons and their family members. Other issues are more general to the nature of home-based ubiquitous computing such as technical, social, and pragmatic issues (Edwards & Grinter, 2001).

What are the implications for policy and regulation

related to your area? Older people aging with a disability are often an unrecognized segment of the population with respect to housing policy and services. In response to the urgent need to increase the availability of options for these individuals, President George W. Bush announced his *New Freedom Initiative* (2001) shortly after taking office. This initiative is, *to increase access to assistive and universally designed technologies and to promote full access to community life.* This landmark policy has broad implications for addressing the important concerns of increasing the availability of supportive technologies and housing that promote the health, independence, safety, and social participation of older adults.

What do you think needs to be incorporated in the design, implementation, and dissemination of technological advances to assure the most positive outcomes? Changing demographics and emerging technologies are creating new opportunities and increasing demand for sophisticated, marketable, affordable, and usable housing for older people. Housing interventions must accommodate changing skill levels of people with multiple impairments. Interventions can improve comfort and usefulness of housing without making houses "medical" or "different." We need to provide information to consumers, designers, service providers, and housing industry professionals. Science and technology together must provide the information needed to produce products and environments that are attractive, accommodating, and safe. There is serious need now for continuity and coordination of efforts, as well as research and information exchange if older adults are going to be able to successfully age in their homes.

What other disciplines need to be brought into your area of work to enhance it? The National Research Council (2000) recently published a report on recommendations for future aging research. One of their key recommendations was for "developing the knowledge needed to design effective technologies to support adaptivity in older adults" (p. 35). This goal has direct relevance to issues of improving the functional independence of older adults. The report also emphasized that for such a goal to be realized "it requires integrating behavioral science and engineering in a context of product design and development" (p. 36). Future efforts must leverage research in rehabilitation, computational perception, computer science, geriatrics, cognitive aging, human-computer interaction, sensory and mobility disabilities, and housing to design technologies to meet the needs of older adults in non-institutional settings. Success in this area requires a breadth of knowledge beyond any one discipline to understand the range of potential interventions including assistive technologies, environmental modifications, smart environment technologies, and combinations of these strategies. Expertise in the multiple disciplines relevant to the development of interventions that are compatible with the needs of older adults is essential to successfully carry out this research, disseminate the findings to appropriate audiences, and to train the next generation of researchers.

What risks within your area of work deserve consideration or additional research? Designing home technologies requires special consideration of issues of control; namely is the computer or the user in control of the interaction. It is possible to design a safe "high-tech prison" where the activities of the occupants are dictated by a set of computer services telling the occupant when and what to eat, sleep, and go to the bathroom. Although these basic activities are critical to good health, it is incumbant on designers to create technologies that enable occupants to make decisions for themselves yet provide necessary failsafes.

What new ethical dilemmas are raised by work in your area or allied areas? The use of aware services in the home raises the issue of privacy. How much information is collected about the occupant and who is privy to that information? For example, in the design of the Digital Family Portrait, only information that is socially appropriate to share between family members (as agreed upon by the family members) is transmitted. A

related issue is *security* of collected but not transmitted information. For example, raw video signals could be used by a service to determine and share changes in an occupant's gait following hip surgery. The raw video needs to be securely stored and deleted when possible to prevent unwanted disclosure.

Looking forward, what application of your work is likely but unintended or worrisome? One primary goal of the Aware Home Research Initiative is to support aging-in-place. To accomplish this goal, information about the occupant may have to be provided to family members or health care practitioners. While such information (such as activity levels, sleep patterns, etc.) may enable the older adults to maintain their independence, it is conceivable that such information could be used against them — in fact, it could be used to make the case that an individual should not be living alone any longer. Another unintended consequence of technology supports in the home might be that family members may over-rely on such technology and hence make fewer personal visits to the elder's home. Attempts to technologically support older adults could conceivably result in the withdrawal of other critically important supports.

In conclusion, we believe that the integration of technology with traditional assistive technologies and environmental modifications, can lead to interventions that will promote successful aging through enhancing the health, safety, independence, active engagement, and quality of life of older adults. This goal remains the focus of the multidisciplinary team working collaboratively in the Aware Home Residential Laboratory. We believe that success will depend on:

- Understanding the older adult as a whole person including sensory, motor, and cognitive capabilities;
- Considering the older adult in a broad context as part of a larger social unit;
- Evaluating the older adult in relation to their physical environment;
- Capitalizing on the strengths of multidisciplinary teams;
- Utilizing the unique environment provided by the Aware Home;
- Disseminating findings to industry, caregivers, designers, and older adults;
- Working with industry to ensure the viability of the developed solutions.

REFERENCES

Colagiuri, R., Colagiuri, S., Jones, S., & Moses, R. G. (1990). The quality of self-monitoring of blood glucose. *Diabetic Medicine, 7*, 800-804.

Connell, B. R., & Sanford, J. A. (1997). Individualizing home modifications recommendations to facilitate performance of routine activities. In S. Lanspery & J. Hyde (Eds.), *Staying put: Adapting the places instead of the People* (pp. 113-147). Amityville, NY: Baywood Publishing.

Craik, F. I. M., & Salthouse, T. A. (2000). *The handbook of aging and cognition.* Mahwah, NJ: Erlbaum.

Edwards, W. K., & Grinter, R. E. (2001). At home with ubiquitous computing: Seven challenges. In G. D. Abowd. B. Brumitt, and S. A. N. Shafer (Eds.) *Ubicomp 2001, LNCS 2201* (pp. 256-272). Berlin: Springer-Verlag.

Essa, I. (2000). Ubiquitous Sensing for Smart and Aware Environments, In *IEEE Personal Communications, Special Issue on Networking the Physical World.*

Fleming, D. R. (1994). Accuracy of blood glucose monitoring for patients: What is it and how to achieve it. *The Diabetes Educator*, 20, 495-500.

Kidd, C. D., Orr, R. J., Abowd, G. D., Atkeson, C. G., Essa, I. A., MacIntyre, B., Mynatt, E. D., Starner, T. E., & Newstetter, W. (1999). The Aware Home: A Living

Laboratory for Ubiquitous Computing Research. In the *Proceedings of the Second International Workshop on Cooperative Buildings — CoBuild'99.*

King, T. W. (1999). *Assistive technology: Essential human factors.* MA: Allyn & Bacon.

Lanspery, S., Callahan, Jr., J. J., Miller, J. R., & Hyde, J. (1997). Introduction: Staying put. In S. Lanspery & J. Hyde (Eds.), *Staying Put: Adapting the Places Instead of the People (pp. 1-22).* Amityville, NY: Baywood Publishing.

Lawton, M. P. (1990). Aging and performance on home tasks. *Human Factors,* 32, 527-536.

Melenhorst, A. S., Rogers, W. A., & Caylor, E. C. (2001). The use of communication technologies by older adults: Exploring the benefits from the user's perspective. *Proceedings of the Human Factors and Ergonomics Society 46th Annual Meeting.* Santa Monica, CA: Human Factors and Ergonomics Society.

Mykityshyn, A., L., Fisk, A. D., & Rogers, W. A. (in press). Learning to use a home medical device: Mediating age-related differences with training. *Human Factors.*

Mynatt, E. D., & Rogers, W. A. (2002). Developing technology to support the functional independence of older adults. *Ageing International,* 27, 24-41.

Mynatt, E.D., Essa, I., and Rogers, W. (2000). Increasing the Opportunities for Aging in Place. In *ACM Proceedings of the 2000 Conference on Universal Usability (CUU 2000, pp. 65-71).* Washington D.C.

Mynatt, E. D., Adler, A., Ito, M., Linde, C., & O'Day, V. L (1999). The Network Communities of SeniorNet. *Proceedings of the 6th European Conference on Computer Supported Cooperative Work (ECSCW 99, pp. 219-238).*

Mynatt, E. D., Rowan, J., Craighill, S., & Jacobs, A. (2001). Digital Family Portraits: Providing Peace of Mind for Extended Family Members. *Proceedings of the 2001 ACM Conference on Human Factors in Computing Systems (CHI 2001, pp. 333-340).*

National Diabetes Information Clearinghouse (1999). *Diabetes Statistics in the United States.* [Online]. Available: http://www.niddk.nih.gov/health/diabetes/pubs/dmstats/dmstats.htm.

Rogers, W. A., Mykityshyn, A. L., Campbell, R. H., & Fisk, A. D. (2001). Only 3 easy steps? User-centered analysis of a "simple" medical device. *Ergonomics in Design,* 9, 6-14.

Rogers, W. A., Cabrera, E. F., Walker, N., Gilbert, D. K., & Fisk, A. D. (1996). A survey of automatic teller machine usage across the adult lifespan. *Human Factors, 38,* 156-166.

Rogers, W. A., Meyer, B., Walker, N., & Fisk, A. D. (1998). Functional limitations to daily living tasks in the aged: A focus group analysis. *Human Factors, 40,* 111-125.

Schneider, B. A., & Pichora-Fuller, M. K. (2000). Implications of perceptual deterioration for cognitive aging research. In F. I. M. Craik & T. A. Salthouse (Eds.), *The handbook of aging and cognition* (second edition, pp. 155-219). Mahwah, NJ: Erlbaum.

Sixsmith, A. J. (2000). An evaluation of an intelligent home monitoring system. *Journal of Telemedicine and Telecare,* 6, 63-72.

National Research Council (2000). *The aging mind: Opportunities in cognitive research.* Washington, DC: National Academy Press.

van Berlo, A. (1999). *Design Guidelines on Smart Homes.* Available online: *http://www.stakes.fi/cost219/smarthousing.htm.*

Vercruyssen, M. (1997). Movement control and speed of behavior. In A. D. Fisk & W. A. Rogers (Eds.), *Handbook of human factors and the older adult (pp. 55-86).* San Diego: Academic Press.

Author Note

Research reported in this article was supported in part by the following grants: Grant P01 AG17211 from the National Institutes of Health (National Institute on Aging) under the auspices of the Center for Research and Education on Aging and Technology Enhancement (CREATE, one of the Edward R. Roybal Centers for Research on Applied Gerontology); Award 0121661 "The Aware Home: Sustaining the Quality of Life for an Aging Population" from the National Science Foundation; and the Aware Home Research Initiative industrial partners.

Figure 1. The Broadband Institute Residential Laboratory at Georgia Institute of Technology, referred to as the Aware Home.

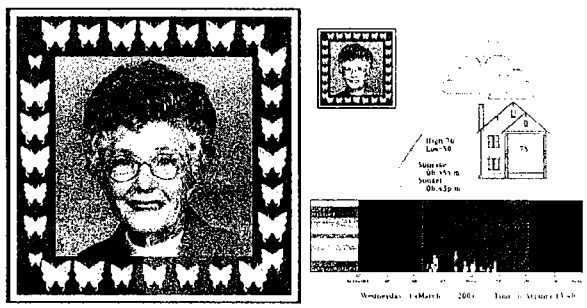

Figure 2. The Digital Family Portrait. At the left is the default display for a Digital Family Portrait. The photograph in the center is surrounded by 28 butterfly icons summarizing 28 days of information, in this case, overall levels of activity. Pictured on the right are details about each day, accessed by touching the butterfly for that day. Details include weather, indoor and outdoor temperature, and a detailed graph of a person's movement patterns within the home.