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Smart Housing: Technology to Aid Aging in Place - New Opportunities and Challenges

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SMART HOUSING: TECHNOLOGY TO AID AGING IN PLACE - NEW OPPORTUNITIES AND CHALLENGES

By

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We are at the threshold of a great change in architectural design. With cheaper and more ubiquitous computing, "smart" spaces and responsive environments are increasingly becoming plausible and affordable. Are we as architects prepared? Can the profession of architecture respond to current computing technologies? Most critics agree that one of the first (most important) problems that "smart" homes will help to address is that of spiraling costs of elderly healthcare. Even if there is a problem, the rural home is different from an urban home. Will the technologies that are designed for the urban home work in a rural setting? This research helps us to understand if architecture can really augment healthy aging in rural home settings. In conclusion, we will examine the role of architecture (and architects) in the context of ubiquitous computing and "smart" spaces in rural areas and propose a possible solution for this problem.

DEDICATION

I would like to dedicate this thesis to my parents.

ACKNOWLEDGEMENTS

I would like to acknowledge all my friends whose contribution to this research has been invaluable. I would like to thank my advisor Anijo Mathew for his guidance and support, I would also like to thank members of the Design Research & Informatics Lab (DRIL), Larry Barrow, Shilpi Kumar, and Sarah Pittman who have encouraged and helped me develop this research. I would like to thank my colleague Vikash Kumar Singh and, Shaima Al'Arayedh for their help and encouragement. I would also like to thank Melva and Sharon for helping us setting up the focus groups. The following schools, departments and agencies gave us additional support for this research – MSU-CAAD; MSU-SSRC; MSU-CAVS; MSU-Office of Research; and the city of Meridian, MS. Last, but not the least (in any manner), we acknowledge our librarian, Susan Hall, without whose help this research would have been incomplete.

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GLOSSARY OF TERMS

Aging in place: This refer to the idea of the aging person remaining in his or her won home rather than in another setting.

Ambient agora: Ambient agora an EU-funded project (www.ambient-agora.org). This project is based on calm or ambient technology to integrate information technology into architecture by means of smart artifacts. This shows that though the computer has disappeared as a device but functionally remains there in a ubiquitous fashion.

Ambient Intelligence: Ambient intelligence is a step beyond ubiquitous computing. Here every individual computer has an explicit focus. Computer embedded in everyday objects create an environment that is sensitive enough to the presence of user and responsive to the user's need.

Aware Home: Georgia Institute of Technology (GeorgiaTech) has developed living laboratory with ubiquitous computing in a 5040-square-foot home called "Aware home". This three-story home serves as a laboratory for interdisciplinary design development and evaluation.

Caregiving: An individual, such as a parent, foster parent, or head of a household, who attends to the needs of a child or dependent adult.

CAST: Center for Aging Services and Technologies.

Disappearing Computers: Due to coherent integration of computers into the fabric of architecture like walls, tables and floors, they are no more perceived as computer "devices" anymore. This phenomenon is termed as disappearing computer.

Focus Group: A focus group is a special type of group having certain characteristics in common, like age, gender, education and interest. The purpose of a focus group is to have better understanding on how people feel or think about an issue, product, or services.

iCAT: The "Interactive cat" or iCAT is a research platform for studying social robotic user-interference. The robot is 38 cm tall and is equipped with 13 servos that control different parts of the face, such as the eyes, eyebrows, eyelids, lips and head position.

Meridian: Meridian city is located in the east central Mississippi. It has a total population of over 39,000 with 10,026 families residing I the city.

Proactive computing: Proactive computing connects embedded systems and sensor technologies with a user-centric view on design. This system allows the user to decide her need but has the ability to take control when the user is unable to decide.

Philips HomeLab: This is a research platform developed by Philips Corporation to do research on intelligent devices in a home setting.

Place-Lab: MIT has developed a "Living laboratory" called PlaceLab, an apartment-scale research laboratory to provide research facilities to test new technologies and

design concept in a real home setting. This natural home setting provides opportunities to do systematic study and evaluate strategies and technologies to implement in real world.

Quasi-rural: Even though the US Census categorizes Meridian as a rural county, it is important to understand perceptual biases of local people. In our research, we refer to Meridian as a "*quasi-rural*" setting primarily because of its unique location and perception within the state of Mississippi.

RFID: Radio Frequency identification (ID). This refers to the technology that uses devices attached to objects that transmit data to an RFID receiver. This is an alternative to bar coding.

Sandwich Generation: Sandwich generation refers to the adult son or daughter who acts as a caregiver to an old elderly.

Smart Home: Smart Homes are truly interactive houses having the latest information and communication technology to link all the mechanical and digital devices of the home.

Social Intelligence: Social intelligence may range from being nice and pleasant to interact with and admitting mistake, display curiosity, to being able to read non-verbal cues of interlocutors.

Swing Bed program: This is a national programs which allow patients to stay in the hospital beyond the end of their acute stay and receive nursing services they need.

Telemedicine: Telemedicine is the delivery of medication from a certain location to a distance place. A more extensive definition is that it is the use of modern telecommunication and information technologies for the provision of medical care to an individual located in a distance and the transmission of information to provide that care.

The Media Equation: The Media Equation is a book Stanford professors Reeves and Nass provide plenty of cocktail-party ammunition with findings from 35 laboratory experiments demonstrating how even technologically sophisticated people treat boxes of circuitry as if they were other human beings.

Ubiquitous Computing: Ubiquitous computing refers to arrays of computers embedded in everyday objects serving people in their everyday mundane works.

Virtual Reality: Virtual Reality is based on the concept of Human Computer Interaction (HCI). In VR the computer creates a three dimensional environment that interactively responds to the behavior of the user. This can also simulate environments and make the user feel like present in real world in that virtual space. To enter into this kind of virtual space the user wears either a head mounted device or a special glove or a goggles and sometime even sensors on her entire body.

CHAPTER I

INTRODUCTION

Background

The demographic shift due to baby boomer generation has brought several new challenges for America's healthcare delivery system. Not only are more Americans living longer but also the number of population that is the age group 65 and above is increasing (Peter, 2002). Adding to this dramatic growth is the number of people aged 85 and above is expected to multiply by four times which is currently numbering close to one million (Dominick et. al. 2003). With increase in age people face various illnesses which ultimately results in "unnecessary" hospitalization. Yet the healthcare system has not developed enough to meet the senior boom. There are far few numbers of healthcare professionals, especially those trained in geriatrics, to meet such a large senior population. Beyond the availability of health care facilities, there are myriad other problems that rural people face because of *access to health care* or the lack thereof. These problems rises from growing distances to fewer and fewer delivery points and the costs involved in doing so, and especially for the frail elderly, the physical challenges involved (JAMA, 2000). The healthcare situation in rural areas is going to be worse in the coming years. One reason behind this is the inadequate number of active physicians in rural areas. Another reason is the migration

of seniors from urban areas to the rural area (Tarmann, 2005). Adding to this inflow of seniors from urban area is the retiree attraction policies which provide several benefits to attract seniors to the rural areas (Bryden 2002).

Problem statement

With increase in age, elderly people face various chronic and temporal illnesses leading to severe limitation of activity in their daily life such as shopping, cooking, answering phone, opening door, paying bills, taking medicine in time and so on. Moreover activity limitation among elderly people in rural areas is higher as compared to their urban counterpart. For example, 21.7 percent people have limitation in mobility in the Mississippi State, giving it a nationwide rank of 3rd among the 50 states (AARP, 2002). There are several other problems such as transportation, access to healthcare units/facilities/systems, inadequate number of active physicians, social isolation and increase in number of family caregivers make the life of a senior living in a rural remote place difficult. These problems force senior citizens to move from their own home to assisted living home or nursing home to get long-term medical attention. This separation produces debilitating effect in their mental and psychological health (Evanko, 1999). A recent report by AARP, *Aging Indicators Study, 2005* (The State of 50+ America 2006 Research Report, 2006) reinforces this finding. The report says 89 percent of people age 50+ want to remain in their own home for as long as possible and a higher proportion of the "old-old" age group expressed desire to stay near their family or friends (98%).

Consequence

Due to the poor economic condition, rural senior citizens are more likely to fall below poverty line if affected by one or more chronic illnesses. Since the country is not prepared to provide an adequate system for financing the services that senior citizens need; many elderly live in fear that any chronic illness will devastate them financially, limit their ability to live or leave them dependent on the welfare of their children. The number of nursing home residents is expected to increase more than double over the next 30 years and expected to exceed to 5 million by the year 2040 (Nazarchuk, 2001). At the same time, there are far few health care providers specifically trained in geriatrics and gerontology (The State of Aging and Health in America, 2004). The increasing population with high shortage of health care personnel and high medical cost will create an economic crisis for the US government.

In 1997, about 22 million US households (roughly one in every four household) were involved in caring for someone age 50 and above and this is expected to rise to 39 million household by 2007. Due to these reason American business is loosing between $11 billion and $29 billion each year as a result of employees caring for family members age 50 and older (National Family Caregiver Association, 2004). In sum, American government with its inability to deal with the situation and because of its inefficient present health care model to deal, it is going to face a severe health care crisis in the upcoming year.

Significance/Purpose

Several research projects suggest the use of assistive technologies in the homes of elderly to help them lead an independent life. Computer initiatives take the discussion one step ahead while proposing the "disappearing" computer – ambient intelligence present in the architecture of homes that can help seniors age in place. "Smart" Homes (domestic environments in which we are surrounded by interconnected technologies that are more or less responsive to our presence and actions) seem increasingly plausible with the emergence of powerful mobile computing devices and real time context aware computing (Edwards et.al. 2001). Once such technologies become realities and find mainstream acceptance, one of its first uses will be in the field of proactive healthcare (Intille, 2004). Such initiatives will help reduce the burden (both infrastructure and economic) on the system; leading to a decrease in the spiraling costs of healthcare and medical disbursement systems. MIT, GeorgiaTech (Abowd, 2002) are developing "living laboratories" – places where the concepts of ubiquitous computing (sensors, cameras, monitors) can be studied with real-life users. These laboratories are developing and testing several products that can be introduced into the architecture of a house, to track, monitor and provide feedback to the resident.

In order to initiate such changes there must be an attempt to test and evaluate strategies and technologies related to proactive healthcare in homes, cost effective responsive environments, and human-computer persuasive interfaces that work in any demography and/or social condition.

It is very important to analyze the difference between the rural and urban health care model and understand the various problems associated with the present health care model in rural areas. There is also a need to understand the technology acceptance by rural people of the United States and understand to what extent they can accept the new technology. This thesis documents various research and available technologies published in scholarly articles and journals over a decade. It will also inform and provide guidelines to researchers and designers in designing "smart" home in rural settings. This thesis will address the problems associated with the senior boom in the United States as a whole and the Mississippi State in particular. It will also give a fair overview of the existing technologies related to "smart" home and current research going on in and around the Unites States. This research will provide guidelines for technologies that could be used for seniors to "age in place" in rural and quasi-rural America, based on several focus groups conducted in Meridian, MS.

Hypothesis

As technology becomes pervasive, its amalgamation into architecture is easier because it inevitably becomes a part of the design process. The problem is - we do not consider computing pervasive yet and seldom does it find integration within the design. However, as architects and designers we must all realize that computing initiatives are working towards creating more powerful and increasingly invisible computers and that the profession of architecture will increasingly be pressured to implement them within the architecture of living environments. The question arises, do we deal with these technologies are independent resources or do we integrate them

into the fabric of the architecture itself? What initiatives are required to develop a better understanding of the technology and its implications? The present technologies might work in urban settings and encouraging results has been noticed in various research labs such as MIT media Lab, Georgia Tech Place Lab and Philips Home Lab. But little effort has been made for integration of these technologies in natural home environment in rural setting to help elderly people "age-in-place".

Therefore we hypothesize that proactive healthcare technology will eventually be a solution for the bigger health care problem of the future. It will ensure healthcare facilities be delivered to the seniors and they don't have to leave their home to go to nursing home or assisted living home to get long-term healthcare. It will also help the government in reducing the spiraling health care expenditure. Moreover it will keep the seniors aware of their health and ultimately help them lead a healthy and independent life.

Research question

A review of the literature reveals that there have been several studies done on healthcare assistance in "smart" and responsive environment for elderly people. The study also shows that the existing healthcare model will not be able to meet the healthcare demand for the upcoming senior boom and for rural population in particular, which could result in a severe health care crisis for rural areas. However much of the research happening in this arena is concentrated in urban centers and economically stronger sections of the society. But there has been few studies done to understand technology penetration and technology acceptance in rural setting. The

question arises – can technologies bred in home labs and in urban centers be effective in rural centers? Will the rural population accept changes to their homes and lifestyles? Is the rural population ready to accept technology or are they unwilling to adjust to change?

Subsidiary questions

This also leads to several subsidiary questions that will augment future research in this area:

a) What is the present health care model in rural Mississippi?

b) What is the difference between access to health care services in rural and urban areas?

c) What is the current socio-economic situation in rural Mississippi?

d) What are the problems that might arise due to the demographic shift of elderly population?

e) What are the variables that influence elderly to utilize healthcare services?

f) What is the current technology penetration in rural Mississippi?

g) Can technology be a solution for healthy living?

h) Can robotic technology provide a solution of home health care?

i) If technology is a solution, what type of technology can be used? Will it be a device or a network? Will it be another form of design?

j) How is acceptance of technology in rural/quasi-rural Mississippi different from other urban places?

k) As technology becomes pervasive and disappears in to the fabric of architecture. How are people going to interact with an invisible technology? Will they accept it or it is going to be another technology fad?

Summary

This thesis is an attempt to answer most (if not all) of the above questions. In the following chapters we will discuss the problem, technology and its evolution and the context of the problem. We will then present a focus group study that was conducted to analyze this problem and the findings from this study. Eventually we will present guidelines for future research and/or designs that will enable the availability of such technology to the rural populations of the United States of America.

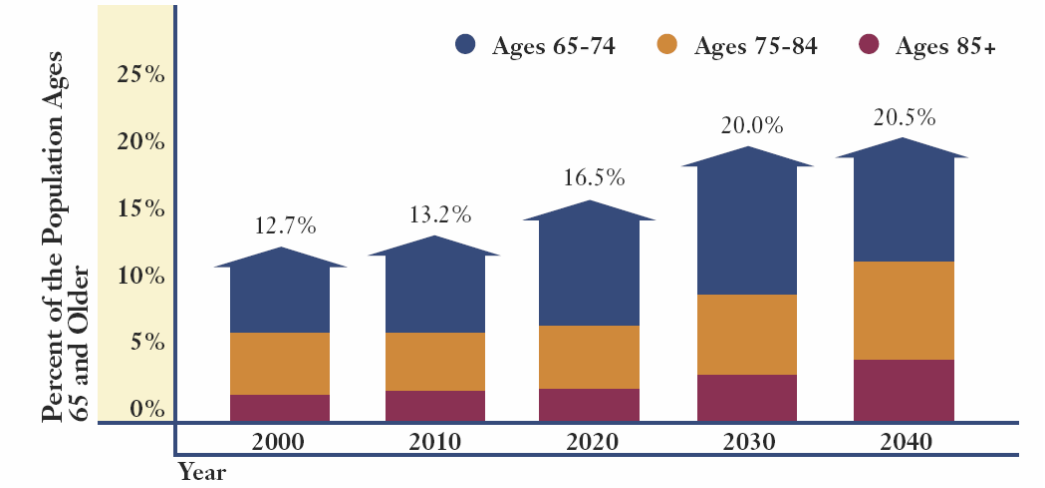
CHAPTER II

PROBLEM STATEMENT

Kate is a 67 year old woman who has lived with her husband in the quasi-rural setting of Meridian, Mississippi for the past 21 years. She has two children, both of whom stay at least 800 miles away in metropolitan urban centers. However, since her husband's death two years ago, things have become increasingly unsettling for her. Healthy and vigorous, she gets regular health check-ups done every month. Today she finds it difficult to drive to the hospital; growing increasingly dependent on neighbors and relatives. She feels isolated and lonely in her own home, often wishing that she could be more involved with her children and grand children. Although Kate does not suffer from any serious chronic conditions, she is susceptible to pollen and can get asthmatic spasms on occasions. Her living conditions in the past two years have deteriorated considerably, leading her two children to consider moving her into a caregiver setting or a nursing home. After careful consideration of several such places, they decide to move Kate into assisted living housing in Lakeland, Florida.

Kate is reluctant to move from the first and only house she has owned; after all this is the place where she and her husband settled after their first job, brought their children up, and went through the ups and downs of weather, politics, and economics. Over the years, she has accumulated a considerable amount of

memorabilia in her home; her house is her home; her home is her identity; and it is the only place she wants to live. After much persuasion, Kate decides to move but is adamant that she will carry as much of her home as she can with her. Today Kate lives in a one room apartment crammed with all her belongings – a space which she has carefully created using artifacts from her earlier home. What goes through Kate's mind every day? Does she enjoy her life here? Does she wish she hadn't made a change in her lifestyle? Does she wish to go back into her own home, back to independence? We don't know…but we do know that Kate is not alone.



Source: U.S. Bureau of the census. projections of the Total Resident Population,1999
"Merck Institute of Aging & Health, www.cdc.gov/aging"

Figure 2.1 Americans are living longer

Aging in America is increasingly gaining the attention of policy makers, researchers, sociologists, economists and health care providers. Due to improved sanitation, better medical care and increased use of preventive health services, life expectancy has increased from 47 years for Americans born in 1900 to 77 years for

those born in 2001 (U.S Bureau of the Census, 2004) . Not only are more Americans living longer but the US population that is age 65 and above is also growing. By 2012, nearly 10,000 Americans will turn 65 every day, and by 2030 20% of the population will have passed their 65th birthday. The average life expectancy at age 65 now has approached 10 years; even at age 85, it is still close to 5 years. This will result in more than doubling of the number of persons aged 85 and older by the year 2030; a group currently numbering close to 3 million (U.S Bureau of the Census, 2004). With this dramatic growth of the "old-old" population, about 43 percent of the United States will need health care or assistance in living at some point in their lives (Peter, 2002).

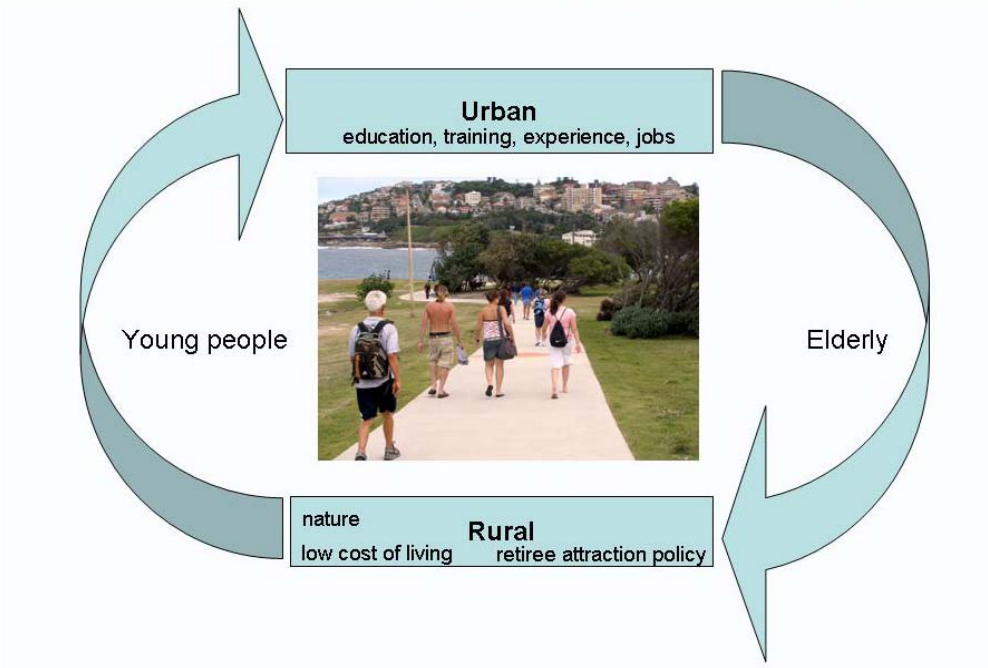


Figure 2.2 Migration of retiree people from urban areas to rural areas and younger from rural areas to urban areas.

The percentage of older people in rural counties is higher than in urban counties. While 7 percent of the total U.S. population lives in rural counties, these places are home to 10 percent of the nation's older population (Tarmann, 2003). The situation in Mississippi is not different. The present population of 65+ age-groups is 14.8 percent and is expected to rise to 18.7 percent by the year 2020 (US Census, 2002). "This is not just a result the aging of baby-boomer generation but a sustained aging across the cross section of the entire population" (Intille, 2004). Adding to the demographic imbalances, are the many retiree attraction policies followed by rural areas to attract older people to exclusive retirement communities. The idea behind retiree attraction policies is to have good economic development in rural areas (Bryden, 2002). Health care then becomes an important industry for these towns, and the Medicare dollars that older people dispose of become a major source of economic activity (Tarmann, 2003). According to Judith Stallmann, professor of agricultural economics and rural sociology at the University of Missouri, this amount accounts for anywhere from 40 percent to 90 percent of rural hospitals' revenue. However, what rural communities might gain from attracting retirees, may simply be an equivalent loss for the cities, turning into a kind of 'beggar my neighbor' situation, or 'zero-sum game' (Bryden, 2002). Moreover there is a natural tendency of migration of younger population to urban places for education, training, experience and jobs. In relative terms, that increases the proportion of the demography aged 65 and older.

Where is the problem?

Assisted home living studies show that 50 percent of population, older than 70 years, needs assistance in their daily activities while 11.6 percent of population above 65 years old has severe limitations in self-care. Moreover activity limitation among elderly people is higher in rural areas when compared to their urban counterpart. In Mississippi, 21.7 percent of the population has limitation in mobility; giving it a nationwide rank of 3rd (negative) among the 50 states (US census, 2002). This shows that there are more numbers of elderly people with activity limitation in Mississippi as compared to other states.

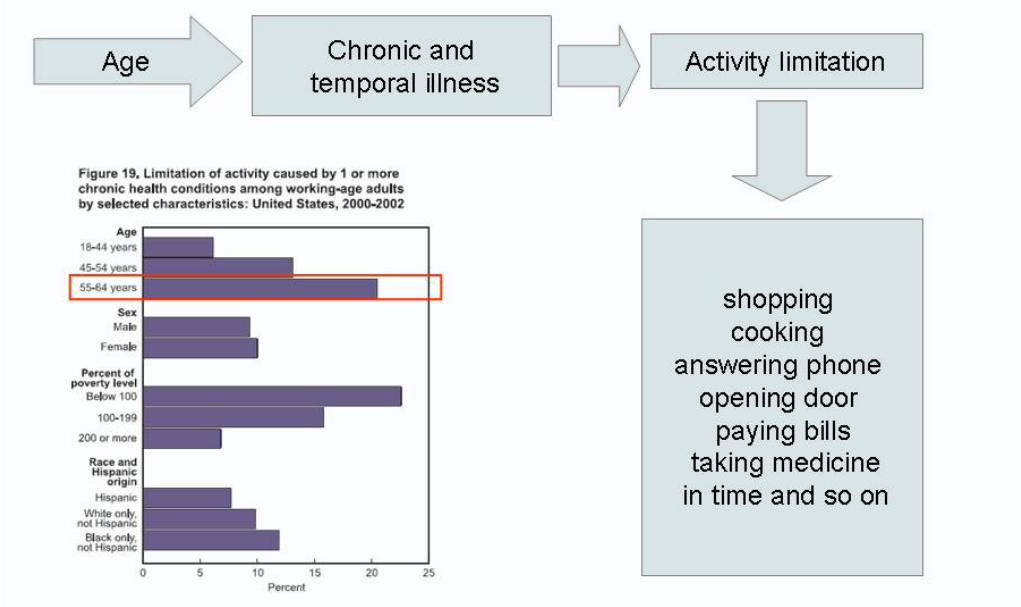
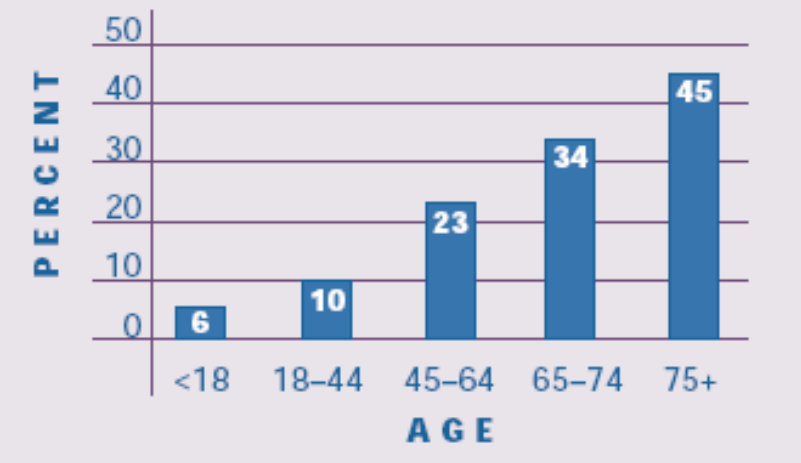


Figure 2.3 Aging process leading to activity limitations

The average median family income of age 65 and above in Mississippi is $ 31,642 as compared to the national average of $ 44,684 (US Census 2004) and it

ranks 50th (lowest) in economic status in the United States. Due to this difference, rural populations are more likely to fall below poverty level than the urban populations in richer states.

Health care conditions in rural areas have significant differences as compared to the urban as rural non-farming elders have the worst health profile compared to the inhabitants of any other residential category; these individuals are more likely to report certain medical conditions (hypertension, arthritis or rheumatism) and have more functional limitations (Nazarchuk, 2001). Healthcare services also differ in rural areas as compared to its urban counterpart in various aspects like the small scale, lower population density, settlement pattern, lower income, greater outreach and access distance, and lack of transportation. This contributes to relative shortage of formally organized social and health service in many rural areas.

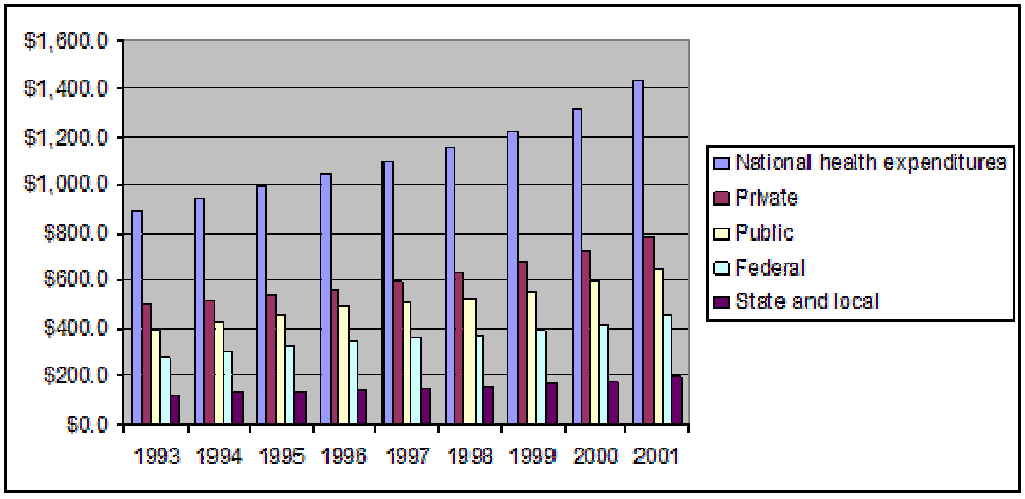


Source: Trupin, Laura and Dorothy Rice, Health Status, Medical Care Use, and Number of Disabling Conditions in the United States, Disability Statistics Abstract Number9 (June 1995), National Institute on Disability and Rehabilitation Research, as sited in "Chronic Condition a Challenge for the 21st century by National Academy on an Aging Society

Figure 2.4 Percent of individual in each age group limited in activities because of chronic conditions

Problem 1: Economic crisis and a break down of the system

The increase in lifespan and the growing burden of chronic diseases among older Americans have created several new challenges. Chief among these are health care costs, an increase in the number family caregivers and greater long term care needs. Meeting these challenges is critical to ensuring that the years that Americans can look forward to are also quality years. Unfortunately, America's health care workforce is wholly unprepared for the coming senior boom. There are far too few health care providers specifically trained in geriatrics; moreover, there is a gap between what many primary care providers know, and what they need to know, to optimally treat older patients (The State of Aging and Health in America, 2004).



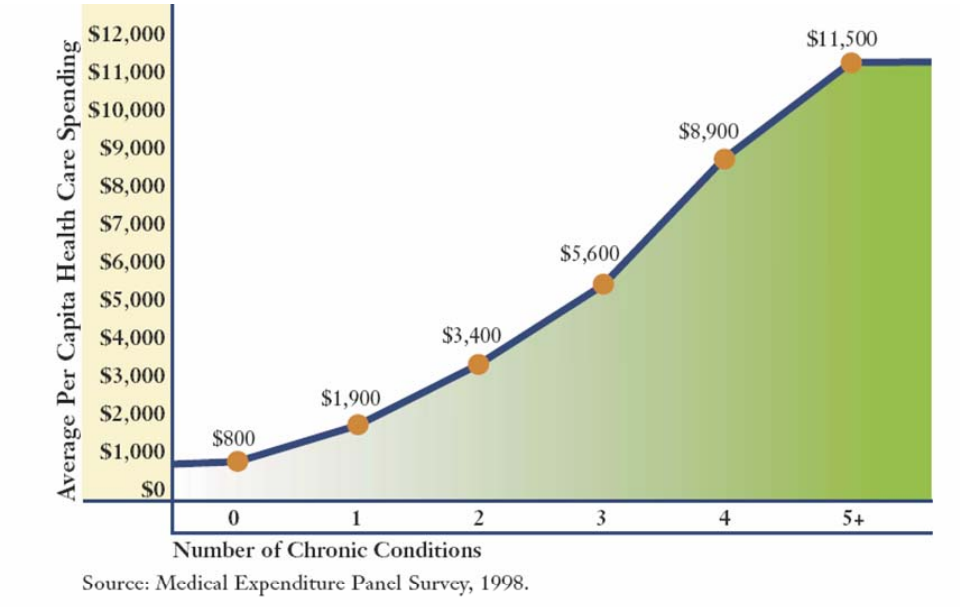
Source: Chronic Conditions: making the case for ongoing care
by Johns Hopkins University, Dec 2002.

Figure 2.5 National healthcare expenditure by source of funds for 1993-2001

The increase in population with high shortage of health care personnel and high medical cost will create an economic crisis for the US government as the United

States is being forced by demographic shift in population composition to consider a group seldom considered - the elderly.

Long-term care is an increasingly important and rapidly changing component of today's healthcare delivery system. Long term care looms on the nation's horizon as long term care comprises become an ever-increasing percentage of nation's expenditure for health care since America is an aging population. The country is not prepared to provide adequate system for financing the services that senior citizens need, and many elderly live in fear that any chronic illness will devastate them financially, limit their ability to live or leave them dependent on the welfare of their children (Nazarchuk, 2001).



Source: Chronic Conditions: making the case for ongoing care
by Johns Hopkins University, Dec 2002.
" Medical Expenditure Panel Survey, 1998"

Figure 2.6 Average healthcare spending verses number of chronic conditions

This demographic shift has a high potential to greatly increase the nation's already high health care costs:

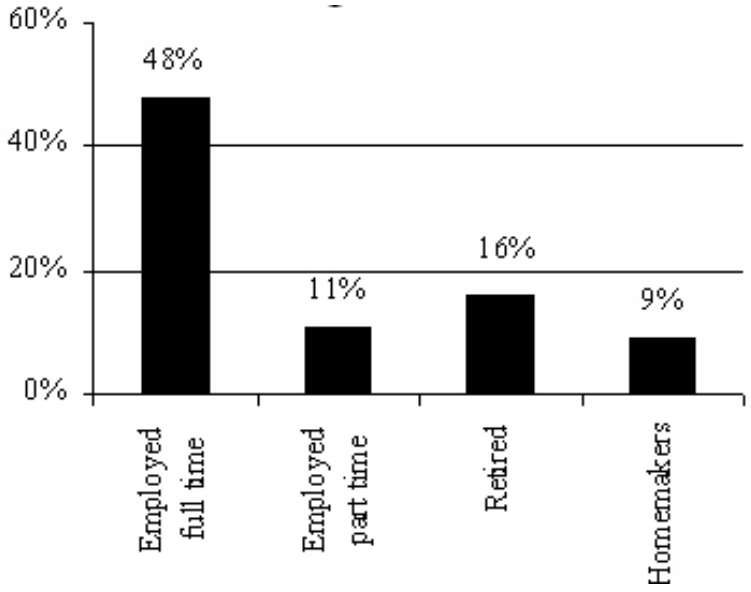
- The cost of providing health care for one person age 65 or older is four times greater than the cost for someone younger than 65 (Centers for Disease Control and Prevention, 2003).
- By 2030, health care spending will increase by 25% simply because the population will be older, and this is before inflation or new technologies are taken into account (Agency for Healthcare Research and Quality, Centers for Disease Control and Prevention, 2002).

Problem 2: Caregiving

As education and employment drive young adults to urban centers, the health and well being of their parents become a primary concern for them. Taking care of one's aging parent can be a very difficult task when responsibility is combined with one's own children and office work load. This often creates significant stress for the caregivers (Boehm, 2004). For many of these "care givers", it is actually desirable to move the old elderly to assisted living conditions because they can monitor the well being of the older relative. Researchers have used the term "sandwich generation" to refer to the adult son or daughter who acts as a care giver to an old elderly (Boehm, 2004). The sandwich generation faces various additional health and social burdens:

- The value of the services family caregivers provide for "free" is estimated to be $257 billion a year. That is twice as much as is actually spent on homecare and nursing home services (Peter 2002).

- Elderly spousal caregivers with a history of chronic illness themselves who are experiencing caregiving related stress have a 63% higher mortality rate than their non-caregiving peers (National Family Caregivers Association).
- The stress of family caregiving for person's with dementia has been shown to impact a person's immune system for up to three years after their caregiving ends thus increasing their chances of developing a chronic illness themselves (National Family Caregivers Association).
- Family caregivers who provide care 36 or more hours weekly are more likely than non-caregivers to experience symptoms of depression or anxiety. For spouses the rate is six times higher; for those caring for a parent the rate is twice as high (National Family Caregivers Association) .



Source: National Alliance for Caregiving (NAC) and AARP caregiving in U.S. April 2004

Figure 2.7 Employment statuses of caregivers age 50 to 64

Caregivers face difficulties in managing office work and caregiving responsibility. Nearly six in ten caregivers are currently employed (National Alliance for Caregiving, 2004). Most of the caregivers aged 50-64 are full time employee, and those who are not working are mostly retired person or are homemakers. Moreover there are more female caregivers as compared to the male caregivers. There are various employer-based and publicly funded support programs available for caregivers (AARP Public Policy Institute, 2005). One of these programs is Family and Medical Leave Act (FMLA). This program allows employees to take up to 12 weeks of unpaid leave to care for some one seriously ill or for a new born baby. There are other programs which allows employee to take explicit *paid* leave for up to 6 weeks.

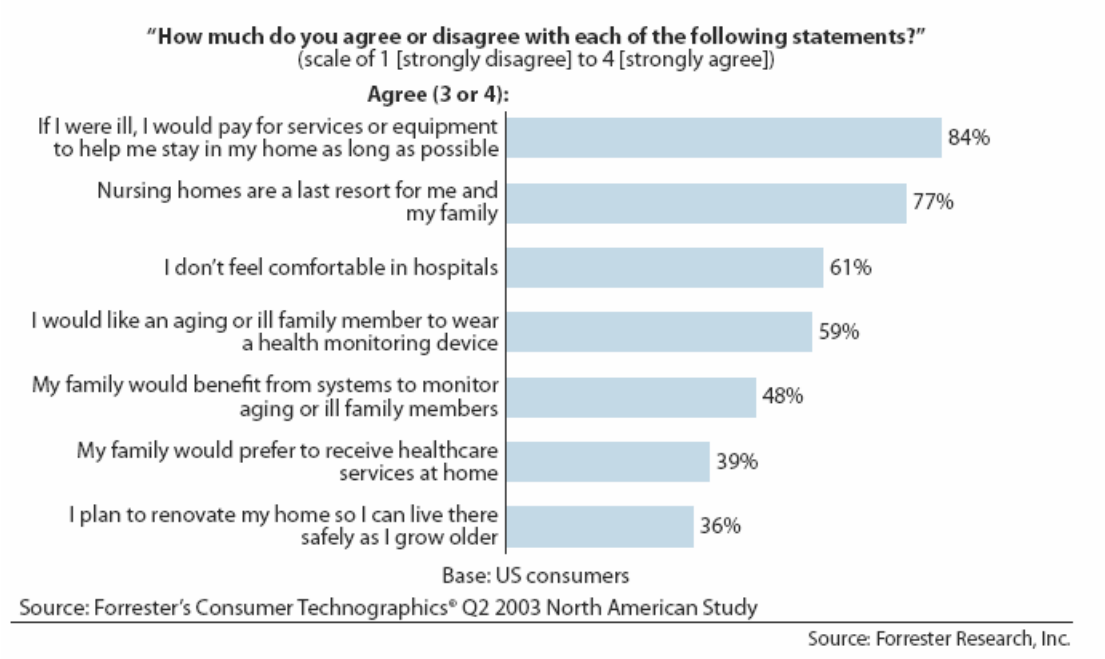
According to a study by NAC and AARP conducted in 2004 there are 44.4 million (21%) caregivers in US providing care to someone 18 and above.
As per this study:

- A typical caregiver is 46 years old female giving 20 hours of unpaid caregiving each week to a family member.
- Nearly 39 percent caregivers are female.
- Most care recipients are female (65%) and many (42%) are widowed.
- The main problem of the care recipients is aging (15%) followed by chronic diseases (9%) and Alzheimer's disease (8%).

In 1997, about 22 million US households (roughly one in every four household) were involved in caring for someone age 50 and above and this is

expected to rise to 39 million household by 2007. American businesses is loosing between $11 billion and $29 billion each year as a result of employees caring for family members age 50 and older (National Family Caregivers Association, 2006).

Problem 3: Aging in place



Source: Who pays for healthcare unbound by Elizabeth W. Boehm. 2004 "Forester Research, Inc."

Figure 2.8 Consumer attitudes to assisted living and hospitalization

"Aging in place" is refer to the idea of the aging person remaining in his or her won home rather than in another setting (U.S. Department of Commerce, 2005) like nursing homes, care homes, residential living centers, assisted living homes, congregate living facilities, personal care homes, and homes for the aged, shelter care homes, adult care homes etc. Other national programs like the Swing Bed program

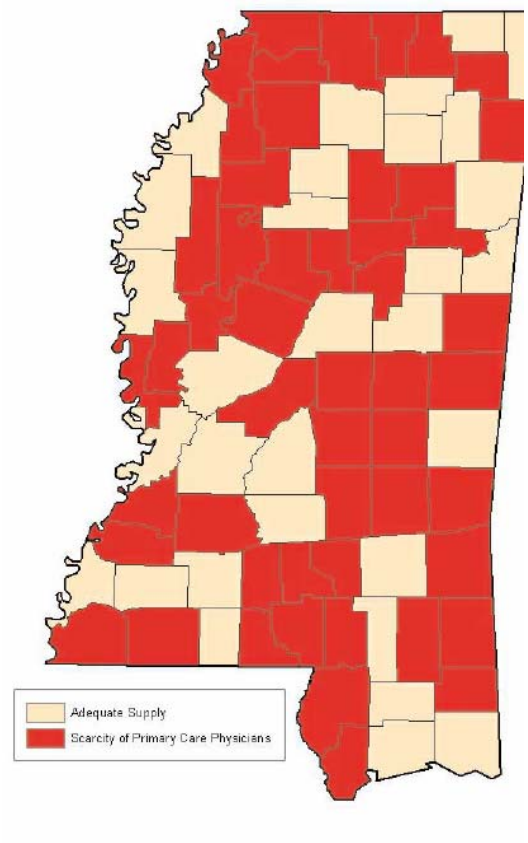
allow patients to stay in the hospital beyond the end of their acute stay and receive nursing services they need. But this may not serve the need of the growing population in future especially that of long term medical care facilities for elderly care. It also does not provide the same living condition that everybody looks for – none of these places can hope to replace one's home. Although almost 1.5 million seniors currently reside in nursing homes — and one-third of those have been there for more than three years — 77% of American consumers say that nursing homes are a last resort for themselves and their family members. Moreover 61% say they don't feel comfortable in hospitals (Boehm, 2004).

Another study by AARP reinforces this finding as presented in the report AARP *Aging Indicators Study, 2005*. The report says 89 percent of people age 50+ want to remain in their own home for as long as possible. Furthermore a higher proportion of the "old-old" age group expressed desire to stay in their home (98%). The top reasons that respondents wish to remain in their community is for personal network for interaction and support. Among these reasons for wanting to remain in same local community are friends (41%), family (33%), followed by safety from crime (22.6%) and pleasant neighborhood/ community (22.5%).

Problem 4: Inadequate healthcare professionals

Another problem with the rural system is that of an inadequate number of physicians. Mississippi for example has one of the lowest active physicians to population ratio in the country. As per the American Medical Association; Physician Characteristics and Distribution in U.S. 2002-2003 edition, there is only 4931 active

physician in Mississippi as compared to 185,439 active physicians in the North-East. Such a figure composes an important aspect of elderly care, as a direct relationship exists between the availability of the health service professionals in a community and extends of the use of the health service personally by the individual of the community (Intille, 2005).



Source: White Paper Executive Summary by J.S Cossman,

Figure 2.9 Healthcare professional shortage areas

In a research on Mississippi's physician labor force using a survey of 616 physicians in 2003 by Dr. Corssman (Crossman, 2003) and four other data source the

following finds were obtained.Nationally, there are 3 doctors to every 1000 residents where as there are only two doctors to every 1000 residents.

- More than 56% of all Mississippi physicians are located in four major urban areas, leaving 51 of 82 counties underserved. Only 12 percent of state's doctors are located in the Mississippi Delta. This uneven distribution of physician results in access to physician in rural areas.
- Nationally, 20 percent of doctors self-reporting as internists, where as there are only 7.5 percent internists in Mississippi. This says that there is a lack of specialists in Mississippi. Moreover specialists in Mississippi are more likely to be nearing retirement.
- 70 percent of doctors aged 35-44 have considered relocating and 32 percent of physicians under 35 intend to relocate. Furthermore over 70 percent of doctors aged 55-64 considered retiring early. The high level of intended relocation and possible early retirement will worsen the physician shortage and may create healthcare crisis in the near future.

"Mississippi physicians are not evenly distributed relative to the population, which produces gaps in access to physician care. More than half (56%) of all Mississippi physicians are located in four urban areas, leaving 51 of 82 counties underserved. Only 12% of the state's doctors are located in the Mississippi Delta." (Cossman, 2003).

Problem 5: Access to health care services

Xiao-Yan Li claims that health care in rural areas is generally influenced by:

1. characteristics of rural environments;
2. characteristics of regional health insurance;
3. organization of medical services markets;
4. relationship between providers and managed care plans.

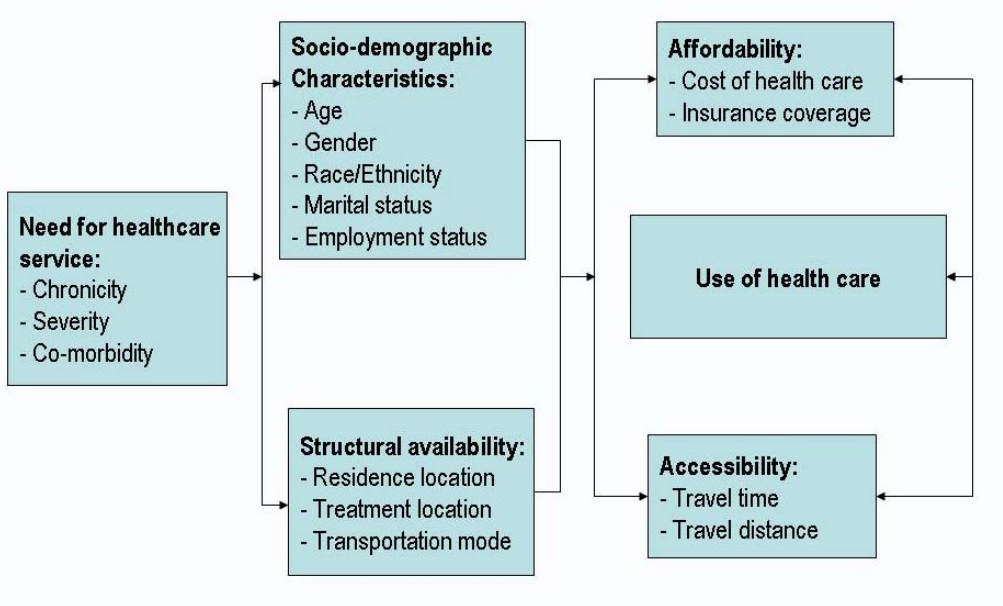


Figure 2.10 Connection between need of health care services and use of health care services

An examination of the studies on this topic suggests that older people in rural areas face growing problems with health and other forms of care, isolation, housing, and transportation, all of which are in some degree inter-related. These problems are made worse by poverty, the incidence of which generally increases with remoteness from cities. Rural areas tend to have access to a narrower and more costly range of

health care services and to be served by fewer health care providers. Furthermore the Medicare reimbursement system actually assumes that it is cheaper to deliver health care in rural areas, and its reimbursement rates for rural health providers is correspondingly lower than it is in cities. This precarious rural health care system results in creating insecurity and instability for the elderly (Bryden, 2002).

These problem in accessing health care services rise from the growing distance to fewer and fewer delivery points and the costs involved in doing so, and especially for the frail elderly, the physically challenges involved (JAMA, 2000). Bailey et al (2000) carried out a study of 'elderly heath care utilization in New Orleans County'. 69% of respondent's physicians were located in the two main centers of population. Those traveling to the nearest Veterans Hospital (3% of the sample) faced a round-trip of 160 miles, necessitating an overnight stay for some. This study also concluded that people who had to travel more than 10 miles to their physician tended to go to their physicians less frequently than those who had to travel shorter distances.

Problem 6: Social isolation

Social isolation is another major problem in the older generation. Because a large majority of the younger generation tends to move to the urban centers in search of better education and job opportunity; older people are forced to stay alone or with grand children at home. Furthermore women also have a longer life-expectancy than men, and therefore there are more single women who are elderly or old-old than there are men. Compared to older rural men, the majority of older women are therefore

more likely to live alone, to be poorer, and to experience greater vulnerability to the problems specific to aging in rural environments (Bryden, 2002). Because men tend to marry younger women, women very often outlive their spouses. Older women are also less prone to remarry if their spouse has died, and are thus more likely to spend their old age without a spouse to provide support. Literature review also shows that women are likely to have more activity limitation as compared to man. Eventually this change in demography will lead to a larger problem with regard to access to health care, transportation, substandard housing and property maintenance.

As people grow older, any connection to their family is valued. Although they prefer to live and age in their own homes; older people look for intimate connections with their children and grand children. However distances and technology provide very limited opportunities for such connections. The 2002 US census shows that about 25% older population lives alone; two problems become evident: one is that of security, and the other of increased dependence on neighbors and close relatives. Increase in insecurity is also a cause of various chronic diseases like hypertension, chronic mental diseases and heart diseases. Though the recent developments in security systems have developed in sophisticated and efficient systems, the lack of integration into the architecture of the home makes these systems out of the control of the inhabitant, eventually these systems need to be an integral part of the architecture as a whole.

As the elderly grow older, they find it difficult to do common tasks that were once easy to do. Driving is a great inhibitor for many of these people. Our studies

have shown that although many old elderly “want” to drive, they are very often unable to do so. This makes them dependent on car pools, neighbors and/or relatives.

Summary

Now we understand that a definite problem exists in present health care system in rural area. The present healthcare model is not sufficient enough to provide health care assistance to the future baby boomer generation. Question arises what could be a solution? Scientists envision that proactive health care technology could help elderly people age-in-place and get long term medical care delivered at home. The following chapter will discuss the present technology that could he used in proactive health care environment.

CHAPTER III

TECHNOLOGY

In the past health care technology was adopted as an aid to disability and independence. Our current research shows that in the context pertaining to the present senior boom, it has come to the attention of many researchers and scientists that technology to meet the health care needs of the aging society is an important aspect of our society's development. The baby boomer generation has played a significant role in shaping the United States in terms of technology, economic development and health care. Boomers are more techno savvy consumer as compared to their predecessors (Boehm, 2004). Therefore it is expected that the adoption of aging-related-technology will not be difficult for the boomers. According to the Center for Aging Services and Technologies or "CAST" aging related technology can be classified into four categories (US Department of Commerce, 2006):

1. Enabling Technologies (helps elderly age and live independently in their own home).
2. Operational technologies (assists aging person to function in the society).
3. Connective technology (assists aging people remain connected with family members and friends).

4. Telemedicine (provides medical assistance to patients using technology from a separate geographical location).

The present senior boom and the realization of the importance of providing healthcare assistance at one's own home have created a different research domain called "age-in-place". This enables seniors to stay in their home and get health care facilities delivered right in their homes. In the long run it will solve the problem of unnecessary hospitalization due to chronic illness and long-term care needs. Chronic patients need regular medical attention for a longer period time; therefore, many seniors with such disability and chronic illness spend a significant period of their old age in hospitals. "Research shows that 77 percent of seniors consider hospitalization a last resort for themselves and their family members. Moreover 61 percent seniors don't feel comfortable in hospitals (Boehm, 2004)".Therefore age-in-place research has gained a significant importance in elderly-healthcare-technology industries.

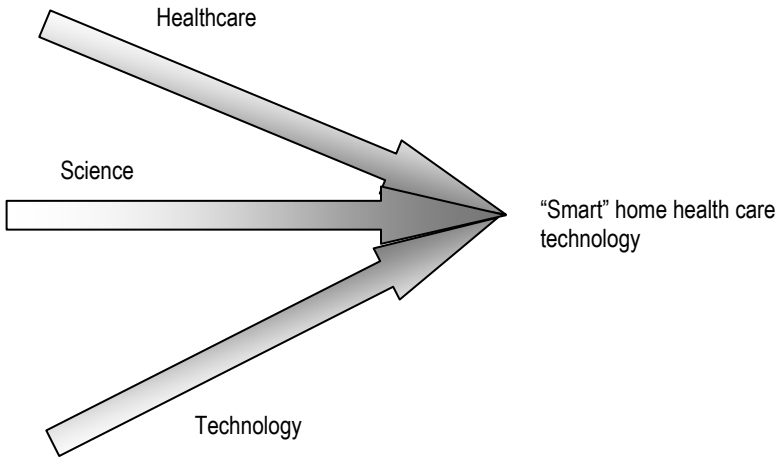


Figure 3.1 Convergence of science, technology and healthcare

Healthcare industry is also focussing on development of various assistive technologies to assist senior citizen live a healthy and independent life. In the healthcare technology domain, the convergence of science, technology and healthcare has produced a significant impact. Such a convergence is also called “Assistive” technology. Assistive technology can be defined as “hardware or software used to provide independence and enable a person to perform and function that was otherwise difficult due to disability”. Assistive technologies can help people with physical disability and aging related disabilities, which comes due to loss of function or ability lost over time as a result of aging.

US census 2002 shows that 25 percent of US population lives alone, moreover the 2005 survey by AARP (AARP, 2005) says this; 94 percent people of the age group of 75+ prefer to stay near their family members and friends. Since distance and work does not allow everybody to do so, older people are forced to stay away from their family members. Several research labs are working to develop technology to allow people remain connected virtually with their family members staying in different geographic locations. But the question arises as to whether the baby boomer will be able to accept these new technologies? One answer to this question can be derived by understanding the technical knowledge of the boomers. The baby boomers have played a significant role in shaping new technology and they are much more informed about the latest wireless and communication technologies. They have used internet to do various kind of financial transactions, to manage bank accounts, and even for online shopping. Therefore most social scientists believe that adaptation of

new technology to obtain health related information should not be a problem for this techno-savvy generation (Boehm, 2004).

Healthcare technology should not be confused with ageing-related technology. Healthcare technology can be used as aging related technology but all healthcare technologies are not aging-related technology. Ageing related technology is considered as a new approach to the healthcare technology for the aging population. Healthcare industries and research centers engaged in developing innovative solutions are looking forward to develop a new health care system and aging-related products to meet the need of the broad range of stakeholder (US Department of Commerce, 2006).

At a recent conference on aging and technology, a speaker recited the following story –of an interview with a young Irish gentleman. The researcher was trying to survey the influence of neighbors on the state of health of residents in a community. In the survey, the young man was asked if he enquired about the health of an older person living across from him. The interviewee replied that everyday morning he would get up and check to see if there was smoke coming from the chimney of the older man's house. If so, he would go about his routines and not bother about it any more. When asked about this queer habit, the young man qualified that if his older neighbor had started a fire in the fireplace (leading to the smoke from the chimney), this meant that he was cooking, and hence deductible that everything was fine. If there was no chimney smoke, this would mean that something was wrong, and the young man would walk across to check on the older neighbor.

Although not completely fool-proof, the young man felt this arrangement worked quite well because neither he nor the old neighbor had to be disturbed unless there was a perceived problem. This anecdote describes the *basic* concept of aging-in-place technologies or "smart" homes – *a home that monitors the well being of the resident.* It does so using ubiquitous computing to analyze activities of daily living (ADL) of residents and seeks to provide assistance or indicate emergency *only* in case of an anomaly in the normal functioning of the resident.

Ubiquitous computing

Mark Weiser (Weiser, 1991) coined the term "ubiquitous computing" referring to arrays of computers embedded in everyday objects serving people in their everyday mundane works. These arrays of embedded intelligent devises could work invisibly and unobtrusively in the background, anticipating the need of the user ranging from daily activities to healthcare. These devices will be able to either remember the past environment they operated in, or proactively build up services in new environment (Lytinen et.al. 2002). There are various commercially available devises that can observe the TV viewing pattern of the user and can record programs that the device assumes will appeal to the user. There are other devices that can order items for the refrigerator when they run low. All these devices can be termed as "intelligent" devices, which assist users in their everyday tasks. These "intelligent" devices work by adapting to the user's needs and by remembering the user's past behavior and accordingly predict possible future patterns.

User adaptive interfaces are also referred to as “intelligent-social interfaces” (ISUIs) (Van Loenen, 2003). These interfaces are more intuitive, efficient and social - ISUIs can adjust to the environment and behave socially. It includes knowledge of the self, emotion, desire, personality, social norms and how they are applied in context. This is also referred to as “social intelligence”. Social intelligence differs vastly depending on geographical location, race, education, and religion. Therefore there is no single definition that can unequivocally define it. Social intelligence may range from being nice and pleasant to interact with and admitting mistake, display curiosity, to being able to read non-verbal cues of interlocutors (Panos, 2005).

Byron Reeves and Clifford Nass (Nass et.al, 1996) in their book "The Media Equation" qualifies that interactions with computers, television, and new communication technologies are identical to real social relationships and to the navigation of real physical spaces. In brief, people behave socially with media like TV, computer etc. just like they behave with human beings. Any human like behaviors by media are appreciated and welcomed by the users. But the biggest challenge is: to what extent computers should be quipped with intelligence. For example in patient-caregiver relationship in healthcare domain, several situations might come where computer will need to understand and provide help in context. Therefore further research is needed to understand the user-help-provider relation and study the importance of technology to the user. To understand the user acceptance and benefits of social intelligence by computer; Philips laboratory has developed a robotic computer called iCat.

iCAT by Philips Lab - A socially intelligent Robert

iCAT (Philips Research, 2005) examines the broader benefit that could be brought upon from the user experience in a more socially complex and coherent home dialogue system. The "Interactive cat" or iCAT is a research platform for studying social robotic user-interference. The robot is 38 cm tall and is equipped with 13 servos that control different parts of the face, such as the eyes, eyebrows, eyelids, lips and head position. With this setup iCAT can generate many different facial expressions - happy, surprise, angry, sad - that makes it capable of achieving social human-robot interaction dialogues. A camera installed on the head of the robot enables it with different computer vision capabilities, such as gesture and facial expression. The embedded microphone on the feet of the robot detects the sound direction and gives it a human like behavior by turning towards the speaker. Touch sensors embedded in its feet and ears helps in getting further information to interact with the user. For the user study at Philips Lab the iCAT was connected to a home network system controlling various in-home devices like light, VCR, TV, radio and to access internet.

The iCAT is capable of behaving like a human through a rich-set of pre-programmed behaviors. But in order to perform like a human and respond socially, these behaviors need to be performed at the right context and at the right time.

Figure 3.2 iCAT by Philips Lab

Figure 3.3 iCAT by Philips Lab showing different facial expressions

To enable the iCAT with social intelligence, the following behaviors have been added, which could be triggered at appropriate time and context:

1. Listening carefully.
2. Being able to use non-verbal cues and other displays.
3. Accessing well the relevance of information to a problem at hand.

4. Being nice and pleasant to interact with.
5. Paying attention to affective signals from the user.
6. Displaying interest in the immediate environment.
7. Remembering little personal details about people.
8. Admitting mistake.
9. Thinking before speaking and doing.

On one hand this is a very good experiment to understand human acceptance towards artificial intelligence added to a robot. On the other hand it raises several questions and suggestions to researcher in designing future technologies and addressing the present issues. The biggest question we asked is - why a device? Some researchers argue that it is tangible and therefore can bring trust to the user. But a device might confuse the user about its capabilities and the type of help it can provide. For example if the device is only designed to monitor TV viewing patterns and assist the user to keep track of her daily TV shows, this device might work fine, but it might fail in another context like providing healthcare. Moreover what happens if this device intervention is removed or stops working?

Now imagine another scenario wherein each device in the entire network can be made intelligent and connected together to a central monitoring system to keep track of each device, we will have a rich network of devices that will function as a synthetic environment. Hence the interaction moves from the device level to the space level. At the end the entire house could become an intelligent space, which can interact with the user and assist her in daily activities. According to Mark Wiser “the

most profound technologies are those that disappear. They wave themselves into the fabric of everyday life until they are indistinguishable from it (Weiser, 1991)".

As the technology disappears into the background and become indistinguishable, several new issues comes in to picture and designers need to identify, compose, maintain and arrange an array of interconnected embedded systems, each with different capabilities and functions. They will also have to adapt and analyze context and learn from user behaviors. For example in a health monitoring scenario, the addition of a new device should lead to coherence with the existing system and understand of the existing system from the memory stored in the previous system.

The disappearing computer

Computers have started disappearing from the visible sphere of users and increasingly becoming smart artifacts built into the architecture. Due to coherent integration of computers into the fabric of architecture like walls, tables and floors, they are no more perceived as computer "devices" anymore. The changes in perception of computers as devices, to "invisible" artifacts are what are referred to as the mental disappearance of computer (Streitze Norbert, 2005).

One example of disappearing computer is the "ambient agora" an EU-funded project (www.ambient-agora.org). This project is based on calm or ambient technology to integrate information technology into architecture by means of smart artifacts. This shows that though the computer has disappeared as a device but functionally remains there in a ubiquitous fashion. The aim of the project was to

collect raw data like mood, activity, emotion etc. and interpret them in some form of graphical interface/ display called “hello wall”, that can be perceived by human senses. This provided communication and awareness about ongoing activities on remote work place. This is an appropriate means of communication with remote team for help, guidance, work, or just for fun.

Figure 3.4 The HelloWall- an ambient display

This is what can be coined as physical and digital integration of space, which implies (Petersen, 2005):

1. Having designers and engineers as part of the research team.
2. Focusing on social interaction amongst co-located people.
3. Moving interaction from the level of object to the level of space plan.
4. Establishing new means of ideals for human computer interaction.

As computers disappear from the scene, they become invisible and disappear as a device from the perception of the users, a new set of issues has come into picture concerning the interaction with the system:

1) How can people interact with invisible devices?
2) How can we design implicit interactions for sensor based interfaces?
3) How can we design for transparencies and coherent experience?
4) Concerns of privacy and security

According to the research team "experience oriented" processes are quiet important in an office or home setting. For example the mood and activities of remote location, team interaction and informal communication; these ultimately augment the perception of physical and social environment. The technology not only remains as an "information world" but also augments the "experience world" (Petersen, 2005). The experience oriented design can be further classified into: 1) direct experience; based on perception like visual, tactile, and haptic sensation, and 2) indirect experience, which is more profound and invisible like flow of electricity in a wire, transmission of TV and radio signals etc.

Proactive computing

According to *Webster Meridian Dictionary* (online edition), the meaning of proactive is: 1**:** relating to, or being interference between previous learning and the recall or performance of later learning <*proactive* inhibition of memory>
2**:** acting in anticipation of future problems, needs, or changes.

Technically the first meaning can be interpreted as the ability to work independently using knowledge of previous experiences without the user taking part in the process. The second meaning can be interpreted as the ability to adjust to future

states of the system from present states. The system changes if the present values are changed as an additional input.

Proactive computing connects embedded systems and sensor technologies with a user-centric view on design. This system allows the user to decide her need but has the ability to take control when the user is unable to decide. Therefore proactive system needs social, cultural and material as much as technical research to make them successful in everyday life.

Both autonomic and proactive systems can take advantage of context by using the environment in which they operate to guide policy decision. Portable wireless and connecting system can augment context aware operation in decision making for this system. According to the Intel research team on Proactive system, the design should be guided by seven underlying principles: connecting with the physical world, deep networking, macro-processing, dealing with uncertainty, anticipation, closing the control loop, and making systems personal (R. Want, 2006). Personalization is as important as dealing with other part of the technology. The perception and acceptance of technology differ vastly from age, gender and occupation. There are several biases and prejudice involved in acceptance towards the technology which could affect the use of technology. For example upon waking up in the morning, some people may like to view their email; others may want to read the local newspaper. In another setting where young and elderly people live together, the needs of an elderly person could be very different from that of younger people. Therefore a single design may not work for everybody and eventually it needs to attain more personalization to gain

wide acceptance of technology. Therefore proactive technologies face both great promise as well as tight challenges in an home environment.

Ambient intelligence

Ambient intelligence is a step beyond ubiquitous computing. Here every individual computer has an explicit focus. Computer embedded in everyday objects create an environment that is sensitive enough to the presence of user and responsive to the user's need. It is capable of greeting the individual by having some type of identification and/or from other devices embedded on them. It has the ability to interact with the user based on previous interaction and memories. Since the environment is aware of the presence of the individual(s), is context sensitive in providing something for the individual(s).

According to Philips HomeLab (Philips Research, 2005), the key attributes of ambient intelligence include:

1. Context awareness: The ambient intelligent device must know the context in which they are being used.
2. Personalized: It is important to provide individual taste and preferences.
3. Immersive: One of the key of the ambient intelligence is to make the experience easier and enhance the quality of experience.
4. Adaptive: One of the primary roles of ambient devices is the ability to adapt to the environment, which relates very much to how people interact with ambient intelligence.

One of the most significant challenges that Ambient Intelligence is facing is to create user-friendly and adaptive interface. How can people interact with invisible devices? How can design implicit interaction for sensor-based interface?

Smart Homes

Smart Homes are truly interactive houses having the latest information and communication technology to link all the mechanical and digital devices of the home. The idea of introducing more technology into the home might fill many with horror - but it seems that we can not escape from the increasing reliance on digital system like wireless communication and control system in our everyday life, for entertainment, for dealing with illness, disabilities and aging, for managing our home (Gann D).

We have already stepped in to the world of digital system and information and communication system have already become ubiquitous. We use digital technology within our homes in multiple ways - central heating systems with temperature regulator, internet systems for information exchange, cell phones for world wide instant communication and many more. In fact, Intel research shows that every day we encounter with at least 150 different computing devices. In a home setting though our household appliances and utilities are managed using small micro-processors, a little effort has been paid to combine these devices to alleviate daily routine works or to facilitate greater effort to assist older people and those physically challenged to live independently.

Initial concepts (of "smart" technology) were used to describe homes in which information and communication technology is installed to provide communication

with the world outside (Moran, 1993). This concept was later adapted as telemedicine setups that provided medical attention through the use of video conferencing. But full-motion video links that show every motion and facial expression of each individual could be quiet disturbing because the user may have the uneasy feeling of being watched. In lieu, an unobtrusive ubiquitous system that can transmit data and keep the user informed about her health is a better solution. Various contextual cues instead of video could help in tracking the activities of the user, for example the sound of running water in the bathroom, the heat of the stove or smell of food could provide lots of information regarding the user's daily activities.

Even in this age of technology many people have not heard of smart homes. Furthermore, large populations of those who are familiar with the term are unlikely to have a clear idea about how it works. People might feel that it is one more technological fad, but once people start realizing the benefit of this new technology, they will begin trusting it, once they start trusting it, they will feel comfortable with it and ultimately it will be a part of their lives. Many of the technology currently available are relatively expensive and only the middle and upper income group people can afford it. But once people start using it, the demand for mass production will increase, which will ultimately bring the price down.

What is a "Smart" home?

A home which is smart enough to assist the inhabitants to live independently and comfortably with the help of technology is termed as smart home. In a smart home all the mechanical and digital devices are interconnected to form a network

which can communicate with each other and with the user to create an interactive space. For example, in a normal home we do have various electronic devices like TV remote controller, automatic room heating controller, timer for cooking and infra-red alarm system. But these are discrete unit operated individually, whereas in a smart home all these discrete devices are inter connected to form an interactive platform which ultimately eases the user's burden from everyday works. The concept of smart home has generated several new ideas in creating intelligent devices to assist people in their daily activity.

The general concept of smart home is like rooms embedded with infrared lights creating an infrared invisible mesh in and around the house. This can detect each and every activity of individuals in the vicinity of the system. This system can be very helpful for elderly people living alone. This system can also inform someone for help in case of emergency. In another situation camera on the door-bell which can trigger the TV showing the visitors detected by the infra-red light installed on the door. Smoke, fire and pollen detectors can detect abnormal activity inside the home and take appropriate action. There are motion trackers and motion detector which can trigger an appropriate light when you wakeup in the night and walk through the corridor to the bathroom.

Virtually there is no limit to this concept. To have a better understanding of how a smart home work lets create a scenario of an individual living in a "smart home". For the purpose of this study let's call her Jennifer staying in a smart home. Jennifer is a 65 year old women living alone in her apartment. Recently she renovated

her home to “smart” home. Jennifer has a habit of listening to the radio at 6 PM in the morning. So at six “o” clock in the morning the programmed radio starts slowly and goes up to the required volume. Jennifer gets up from her bed and steps on to the floor; the infrared sensors detect her movement, and trigger the blinds to open, bringing daylight into the room. When she starts moving towards bathroom located at the end of the corridor; the sensor embedded in the corridor triggers the corridor lights-up to illuminate the corridor slowly. When she enters to the bathroom, the bathroom light illuminates automatically. The mirror being an intelligent mirror, she could see the weather report, news report from the popular news channel and even new emails on the mirror itself. After she finishes her morning chores she views indications of her blood sugar level, blood pressure and weight displayed on the interactive mirror. She could even see the suggestion of health information that her doctor advises her to follow. She then steps to the bathtub - she does not have to worry about overflowing as the water overflow detector can take care of that. While taking bath she listens to music of her choice – a piano piece that maintains her mood.

She goes to the dining table and the electric tea-maker starts preparing tea for her. She sits down on her dining chair and a message goes to her son staying in another country that she is fine and having her breakfast now. The ambient intelligent wall in front displays remote activities of her son’s apartment. She has an option to communicate with him or with her family physician about her health. She remembers once when she fell down on the floor and the motion detector sensor detected the fall, informed her son and the security guard of the apartment. The guard rushed in for

help, the son called immediately to ask about her health and a nurse practitioner arrived immediately to make sure everything was alright.

She has bridge party scheduled at her house tonight. She goes near the refrigerator and the display screen on the refrigerator displays the items she is running low on. It has an option to order those items online from the nearest supermarket with the push of a button. She does not have to worry about going to the grocery store and taking the pain to bring it home. She pushes the button and technology takes care of the rest. She goes to her living room and sits on the sofa. The new iCAT she bought recently greets her and offers the best TV program and even it offers the TV program she missed yesterday. The iCAT has capability of recording TV program she watches often and it has the ability to socially behave with the user, which in other term is called social intelligence. The doorbell rings and a small window popup on the TV showing visitors standing in front of the main door.

She requests the iCAT to open the door and the iCAT responds immediately and opens the door and greeting visitors to the home. They start to talk and in sometime the conversation becomes intense. The carbon dioxide detector finds that the oxygen level in the room has dropped. It pours some oxygen into the room without interfering with the conversation. After the party, Jennifer decides she will go to bed. Sensors recognize that she is going to sleep Automatic sensors dim the lights but advise her to close blinds and make sure that the front door is locked.

Such designs are not fiction but actual real life technologies that have been implemented in research laboratories like PlaceLab, MIT media lab and other

research labs. But to implement this in the real world will be the greatest challenge. Even predicting what the future "smart home" could look like is a very difficult task. The technology used in smart homes have still not matured to a point where it can find mainstream acceptance; thus requiring a comprehensive study of the evolution of technology is essential in order to project the future applications for smart homes.

Summary

In this chapter we presented a comprehensive overview of the current available technology that will eventually shape future technology for healthcare. But to understand what will be applicable in the future, an understanding of evolution of technology is very important. In the next chapter we will discuss evolution of some of the major technologies that led to the development of "smart" technology.

CHAPTER IV

EVOLUTION OF "SMART" TECHNOLOGY

Evolution of smart home

The development in home automation has played an important role in the emergence of smart home concept. Therefore a comprehensive study on the evolution of technology is needed to understand and *design* the future smart home.

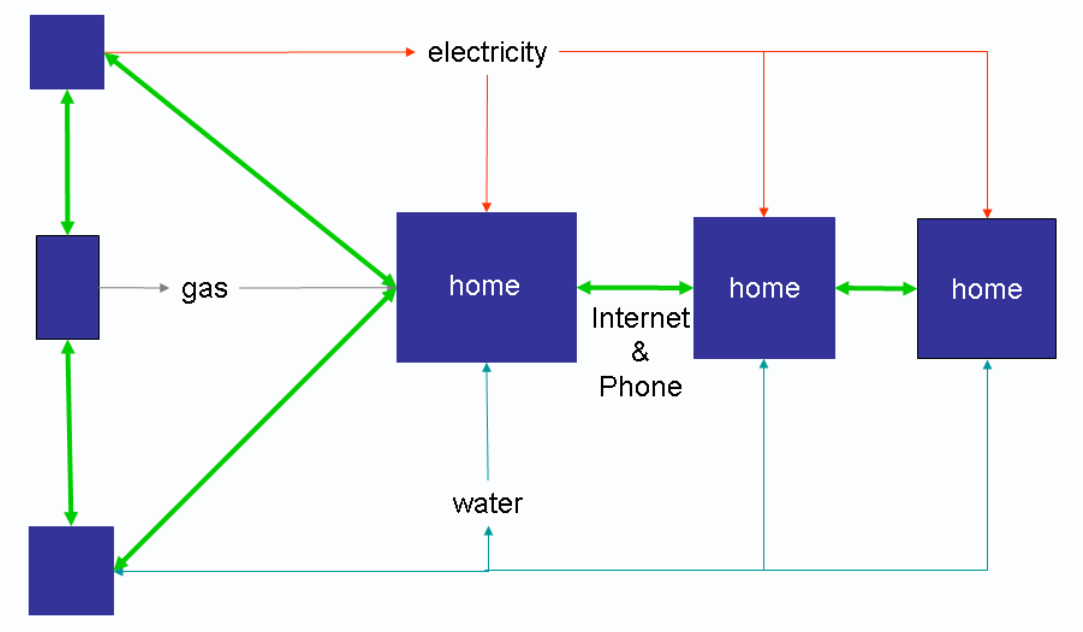


Figure 4.1 Home as a part of the networks

In the early day's home remained as a discrete unit without any connection to external infrastructure. Its main purpose was to provide shelter and protection from

extreme weather, insects and animal. In the later period with the development of technology such as gas, electricity and sanitation, the home got connection to external infrastructure through water pipes, gas pipes and electric wires. The home no more remained a disconnected unit but became a node of a local network. In the modern age this network has increased form a local connection to the World Wide Web (WWW). Now the home has become a part of a much larger network connecting the entire world. This international network has also served as an information highway by connecting each home irrespective of geographical location. The development of such a network has also effected the appliance industries, providing a variety of functions and acting as an interface in the home and to the world outside through sensors and wireless technology embedded in it.

In the chapter we will examine the evolution of each of the above technologies and discuss how it led to the development of "smart" technologies.

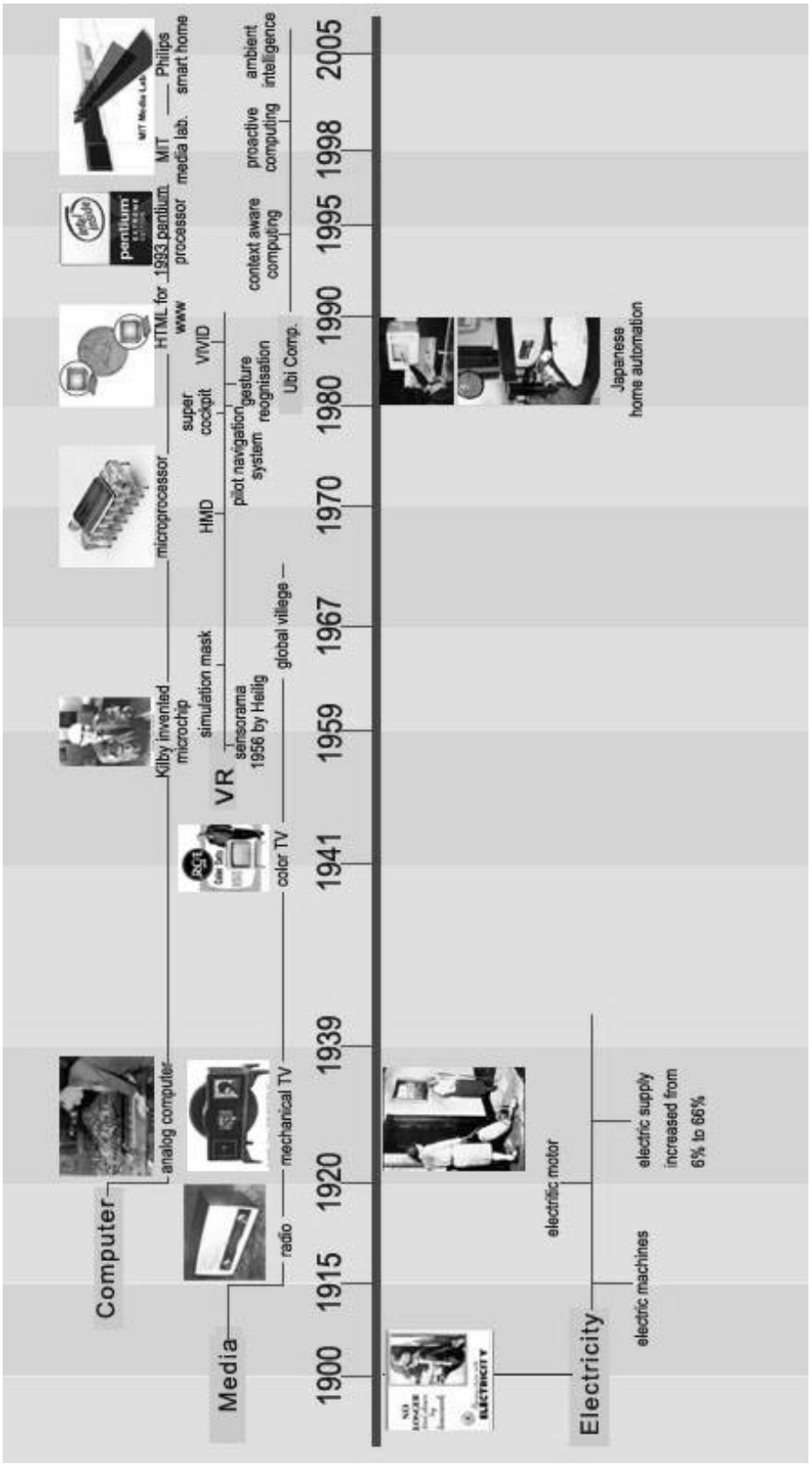


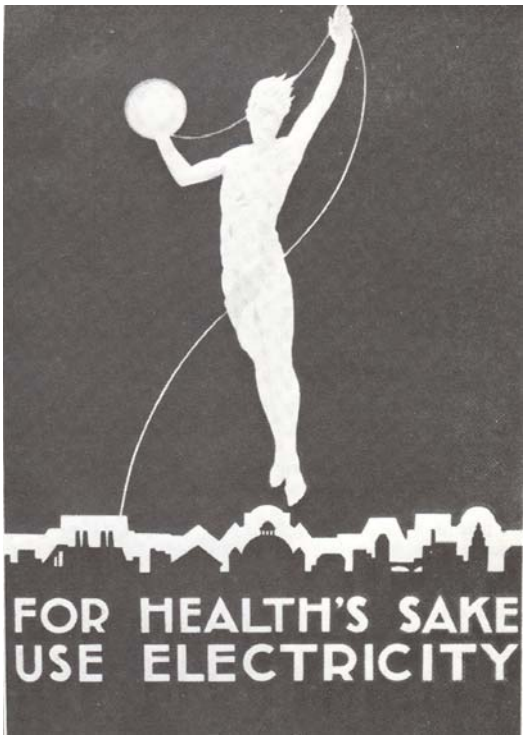
Figure 4.2: Evolution of technology.

Electricity and technology in home

During 1900 electricity brought major changes in the domestic appliances industry. Electricity not only provided a safer means of power but also empowered the manual home appliances with electrically driven automatic technology. Machines like vacuum cleaner, washing machines, and sewing machines reduced the burden of domestic work. The aim was to replace domestic servants with machines, so that one person could look after the whole house with time to spare for other activities (Hardyment 1988, 177-179) like reading book, entertainment or to spend time with family. The major brands like Belling, Creda, Electrolux, Hoover, and Keen Wood; manufactured electrical appliances for kitchen, bathroom and living room. But the electricity was expensive then, therefore these appliances faced lots of difficulties in getting into every household. In later period electricity got subsidized and people started using electricity more then before. Between 1918 and 1939, electricity supply for both existing and new household increased from 6% to 66% (Forty 1987). A large number of houses were embellished with the new and safer mode of electricity for lighting. Initially there were only one 5amp socket were provided to every household (Forty, 1987) which could hold only one electric iron or another appliance but later newly designed homes had more then two sockets.

Adrian Forty further argues that electricity was not welcomed so well heartedly by every individual at that time as a safe mode of energy, rather there are instances where “two old ladies who anxiously kept plugs in all the electrical sockets to prevent electricity leaking out; another old lady was said to be terrified by the

installation of even a bell least the workman be killed in the process". To replace the fear and prejudice, several educational programs were launched. None of this could entirely dispel the fear that remained in people's minds. Therefore a new innovative step was taken to replace the dark and dangerous look of electricity with the more positive, miraculous source of energy that could alleviate the trouble of the world and bring light and happiness in their life. Electric power promised to take the burden of mechanically driven work like washing, cleaning, cooking and sewing with more electrically driven deputy.



Source: Adrian Forty's book titled "Object of Desire" 1986

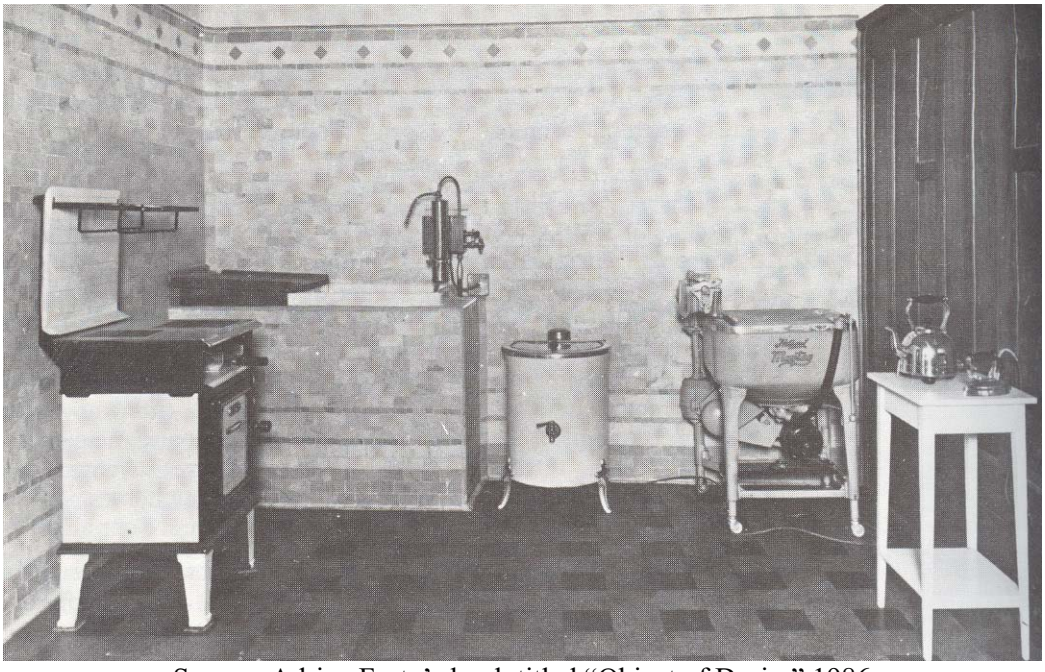
Figure 4.3 Electricity Development Association poster, 1927

During 1920 these appliances become a part of every household and it slowly evolved beyond a luxurious commodity. Another major change occurred in the appliance industry with the invention of electric motor which provided power to mechanically driven appliances like washing machines, water pumps etc. and saved time and energy. According to Adrian Forty the conditions for growth of appliance industry were right in the mid 1920s. With the diffusion in electricity into general households and the introduction of motor, many patents were filed between 1918 and 1939 (Gann, 1999). Seeing the potential of electric appliances many industries produced new appliances for cooking, washing, cleaning or space heating. To reach the consumer, more attention was paid towards efficiency and price rather then the design of the product. As a result myriad number of appliances came for anyone who could afford them (Forty 1986).

Until 1930's appliance industry faced lots of problem in satisfying the consumer. The demand was to provide an efficient and superior to gas appliances to meet the challenge, as gas was still a cheaper form of energy. The electrical appliances were more cumbersome looking and did not fit well to the existing space in the house as a whole. Some critics say that they were more old fashioned and ugly looking appliances. Electric cooker faced lots of criticism due to its awkward look and limited control for the user.

Source: “Object of Desire” by Adrian Forty ,1986

Figure 4.4 Left: Magnetic electric cooker, 1914. A massive electric appliance with very less controls. Right: English electric cooker 1961. A more compact, clean and well designed appliance



Source: Adrian Forty’s book titled “Object of Desire” 1986

Figure 4.5 A well equipped kitchen with cumbersome and awkward appliances

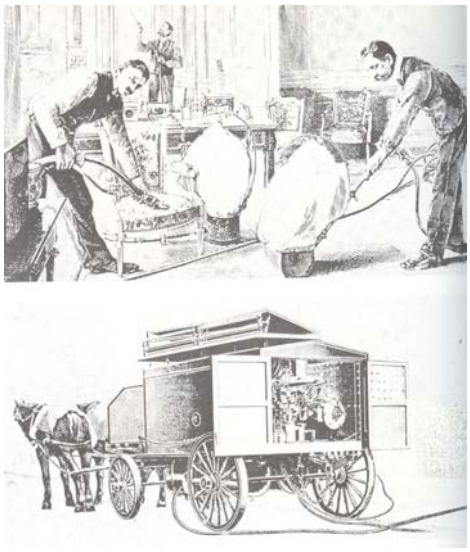
The appliance industry faced many drawbacks in reaching every household as the appliances were:

1. expansive for average household income,
2. cumbersome and did not fit well with the existing infrastructure,not well designed to attract consumer, and less power efficient.

Source: Adrian Forty's book titled "Object of Desire" 1986

Figure 4.6 Publicity photograph for Hoover electric vacuum cleaner, 1927

A successful integration of these appliances was not possible without proper installation of these appliances during the design phase of a new home. Architects, installer and designers have played a major role in designing and planning homes in consideration of these appliances. This improved the standard of living and provided a labor saving, hygienic, safe and comfortable home.



Source: Adrian Forty's book titled "Object of Desire" 1986

Figure 4.7 Mobile compressed air cleaner, France 1903

At this time, separate from home based technologies, various other parallel technologies were emerging that would prove important to the development of the smart home like virtual reality, computer, internet, media and healthcare technology.

Virtual reality

Virtual Reality is based on the concept of Human Computer Interaction (HCI). In VR the computer creates a three dimensional environment that interactively responds to the behavior of the user. This can also simulate environments and make the user feel like present in real world in that virtual space. To enter into this kind of virtual space the user wears either a head mounted device or a special glove or a goggles and sometime even sensors on her entire body.

During 1990s it was a hot topic of discussion and a lot of ambitious statements were made, but the limitation of technology to translate the idea into reality and produce a high quality realistic output, limited the capability of VR. There remained a gap between what VR was expected to do and what it really achieved. The present situation is much better than before and we can assume that the future computers will be much more efficient than the present ones. To understand what VR is capable of and why it failed to achieve, a better understanding of the background and the historical perspective is important.

The history of VR could be dated back to 1950, when Douglas Engelbert, an electrical engineer and former naval radar technician got a new idea of connecting computer to a screen to view digital information. Initially this idea was discarded but in late 1960s, people started thinking about its possibility. One reason behind this is the parallel development in graphics technology and emergence of more user friendly computers.

In 1960 Morton Heilig created a device called “Sensorama Simulator”. This device used 3D video obtained from a 35MM camera. The setup also included a stereo sound integrated with a full 3D camera view and a fan to simulate wind. The setup was crude but it was the first step towards VR. In 1966, Ivan Sutherland, took the Sensorama and redesigned it. He used graphic accelerator instead of the analog camera (Hamit, 1993) which gave more realistic effect as compared to the previous setup. Seeing the potential of this new technology, various research organizations including NASA spent millions of dollars to create flight simulation and combat

simulation. In later period with the evolution of display technology with modern advances in graphics and enhanced high speed processors, VR technology evolved to its greater potential.

Source: http://www.carnetpsy.com

Figure 4.8 Sensorama simulator by Morton Heili.

The US military force first created a helmet to simulate a real life combat operation. It allowed the military to give training to pilots and putting them in difficult situation in virtual space. It avoided the real risks to pilot's life and simultaneously let the pilot prepare themselves for such dangerous situations. But the biggest market of VR became the gaming industry. Video game industry immediately adopted this technology to make simulation games to target the enthusiastic and adventurous kids and young individuals.

Source: http://www2.ncsa.uiuc.edu/Cyberia/VETopLevels/Images/glove.gif

Figure 4.9 DataGolve

One of the biggest achievement of VR in 1980s, was sensory glove, an input device based on hand gesture technology. In a later period it was adapted as PowerGlove by the gaming industries. In 90's it became a fad, as people found that it is heavy and computers were too slow to respond. It often produced headaches and motion sickness as the most common side effect. People stopped using VR technology and no more remarkable developments come up in VR for a long time after that. People stopped talking about virtual reality in the late 90s. Some of lessons that can be learned from the failure of VR are:

1. Technology should be user friendly and easy to use.
2. It should serve some real purpose rather then just entertainment.
3. The device need to be portable and should fit well in to the user's need.

After 20 years the technology has developed a lot and VR is showing a real comeback to the forefront of scientific discoveries. Researchers have now beginning to understand crucial human factors (NASA, 2005), they have understood the

involvement of human and the importance of a human centric design to create a sustainable technology. Helmets have become lighter and smaller, the processor is much faster now, to eliminate the jerk effect of the earlier design.

New technologies have evolved since then - scientists are investigating on writing images into the retina of the eye (Scot, 1996). This would allow one's retina to act as a screen. Moreover VR has a great future in "Unmanned Air Vehicles" where a pilot can operate the vehicles from the ground, avoiding the risk of going for dangerous mission. A primitive version of this technology was used during Gulf War.

Virtual Reality has another potential market in architectural modeling, where a 3D model can be created in a virtual space and can be shown to the client. This could also allow the users to move around the computer generated model in real life and experience the space. Once virtual reality finds a real use in everyday life it could become a part of every household.

The internet

The concept of connecting computers to form an interconnected network was conceived around half a centaury ago by Defense's Advanced Research Project Agency (ARPA). It was an endeavor to connect computers and exchange messages and information through a nationwide network. In late 1960s a research team formed by ARPA in California explored ways to connect computers in laboratory. Later in 1967 ARPA with the help of Stanford University designed a system framework to connect two computers located in separate geographical location. They installed the

first two network nodes in Stanford University and UCLA and in 1969 they were able to send the first text message between the two computers located in the two nodes.

The network soon began to expand and more nodes were created across the country in various universities. The major upshot came with the development of the Internet Protocol (IP). It enabled to connect indefinite number of computers to the network. With the wide proliferation of this network various research institutes like National Science Foundation (NSF) and other private agencies showed their interest in this technology. NSF builds its own network and named it NSF-Net. It spread the internet protocol to universities across the country and to government agencies like NASA and Department of Energy.

Internet users increased manifold during 70s. The wide involvement of users seeking information, education, communication and entertainment made the system very popular. In 1994 new commercial network like IBM and MCI joined this technology movement. It brought the network out of the universities to common people.

Though the genesis of internet dates back to 1960s, it was only after 1993 that it came outside universities to common people. The main reason was the use of difficult interfaces and computer language. It was out of reach for people with less knowledge on computer languages and coding. The deployment of Mosaic, a software program, changed the perception of the personal computer and internet. It provided a user friendly interface with easy navigation from page to page with a single mouse click. It also provided easy to read text with rich display image to

explore the “World Wide Web”. Since than its popularity has increased and has become a part of everybody’s life. Mosaic was the world’s first internet browser – the predecessor to Netscape. Since then several browsers have come into the market – MS Internet Explorer, Mozilla Firefox, Apple Safari and so on – almost all of which is based on the original Mosaic kernel.

The present form of Internet is just an extrapolation of the local network that started almost half a century ago. The framework is still growing and it has already millions of users allover the world. Not only is the internet connecting computers across the World Wide Web but has entered to even appliance level into our homes. We are entering into a ubiquitous computing word with devices connecting together through an invisible wireless networks forming infinite number of nodes across the world. The computer is getting smaller and better with faster processing and display technology. The network technology is also improving with faster broadband and T-LAN internet. Seeing its growth it’s very difficult to predict what the future holds. However we can safely claim that the development will change the way we live.

Telemedicine

Telemedicine is the delivery of medication from a certain location to a distance place. A more extensive definition is that it is the use of modern telecommunication and information technologies for the provision of medical care to an individual located in a distance and the transmission of information to provide that care (Zundel, 1996). This concept of providing medical attention is usually done for remote places deprived of good medical services.

A typical telemedicine setup is a central medical center located in a specialized hospital with several remote satellite medical centers located in rural places. These satellite medical centers are usually staffed with two to three nurses or physician assistants, equipped with technologies for telephonic conversation and video conferencing. With this setup the healthcare professionals take necessary reports and primary checkups of the patient and send those reports through internet to the central medical hospital. These reports could be seen by specialist located in the central hospital, who can provide medical attention to the patient. Telemedicine can also provide one-way video consultation and two-way audio conferencing.

Telemedicine has several benefits like:

- It is cost effective as one physician can look after several patients regardless of geographical location.
- In this setup the physician does not have go the remote place physically; nor does the patient have to go to the doctor - medical attention is provided by specialists from a remote setup.

- It can provide medical training to health care professional located in rural places.
- It permits the physician to do medical research despite of geographical separation.

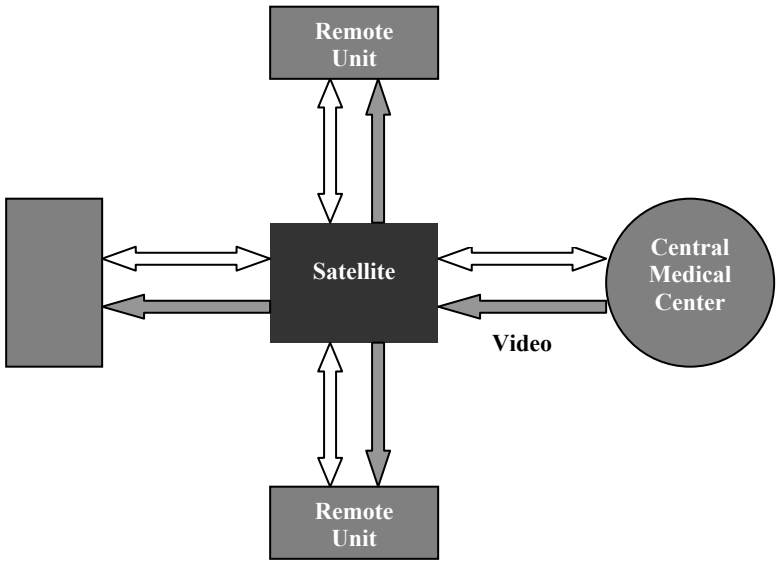


Figure 4.10 Diagram showing two ways audio and one way video conferencing of earlier telemedicine model

The concept of telemedicine originated when African villagers used heliograph and bonfire to warn people to stay away from villages infected with serious disease like plague or smallpox. During the civil war telegraph was used to provide information about casualties and to seek medical attention for injured shoulders. The most important step towards modern telemedicine was taken by NASA during 1960's. NASA designed a setup to provide medical attention and

gather physiological information like blood pressure, blood glucose level, pulse pressure, heart rate etc. of astronauts by a team of physician located in the base. They monitored 24/7 physiological changes and provided just in time medical attention to the astronauts in the spaceship. Another major development in the telemedicine concept came with the introduction of television.

During early 1960's television and video communication provided new setting for telemedicine. In 1964 the first video link was established between Nebraska Psychiatric Institute in Omaha and Norfolk State Hospital, 112 miles away. This link was used for education and consultations between specialists and medical practitioners (Banschoter, 2006). The first complete telemedicine system came up in 1976; it linked a Medical Station at Boston's Logan Airport to Massachusetts General Hospital. This setup provided health services to airport employees and to provide medical attention to the travelers. This study showed that tele-diagnosis can increase the availability of quality medical care (Murphy, 2006).

In 1971, Lister Hill National Center of Biomedical Communication chose Alaska as a research site for telemedicine. The primary purpose of this research was to study the use of satellite in telemedicine to provide healthcare in extreme remote place. Both two-way radio and one way television were installed in the sites for communication purposes. The study concluded that the satellite system is workable and can provide medical assistance to patients and primary healthcare provider for practically any medical problems except emergency medical care as it needs immediate attention (Foote, 2006).

During 1977 to 1984, Various research and projects were attempted; NASA's project for video requirement for remote Medical Diagnosis, Memorial University of Newfoundland's project to promote telemedicine for remote education and medical-care using satellite system with interactive audio network, and North-West Telemedicine Project in Australia to provide healthcare to people living in remote towns of south of the Gulf of Carpentaria to study the use and effect of telemedicine.

In 1989, NASA conducted the first international telemedicine project with than USSR, when a severe earthquake divested Armenia. It was USA/USSR joint project to provide online medical attention to the earthquake victims. One-way video, radio and facsimiles were provided by a medical center from Armenia to four medical centers in USA. This project demonstrated that telemedicine can provide medical consultation in any place in the world with the help of satellite communication. Several new telemedicine projects have been attempted after this and still lots more research are going on to provide better services. Some of the disadvantages in the earlier projects are the immature technology and slower processor speed, but the present technology is much better than the past and future telemedicine will be able to solve some bigger issues that were once impossible.

Smart Homes and labs

Several computer scientists and designers are working together in lab settings to develop future smart homes. MIT's PlaceLab, Philip's Home Lab, Florida State University's GaterTech Lab and GeorgiaTech's Aware Home are some of the current research laboratories working on smart home research. These are the places where the

effectiveness of technologies such as sensors, cameras and other wireless digital devises are studied in real home setting with real people residing in it. In the following pages, we will examine three such "home-lab" setups to provide a framework for our discussion.

MIT's PlaceLab

MIT has developed a "Living laboratory" called PlaceLab, an apartment-scale research laboratory to provide research facilities to test new technologies and design concept in a real home setting. This natural home setting provides opportunities to do systematic study and evaluate strategies and technologies to implement in real world. The lab has been designed to study:

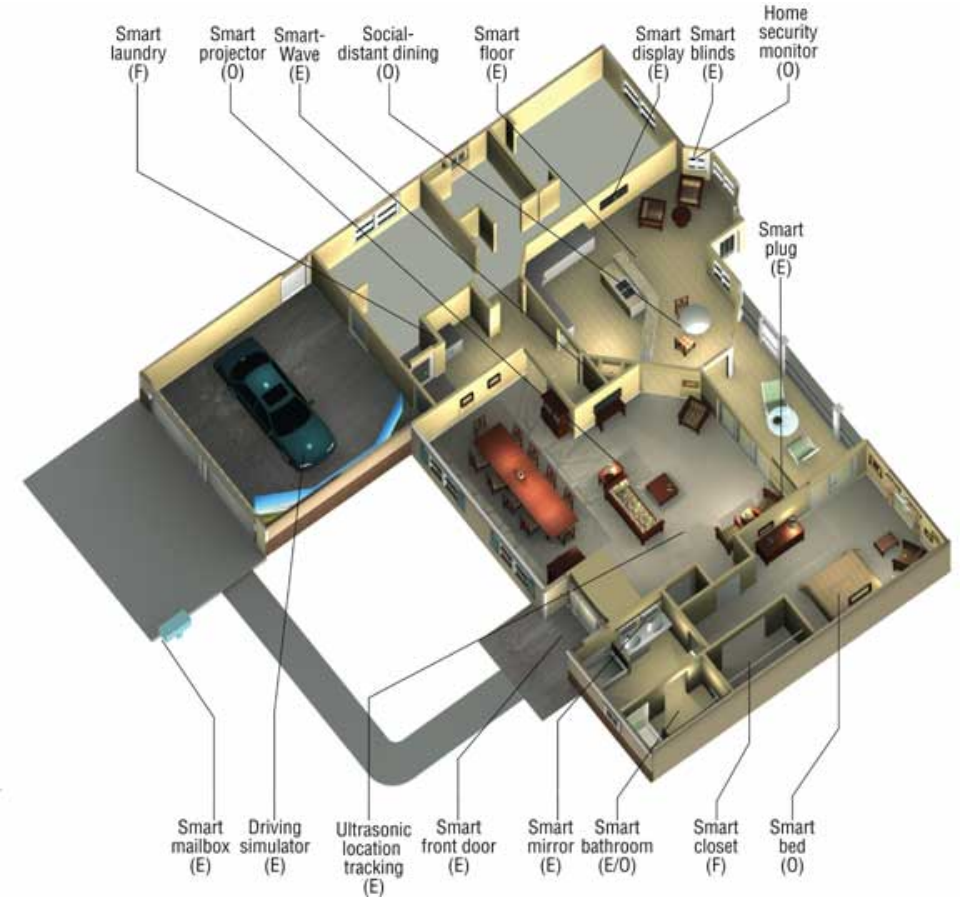
1) proactive healthcare activities of daily living,
2) biometric monitoring and indoor air quality,
3) understand and find a solution on issues like privacy and trust.

Place Lab is capable of accommodating multiple and concurrent research by different research groups at a time.

Figure 4.11 PlaceLab a House_n + TIAX project

The Gator-Tech Smart Home

University of Florida's Mobile and Pervasive Computer Laboratory has developed a programmable space called Gator-Tech smart house for elderly and disabled people. The goal of this project is to create an assistive environment that can sense themselves and the residents to provide remote monitoring and intervention services. This project has focused on basic system integration like interconnecting sensors, actuators, computers and devices in the environment (Helal et. al, 2005).



Source: IEEE Computer society (www.computer.org)

Figure 4.12 Currently active or under development hot spots in the home

Source: Mobile and Pervasive computing at University of Florida (http://www.icta.ufl.edu/gt.htm).

Figure 4.13 University of Florida Gator-Tech Smart Home

The design team has developed the following smart artifacts for the Gator-Tech smart home (Helal et. al, 2005):

Smart mail box: The mail box senses the arrival of a new mail and notifies the occupant.

Smart front door: The door has a RFID tag embedded init which helps is a keyless entry of the residents and authorized personnel. It has also a microphone, a camera and text LCD, speaker that the occupant can use to communicate with any visitors. This helps the occupant to open the door without physically moving from his place. It helps in maintaining the security of the home.

Driving simulator: The garage has a car with a driving simulation capacity. It can evaluate the driving ability of the user and gather data for research purposes.

Smart blind: The windows have automated blinds that can be controlled remotely or even it can work in context. For example if the user is watching TV and the window is throwing glair of the TV it can automatically close the blinds.

Smart bed: The bed in the master bad room has special sensors embedded in it to monitor the sleep-patterns of the occupants and keep track of the sleepless night.

Smart mirror: The mirror in the master bed room is capable of displaying important health related messages and reminders.

Smart bathroom: The master bathroom has a toilet paper sensor, a flush detector, a shower with temperature regulator, a soap sensor that notifies the service center if it runs low. The future technologies on which the research team is working on are biometric monitoring system to monitor body weight and temperature.

Smart microwave: The kitchen microwave has the capability of assisting the user in regulating temperature and help in cooking.

Smart refrigerator: This feature is under development and the future refrigerator will be able to prepare the shopping list and can even order items running low. It will also be able to provide assistance based on items available in the refrigerator.

Smart-distant dining: This enables people to share meal with a relative staying in a different geographical location with the help of video and audio technology installed in the breakfast nook.

Smart cameras: The camera installed on the front porch and patio reinforces the security system.

Ultrasonic location tracking: Sensors located in the living room can detect the location, movement and orientation of the occupants.

Smart floor: Sensors in the floor can monitor movement, track position as well as detect fall. For this purpose the designers have raised the floor a little bit to have proper wiring and install sensors in the floor. This helps in getting precise user position in the room.

Smart phone: The phone functions like a traditional phone but it has been connected with all appliances and media player of the house. It can convey remainders and important information to the resident while they are away.

There are several other smart devices like smart thermostat, smart closet, smart leak detector, smart stove, home security monitor, emergency call for help and cognitive assistance. The programming in Gator-Tech smart house works on context which are managed by embedded sensors and actuator embedded in the home. Actuator are physical devices with which people can interact where as sensors can observe as actuator's effect. The designers believe that this setup will be able to provide security and help the baby boomers live an independent life.

The GeorgiaTech's Aware Home

Georgia Institute of Technology (GeorgiaTech) has developed living laboratory with ubiquitous computing in a 5040-square-foot home called "Aware home". This three-story home serves as a laboratory for interdisciplinary design development and evaluation. Aware home is based on sensing and perception technology, to provide an interactive experience in a home environment to help

elderly people age-in-place. It provides a research platform for designers and software engineer to work together and designing a robust and reliable technology. It also explores the social, political, legal and economic benefit and concerns related to privacy and autonomy. This research project addresses some of the very important social and technology aspects related to smart home. (Aware Home Research Initiative, 2005)

Photo by Gary Meeks

Figure 4.14 Aware Home by Georgia Institute of Technology

Source: www-static.cc.gatech.edu/

Figure 4.15 Digital Family Portrait by Georgia Institute of Technology

To enable people live independently and age-in-place the aware home provides several smart artifacts and devices like;

Digital family portrait: As people grow older, any connection to their family member is valued. Older people look for intimate connection with their family members. But distance, geographical separation and work pressure makes this impossible to do. This need is a big concern for family member living by themselves. "Digital Portrait" is one of the endeavors to reconnect distant family members and allowing them to remain aware of each other. The digital portrait frame changes daily and reflects a portion of the family life. The portrait captures observations similar to someone staying next door in the same house.

Summary

One of the biggest problems that ubiquitous computing could solve is the spiraling medical cost of the United State to provide healthcare to elderly people. This chapter gives a fair over view of the present technology and upcoming future technology that could be used in a proactive healthcare environment. But the question arises; will the technology that has been tested so far in laboratory settings work in the same manner in natural home setting in a remote place? To answer this further research is needed to see the perception and penetration of technology in rural area.

CHAPTER V

CONTEXT

By now it is clear that a definite problem exists with the present healthcare delivery system in rural areas and a sustainable solution is needed to deal the future baby boomer situation. We have also seen various technologies under development in several research laboratories and the new technologies that are coming up. From the previous chapters we can derive consensus that the rural population is very different than the urban population due to its unique settlement pattern, geographical location and perception towards technology due to different education levels.

The need

As technology becomes pervasive, its amalgamation into architecture is easier because it inevitably becomes a part of the design process. The problem is - we do not consider computing pervasive yet and seldom does it find integration within the design. However, as architects and designers we must all realize that computing initiatives are working towards creating more powerful and increasingly invisible computers and that the profession of architecture will increasingly be pressured to implement them within the architecture of living environments.

In order to initiate changes within living environments there must be an attempt to test and evaluate strategies and technologies related to proactive healthcare

in homes, cost effective responsive environments, and human-computer persuasive interfaces that work in any demography and/or social condition. However much of the research happening in this arena is concentrated in urban centers and economically stronger sections of the society. But the real need for such research, as suggested by statistics, is in areas like South Central United States where the current clinical model is unable to reach the average consumer. The question arises – can technologies bred in home labs be effective in homes, especially rural homes? Will the rural population accept changes to their homes and lifestyles? Is the rural population ready to accept technology or are they unwilling to adjust to change?

Therefore research in this domain has paramount importance to understand the type of technology that could be used while designing smart home for rural senior population. Although the use of technology to aid healthcare will eventually reach our homes, it is important to establish a framework for the design of such technologies. Implicit within this is the need to understand technology penetration and adaptation in rural areas of the country.In order to do this, we selected Meridian, Mississippi; a quasi-rural setting surrounded by rural areas as our study site.

Intention

We chose a quasi-rural city in Mississippi as most suitable to experiment with the new technology to aid age-in-place because Mississippi can be termed as a quintessentially rural state with a large population under poverty line and with very little access to technology. We believe that such technologies can make a different but before deploying or proposing designs for technology, a better understanding of its

acceptance, both from the design and cognitive point of view is important. Therefore we decided to conduct a series of focus group studies. This study should essentially provide us with important "first" information that can be used to understand the problem. The study will also help us to ask important questions that could eventually lead to the development of solutions. Such an understanding of the problem is paramount before we start designing because it will influence the design in a much more positive manner.

Hence, the group discussions included care providers, care recipients and the healthcare providers in an attempt to understand perception towards technology in different domains of the health care sector for elderly care. The focus group study will help us providing design guidelines to designers, scientists and engineer for designing future smart home as a mode of health care delivery system for rural elderly population.

Before designing this focus group we embarked on a study of the models of healthcare in Mississippi. Such a study was conducted to better inform the design of our groups – enabling us to understand healthcare delivery models and predict future scenarios.

In the following paragraphs we will derive the context of healthcare within Mississippi by first understanding evolving models of healthcare delivery and finally zooming into Meridian in order to establish its history and demography as a contextual enquiry for our research.

Models of healthcare

This section evaluates the past and present health care model. Such a study will help us project the future model of health care system from the present system, where technology will assist both the healthcare provider as well as the healthcare recipient without physically moving from hospital or home respectively.

Healthcare model before 1900

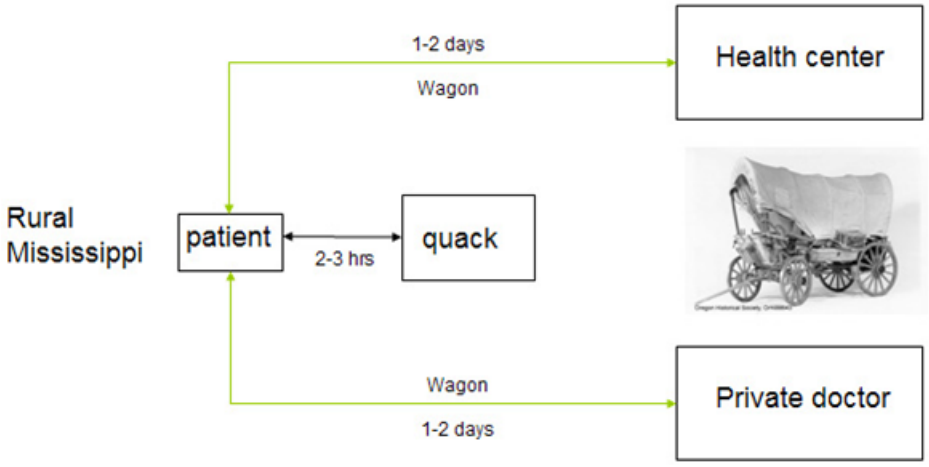


Figure 5.1 A conceptual healthcare model before 1900

Providing healthcare before 1900 was a very difficult task due to poor transportation and communication system. It might be taking two to three days to get medical attention. The only mode of transportation was the wagon or some other primitive form of communication. Again fewer active physicians were also a big concern for rural people. Some quacks (i.e. local physician without a license to practice medicine)

were the only people with some knowledge in medicine to provide immediate medical attention.

In 1897 The Mississippi State formed medical board and appointed licensed doctors for medical practice. The number of physicians increased and access to a variety of medical services like Homoeopathic and Allopathic services improved (source: dissertation on a history of Nursing in Mississippi by Linda Emerson Sabin page: 122, UMI). Most medical care was a domestic activity with diagnosis, treatment and recovery taking place at home. Events like epidemic, traumatic accident and chronic illness seek the patent to go to physicians. But there were very few physicians available in a large stretch of the city. A census report from Columbus on Devis's sanitarium says that there was only a maid and the doctor's family resided at the hospital in 1990.

Healthcare model after 1900

With the invention of the car in 1900 the transportation system improved and provided a faster mode of transportation but bad road condition in rural areas was still a big hindrance. In the later period the transportation system improved and the time to reach help decreased substantially.

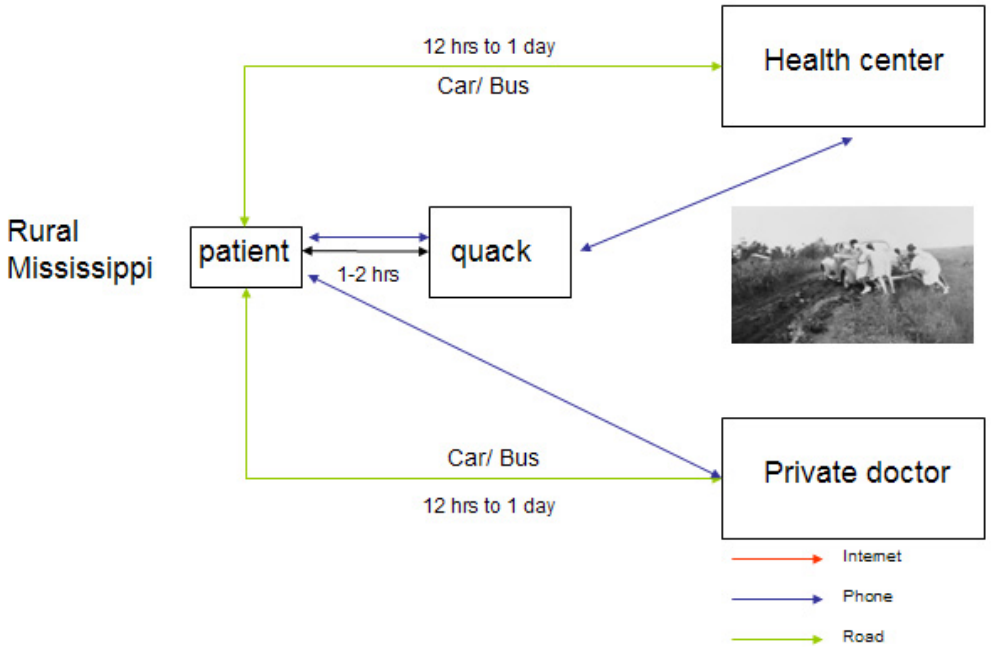


Figure 5.2 A conceptual healthcare model after 1900

In 1932 Dorothy Freebee started a mission with her co-workers to help rural people of Mississippi State. She used to go to remote places or rural Mississippi to help the needy. She organized several medical camps to educate and provide medication to patients in rural areas.

Present healthcare model

The present situation of healthcare in rural Mississippi is based on communication and transportation technology. Better highway and airways ensure faster and more accessible mode of transportation for everyone. Telecommunication and the internet is providing just in time service to the needy in remote places.

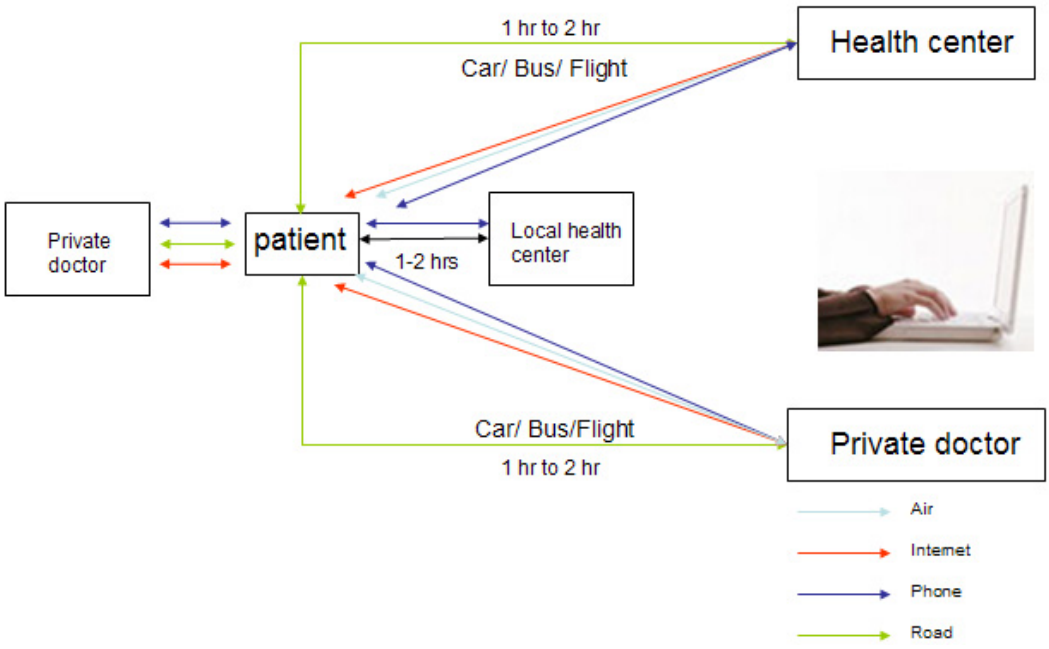


Figure 5.3 A conceptual present healthcare model.

Patients can reach hospitals through various means - road, air and communicate with the health care provider through the telephone and internet. The number of hospitals and physicians has also increased during the course of time and this has resulted in a better health care facility. There is more awareness and funding opportunities for providing rural healthcare. Internet use is increasing and myriad health services are available on the internet. Information on medications, diseases and even location of hospitals can be easily found.

The new patient is a more informed person; aware of diseases, their effects and the symptoms. The emerging concept of telemedicine is finding widespread use in remote areas where healthcare access in minimum.

Future projected healthcare model

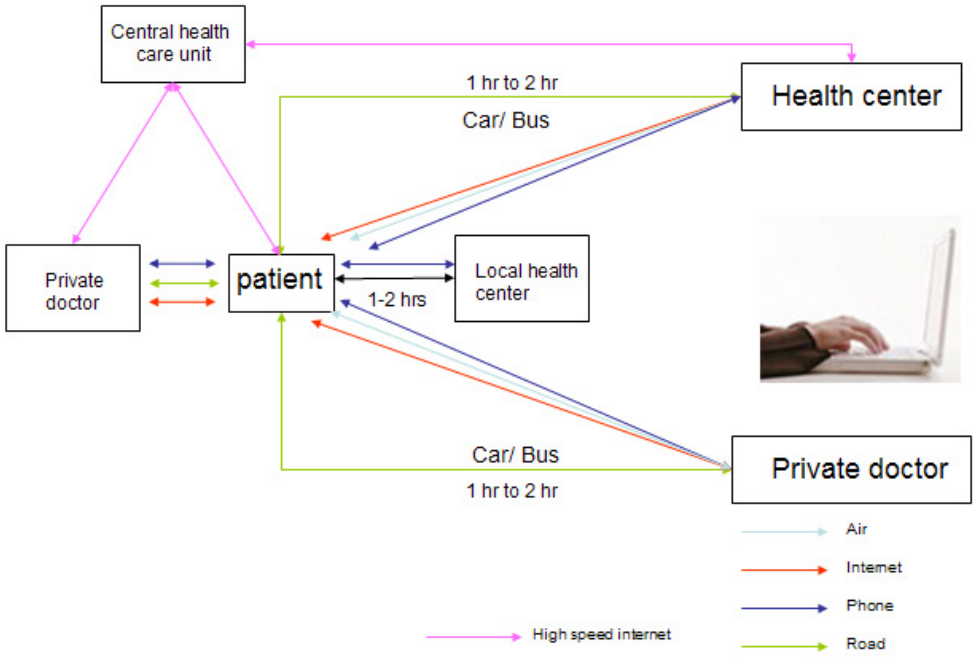


Figure 5.4 A conceptual future healthcare model.

Rapid increase in mobile and ubiquitous computer technology is giving added impetus to health care services. To meet the demand of the increasing population and just in time responses, researchers and social scientists from various disciplines like medicine, computers, engineering, architecture, sociology, communication, psychology and economics have already started working together to find an alternative solution for the present model of health care system architecture.

One possible solution to this could be virtual medicine where technology will assist both the patient and physician alike to provide 24/7 assistance. This will bring the communication bridge one step closer between the patient and the doctor. A central health care unit can be formed which will collect 24/7 dada from the patient

and provide to the doctors. This setting does not require the patient to be hospitalized or even go to the hospital. Instead the patient can remain in his/her own natural home and get the medical diagnosis and treatment (unless hospitalization is required). Reducing the physical load would also add to increased efficiency in healthcare providers and thus aid in better healthcare services. This system will be more helpful for long term health care for chronic patients.

Such a system will not only be effective in reaching healthcare to rural areas but will also reduce the cost of healthcare and healthcare infrastructure required for the current "brick and mortar" model.

Meridian

Meridian is located in the east central Mississippi. It has a total population of over 39,000 with 10,026 families residing I the city. The median age of the population is 35 with 14 percent population aged 65 and above living alone. The city is considered as a good place for retirement life due to its low housing price, low crime rate and low income tax as compared to other cities. It has also three major hospitals with over 1,150 beds. The city has a good communication and transportation system. It is connected with all other cities through better road, rail and air transportation system.

History

History of Meridian could be dated back to the time when native Indians settled in the area, there is hardly any data available on the demography pattern

during that period. But it was 1831 Richard McLemore, the first white settler in the area (Lowry Robert 1974) came to the city. He possessed most of the land of the area. He offered free land to people and invited people to build the city. Later new business opportunity came to the city with the establishment of the new railroad crossing i.e Mobil & Ohio line by the Vicksburg & Montgomery line in 1854. At that time the city was having very few educational and official building, the only notable architecture was Richard McLemore's residence (Meridian Centennial 1960). In 1860 the name Meridian was officially accepted, at that time Meridian was a very small village consisting of only 15 family members.

Source: www.epodunk.com

Figure 5.5 Meridian, Mississippi, early 20th Century.

The city started growing due to the new rail crossing, new churches, hotels and offices were built. But the situation did not remain the same and it changed with the outbreak of the civil war. The city turned into a military army. In February 1864,

Gen. William T. Sherman of the federal army invaded Meridian. It was Gen. Leonidas Polk, then the commander in charge of Meridian, could not defend the city due to a very small army force. He left the city on the mercy of the invaders (Lowry Robert). Gen. William's army destroyed the entire city - houses were burnt, the railroad was destroyed and the grist mill was turned down.

Even such a big set back could not stop the city and the people of Meridian started rebuilding it immediately but quietly. The railroad was reconstructed, the bank was started, factories began to produce new goods and the city entered to a new era of reconstruction (Lowry Robert). Meridian grew till 1871, when another big set back turned all happiness into sadness. The first cotton mill was accidentally destroyed by fire just when it started to pay. But new factory and industries brought the city back into action and filled the gap.

During 1890 and 1930 the city entered into the most progressive era. A lot of credit for this goes to Capt. W. H. Hardy. He brought the NO and NE rail road to Meridian. Moreover, the proposed road to New Orleans got completed in 1883. The new transportation brought the city with new opportunity for business and communication (Shank). During this time much of the skylines were built including the Grand Opera house. Mr. C.W Robinson, then a prominent figure, joined Capt. W.H. Hardy. He helped Capt. Hardy in establishing industries and improving the city infrastructure.

Around 1900, the Threefoot building was built. It was a master piece of art-deco architecture. It becomes the tallest building in Meridian – a skyscraper. Meridian

is also known for its educational buildings. At present the city has seven public school buildings and several college buildings. Meridian is also well known for its churches and it comes within the “bible belt” of the United States.

Mayor E.H. Dial has also played a major role in shaping the city with fine system of sewerage, street paving and laying side walks. He also prepared and secured the adoption of a number of ordinances. According to 1900 census Meridian was ranked first among the manufacturing cities of the states with 119 industries in the city. The total population was 1450 by 1900 and it is grew rapidly. Now it claims the largest number of population in any city in Mississippi. Meridian is also known as the "Queen City" and it was the second largest city next to Jackson, Mississippi's capital ("King"). In current studies however - Biloxi is the second and Meridian has dropped to the third.

Demography

According to US census 2000, Meridian population is 39,968 with 15,966 households and 10,026 families residing in the city. The total population density is 342.0/sq. km. There are 17,890 housing units at an average density of 153.1 /sq. km. According to race the city consists of 43.99% white, 54.37% African American, 0.17% Native American, 0.60% Asian, 0.03% Pacific Islander, 0.28% from other race and 1.08% of the population are Hispanic or Latino of any race.

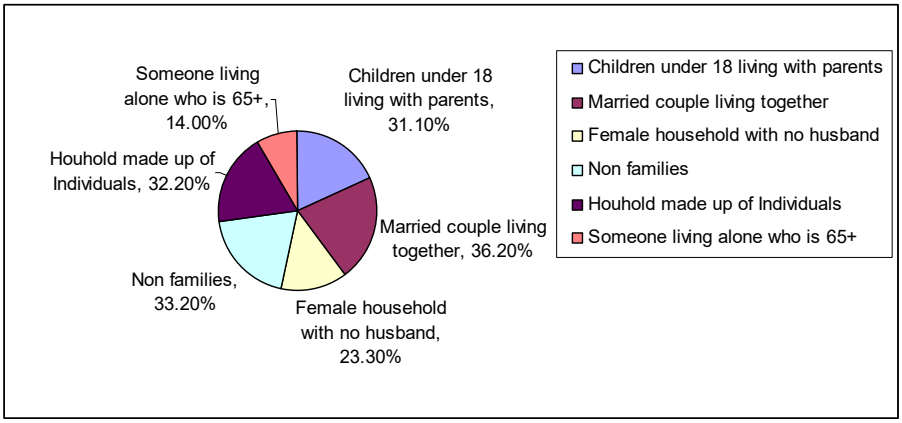


Figure 5.6: Meridian demography (US Census 2000)

Meridian consists of 15,966 households, out of which 31.1% have children under 18 living with their parents, 36.2% have married couples living together, 23.3% have female households with no husband present, and 37.2% are non families, 33.2% households are made up of individuals and 14.0% have someone living alone who is 65 years of age or older.

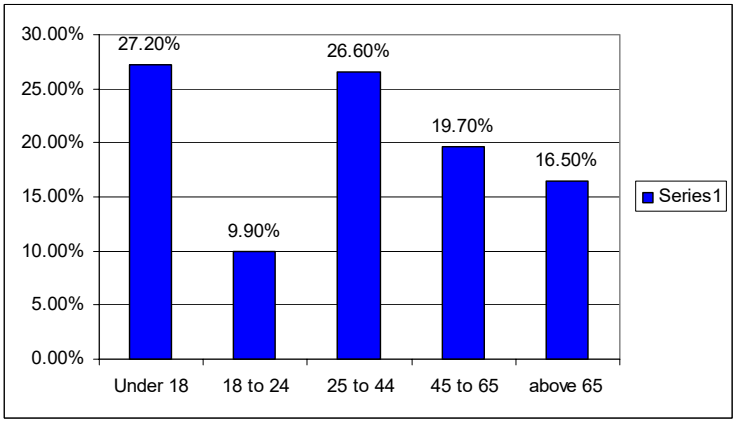


Figure 5.7: Population ratio by age (US Census 2000).

The median age of Meridian is 35 years. For every 100 families there are 84.0 males and for every 100 females age 18 and over, there are 77.0 males.

The median income for a household of Meridian is $25,085. Median income for a family is $31.062. Per capita income of the city is $15,255, and 28.6% of the populations are below poverty line. Out of the total population 40.8% of those under the age of 18 and 22.0% of those 65 and older are living below the poverty line.

Location

Meridian is located in east central Mississippi very close to the west border of Alabama. It also comes near a major transport junction: I-20 and I-59 along with U.S. Highway 45. Moreover the Amtrak railway station serves twice a day to and from New Orleans and New York.

The following are some of the major cities and the distance and driving hours from Meridian.

- Jackson, MS.....93 miles (1.5 hours)
- Birmingham, AL....154 miles (2 hours)
- New Orleans, LA...202 miles (3 hours)
- Memphis, TN.....231 miles (4 hours)
- Atlanta, GA.....297 miles (5 hours)

Meridian is in the 'Pine Belt' and is a distributing center of timber. Also, Meridian is a commercial and industrial center for east Mississippi and west Alabama.

Meridian is also a good place for retirement life. The average buying price for a house is $79,912. It is a lot cheaper than Hattiesburg's $94,000. In addition, there are three huge general hospitals and the total number of beds is over 1,150. Hattiesburg has only 750 beds.

Low Crime - Mississippi's crime rate is below the national average, and Meridian's crime rate is the lowest in the state.

Low Taxes - no state income tax on retirement income.

Transportation

Railroads: mtrak's Crescent train connects Meridian with the cities of New York, Philadelphia, Baltimore, Washington, Charlotte, Atlanta, Birmingham and New Orleans. The Amtrak station is located at 1901 Front Street.

Air Transportation- The town is served by Meridian Regional Airport to the southwest, located at Key Field, 2811 Airport Boulevard South.

Interstate Highways-Interstate 20, runs west to Jackson, Mississippi and east to Tuscaloosa, Alabama . Interstate 59, joining with I-20 at Meridian, runs north to Tuscaloosa, Alabama and south to Laurel, Mississippi, and New Orleans.

U.S. Highways-U.S. Highway 11 runs parallel to Interstate 59.
U.S. Highway 45 runs north to Columbus, Mississippi and south to Quitman, Mississippi and Mobile, Alabama.

U.S. Highway 80 runs west to Jackson and east to Demopolis, Alabama and Montgomery, Alabama.

State Highways-Meridian is connected by four major Mississippi Highways:

- Mississippi Highway 19
- Mississippi Highway 39
- Mississippi Highway 145
- Mississippi Highway 493

Why Meridian?

Various research and surveys has already been done in urban settings, but a little effort has been made towards technology penetration into rural areas. Rural areas varies widely from the urban in terms small scale, lower population density, settlement pattern, lower income, greater outreach and access distance, and lack of transportation. Moreover the population composition in rural area is very different as compared to the urban. Therefore technology adaptation in rural areas varies widely. To have a better understanding no the above issues we chose Meridian Mississippi as our research site.

As per US census 2000 the population of meridian is 39,968 and the total population density is 342.0/sq.km giving it the status of a rural county. Defining rural area is very complicated task (primarily due to the large variation in definitions). The simplest definition is that which is provided by the US Census Bureau definition. According to this; rural areas comprise open country and settlements with fewer than 2,500 residents. Urban areas comprise larger places and densely settled areas around them. Urban areas do not necessarily follow municipal boundaries. They are essentially densely settled territory as it might appear from the air. Most counties whether metropolitan or non-metropolitan contain a combination of urban and rural

populations. According to US census counties that are not urban are described as rural.

The Census Bureau defines an urbanized area where it finds an urban nucleus of 50,000 or more people. They may or may not contain individual cities of 50,000 or more population. In general, they must have a core with a population density of 1,000 persons per square mile and may contain adjoining territory with at least 500 persons per square mile.

Even though the US Census categorizes Meridian as a rural county, it is important to understand perceptual biases of local people. In our research, we refer to Meridian as a "*quasi-rural*" setting primarily because of its unique location and perception within the state of Mississippi. The important thing to note here is that although the extents of Meridian encompass an urban outlook, the encashment area of Meridian goes far beyond and includes many rural villages.

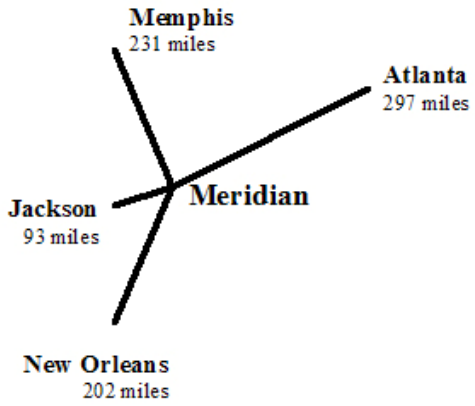


Figure 5.8: Location of Meridian in relation to its neighbor major cities

Meridian lies in two to five hour driving distance from the four major cities shown in the above figure. It is also considered as the commercial and industrial center for east Mississippi and west Alabama.

However the most important criteria for our selection was the fact that Meridian is a favorable place for retirement life as there are no state income taxes on retirement income and the average buying price for a house is $79,912 which is a lot cheaper than other cities. Meridian also possesses three huge general hospitals with a total number of beds over 1,150. These hospitals will prove as fertile research grounds for any future development of technology in this area.

Summary

This chapter presents a fair overview of the city Meridian. Due to its location, transportation, history and present medical condition we chose Meridian as our site of study. The following chapter will give an outline of the research method that we used for our research.

CHAPTER VI

METHODOLOGY AND SETUP

The focus group was designed to evaluate the idea and get a better understanding of the problem associated with acceptance of technology in rural setting. A focus group is a special type of group having certain characteristics in common, like age, gender, education and interest. The purpose of a focus group is to have better understanding on how people feel or think about an issue, product, or services (Kreuger R.A.). Focus group usually comprises of five to ten group members. The medium size group usually gives better result as each member in the group gets equal opportunity to present his/her ideas and thoughts. In a very large group the discussion leads to arguments and some member dominates over other and everybody does not get equal opportunity to talk and the group turns to fragments. People starts talking among themselves rather than addressing to the group. On the other hand a small group lacks arguments which results in a smaller pool of ideas (Kreuger R.A.). Therefore formation of groups is very important to draw better results.

Why use focus groups?

Focus group provides a natural environment as compared to an individual interview or a survey, because in a focus group participants influence and get

influenced by other group members. Since a focus group comprises of people with a common interest they feel more comfortable about self-discloser. According to Kreuger people face lots of difficulties in expressing their view points. In a interview setup people often do not feel comfortable enough to express themselves. For example children have a natural tendency to disclose things about themselves, but over time they learn the value of social dissemblance. Over time the spontaneous self discloser turns to be politically correct sentences due to social pressure. This affects the outcome of the result and gives ambiguous and improper result (Kreuger R.A.), where as focus group leads to serious arguments on various issues. There are several reasons why people self-disclose in a focus group setting;

1. they find one or more common characteristics among the fellow participants like age, gender, sex or occupation,
2. subject tended to disclose more about themselves to people who resembled them in various ways than to people who differs from them (Jourard. S 1964),
3. subject finds the environment non-threatening and comfortable,
4. even if they disagree with what they say in a focus group setting, they are less likely to see each other again and make an issue about it,
5. they know they are not being judged by anyone but they are getting a chance to put their viewpoint which they might not have talked about before,
6. sometimes participants come without an inclination to talk on the topic but they get ideas from the fellow participants and later are able to convey their own thoughts on the topic.

Focus group study often gives new ideas, which helps in generating hypothesis (Jourard 1964). It provides a rich understanding of participants' beliefs and experience (Morgan D.L). It also helps in decision making, assessing user's need, product or program development, planning, goal setting and product testing. Focus group study helps in decision making before, after or while developing any product or working on a business model. It also helps in testing ideas and perception of users about the product or program. During the early stage of program or product development it helps to understand, see and value what other people think about the product or idea. It informs about the like, dislike or even it gives new ideas and helps in developing the same idea into a real product or program. In product testing stage designers comes up with pilot project and shows it to a targeted audience in a focus group setting to find out their perception towards the product. After conducting several focus group study designers draws inference and reconsider changes in their design to develop final prototype. This decreases substantial risk in design failure and helps in decision making and marketing.

Sample

Targeted audience plays a very important role in focus group. A careful consideration of sample recruitment can help in managing the focus groups. In this research focus group studies were conducted in a quasi-rural setting in the city of Meridian, Mississippi and West-Point, Mississippi. Three focus groups were set; the first group comprised of care provider like family members, friends, and neighbors. In the second group health care providers from the medical center of Meridian were

invited to take part in the discussion where as the third groups comprised of elderly people of 65+ age groups. Separate focus groups were set to get better understanding of each group's perception about healthcare technology. Homogeneity in the group was maintained to get each group's viewpoints. In a focus group decision are usually made by the decision maker after a careful analysis of each focus group discussion.

Human subject approval

Permission to conduct the focus group study was obtained from the Institutional Review Board (IRB) at Mississippi State University (Appendix B). Following consent from IRB, a copy of the consent form (Appendix C) was handed over to the human subjects and was asked to sign the form and willingly joining the study. It was clearly stated that no identifiable data will be produced or released to any one; that their name and identification will be kept confidential else if required names and places will be changed or be given a code number for documentation or publication.

Selection of subjects

The biggest county of Meridian is Lauderdale County with a total population of 39,968 and population density of 885.86/sq. miles. The median age of the county is 35 as per 2002 U.S. Census and 16.5% of population age 65 and above. For the purpose of our study we selected three groups and all the subjects who met the study criteria were contacted for inclusion in the study. The criteria for inclusion in the study included:

1) Elderly aged 65 and above staying alone with or without disabilities.

2) Healthcare provider from providing health care to elderly persons.

3) Family or friends with caregiving experience for someone aged 65 and above.

Before conducting the real focus groups a mock-up focus group was conducted in a long term care centre in West-Point, MS. The group consisted of healthcare providers (nursing staff and therapists) dealing with geriatrics. The idea behind the mock-up was to test the questions and to get a general overview on the overall focus group setup. The questions were studied and minor flaws were observed from the focus group setup. This focus group provided valuable information regarding the study and also helped us test our questionnaires for the rest of focus group study. Moreover it also provided a guideline to analyze the study report and formulate the findings. Various trends came up from the study which helped us focus our study on the similar trend in the later studies.

Technologies used for the study

Focus group study needs lots of effort in transcribing the discussion and analyzing from all the transcripts. Therefore a clear recording of the discussion is very important. To meet this demand a multidirectional microphone was used with larger capture area in order to capture sound from all direction. The micro phone was connected with a computer having special software to record the discussion. Since the study needs lots of effort to arrange it and can not be conducted again; and even if we were able to conduct the study, it may not be possible to retrieve the same kind of

information every time. Thus, a backup setup was very essential to avoid any technical failure in this case; we used a video camera to record the group discussion. But to address the privacy and anonymity issues no movie was shot, but only the sound recording capability of the device was used. The sound recorded by the software was converted to MP3 format to decrease the file size without loosing any sound quality.

Other technology used during the study was a projector to show Images and play movies on the screen to provide visual clue and initiate discussion on a specific topic.

Sample recruitment

Sample recruitment was done through personal contact, through email (Appendix 4) and through phone. Shelter homes and assisted homes were contacted to recruit human subjects aged 65 and above. Approval from the authority and physician was obtained to contact the subject. To recruit sample groups, healthcare providers - physicians, nurses and occupational therapists were contacted.

All potential participants were contacted once again before the study over phone. They were requested to join focus group discussion at the specified date, time and venue. In each setting the purpose of the study was explained by the principal investigator. The participants were told that their participation would involve a 45 minute to one hour group discussion. Written consent for study was obtained to use the discussion to draw conclusion and use in the research. All consenting participants

were told that their identity will not be revealed at any point of the time and all records will be destroyed after the research is done.

A written explanation of the research project and a copy of the written IRB consent form were given to each consenting subject. Sufficient verbal explanation was provided to explain the purpose of the study and the importance of the study in the research.

Pre-interview activities

Before the focus group discussion a proper seating arrangement was set up to ensure that everybody will be seated around a table with equal spacing and visual contact with the other participants. The projector, micro phone, and computer laptop was set in proper position keeping in mind that they can view the screen properly and their voice can be recorded carefully. Drinks and snacks were prepared and were set on the service table. Microphone and computer were checked to ensure that they were recording and working properly. The backup recording device was installed in an appropriate place. Once the participants entered into the room they were welcomed to the room with an informal small talk to help them feel comfortable. All the participants arrived on time so we didn't waste any time. All the participants were invited to have drink or snacks before starting the discussion.

Once everybody was ready for the discussion the consent application (Appendix C) and the pre-focus group questionnaire (Appendix F) were handed over to them. They were requested to go through it, answer the questions, and sign the consent form - a requirement for the IRB. Once everything was set and ready to go

ahead and start the discussion, the advisor addressed the group and welcomed them to the discussion and handed over the proceeding to the moderator to carry on. The moderator welcomed the group once again and introduced the each team member. The moderator informed the participants about the importance of the discussion and explained what a focus group discussion is and what the investigators are looking to derive from this study. He also informed the groups about the technology they are going to use and what the purposes behind using these technologies are. It was also informed that their identity will not be reviled to anyone at any circumstances and all these documents will be kept confidential.

The study

The first group consisted of healthcare provider especially dealing geriatrics patients. The group consisted of both young and experienced health care professionals. The second group consisted of care providers having some experience in providing care for some one in their own family or friends. The last group consisted of elderly people of 65 and above age group.

Summary

In this chapter we discussed the study methodology that has been adopted for the research. With the help of the audio records, a complete transcript was prepared for further analysis. In the next chapter we have selected some of the salient points that came up during the discussion for further analysis; further we also used the points in order to develop guidelines for future research.

CHAPTER VII

FINDINGS

Focus group results

America is getting older

In the United States, the rural population is "older" than the urban population. 11.9% of the total population is of the age 65 years and above, while 13.9% of the non-metro population is of the age 65 years and older.

> *"I have an old grand mother of age 92 and half, who still lives in a two storied old farm house… she, wants to live there as long as she is alive."*
>
> *"My grand father still lives independently. He is in his 80s."*
>
> *"Both my parents are 85 years old and now their health is declining gradually."*
>
> *"Both my grand father and mother are in their mid 90s, still they are living independently. living alone in a home*."

Aging leads to problems

With the increase in age, people face various chronic illnesses leading them to activity limitations like remembering things, doing shopping, taking medicines in time. With the increase in number of chronic conditions long term care became paramount. Following are some of the findings from our care provider and healthcare provider on their care-giving experience.

"I was a care-giver 10 years ago for an elderly person. She had no relatives at all."

"I am a long distance care-giver for my mother who has multiple medical problems."

"My grand father still lives independently. He is in his 80s. As business and education drives every body all over the world they remain alone in their homes."

Technology

Computer scientists envision that one of the first uses of ubiquitous computing at home will be in the field of proactive healthcare. Intille (Intille, 2004) claims that using technology at homes could be one way for potentially reducing the spiraling cost of medical expenditure. Intel research says that we encounter with almost 150 different computing devices every day (Want, 2003). Now that we have already stepped into the world of computing and we can not escape from not adopting the new technology. When we asked our participants what is their perception towards the existing technology and how do they feel about living with these new technologies. They said this:

"Technology is terrible for older people. It's so difficult for them to grasp and understand the working of the technology. Just a remote control at the senior citizen's center… they can not operate a remote control, since the buttons are too tiny… they can not see them properly. They get confused about everything. Say, if they press a wrong button and they experience some unexpected changes, it changes everything and can not fix it. Things like this and I think it's really hard for them."

"My mother cannot use a computer; I think she must be afraid that she may break it."

"I really feel frustrated with computers. I have a laptop and I get frustrated using it… People, who have never been involved with this…, they do have a problem…"

"My parents are 79 and 76. If the power fails, I have to set the TV, set the microwave, reset all plugs because they cannot do it. They just say "I cannot do it."

"Same case with the "back phone", we can take pictures, send email and do text messaging. "Do I understand all this? … No… am getting used to it with the help of my children."

"I don't have cell phone "I don't want people find me" My friends have cell phones and they have children who send text messages to them but they cannot send text messages back to them, as they do not know how to use it."

"I think they are open to the new technologies, like they were in the days of early 80s - they used to sweep the porch by hand but once the blower came up they adopted to that, to make their life easier. So I do think that people are open."

We found that, the biggest problem with the current elderly generation is that they have never been involved with the day-today technologies. Hence, in many cases it is very difficult for them to adapt to these new technologies. It is very important to educate them and help them in understanding the benefits of the technology.

On the other hand the baby boomer generation has grown up with technology. They have developed this technology and they use it everyday as a part of their life. Present baby boomer (future elderly) will not face any such problems in accepting the technology. Nevertheless, the designer needs to consider various design issues to decrease cognitive load and create simpler interfaces. Our studies show that this will lead to a wider range of acceptance among all age groups.

"The present day baby boomer generation in the next five years will have absolutely no problem with them. They have grown-up with that…that is a part of their life. So it is moving very fast like wait a minute (laugh) so it will really make a difference in the next five years."

"I don't know how many will be willing to learn computers when they are sick and have to go to a nursing home, but people who have the computer knowledge and go to the nursing home could use the facility properly."

"I think making new technology as close as to the old technology will surely make a difference. For example, don't change the whole system just simplify it…make them feel more familiar, with some simple operation."

"I think the technology is moving so fast that what you use today you won't be using that tomorrow. When I was in school, there were no computers, we were using calculators then. But now the whole scenario is changed, drastic leap from calculators to COMPUTERS … And in the future, technology well help the elderly because in the very near future we can see that we need not have to teach computers, what we need to do just talk to them about its usage & work and they will implement it practically with out any manual help. So I think technology is great…"

"When you say about technology, it's like you speak and the lights are turned on and here you don't have to do anything but just you have to speak.., that seems perfect."

Cell phones

Cell phones have created a new impetus in communication technology because of its power to connect to anyone irrespective of his/her geographical location. Now due to its ubiquity people have started thinking of using it for many different things like entertainment, shopping and even for health monitoring. These are some of the findings on the use of cell phone technology which shows that it could be an excellent mode of information exchange in the future coming health-care domain. Even here we see that a great deal of improvement is required in the design of interfaces. Mostly the elder group of the society feels that the current cell phone interfaces are difficult to use.

"Cell phones are really crucial findings. But the problem is, they are not always friendly. The menu is sometimes so complicated with many selections and options."

I picked-up a cell phone today that was not mine and could not figure out how to use it.

In our region there is no cell phone coverage.

"With a cell phone you can get information immediately, for example if you are discussing something and you need to look for information, you need to go to the computer and find it. Again we don't have internet access everywhere, so if you can get that information on your phone, that will be wonderful. Sometimes we have to remember to get that information later but if we can give that information right there that will be wonderful."

Internet

Internet is arguably the most important technology of the 20th century. It has not only opened the world to the new information highways but it has also helped in connecting people and keeping them informed. Our study shows that the internet has already entered to each and every corner of the world including the rural areas. There are various instances where even elderly people of rural areas have shown interest in taking the benefits of the internet.

There are a good number of seniors who use the internet to get information. My elderly parents live in rural Alabama and they all use internet, in fact they help me sometimes.

"The nursing home at Columbus has a computer in the room to check emails. They get on the internet regularly. Also in Columbus at the independent living apartment, they have an internet room that is about the size of a computer library and they all use it… The interesting thing is that, the computer library at the rural area is where the elderly tend to go for socialization."

"I have come across a few elderly who do use internet to get health related information; I have actually given them a list of websites which they can browse on their own. "

The Internet has proved to be very helpful for the younger generation where they have used technology for almost everything and they have a shorter learning curve, but present computer systems and interfaces are not easy for elderly people to adopt and they face lots of difficulties in learning it.

"I don't know if there are too many who will be or could be willing to learn computer…one reason behind this is that computers are intimidating. An easy way to understand interface could solve the problem."

Health care technologies

The care-giver and health care providers are very much aware of some of health care devices available for elderly people. In our group discussion we came across several instances where elderly people have used healthcare devices to get the benefits of technology.

> *"We have a lady in our church she goes to a doctor in New Orleans every three weeks, now she has some kind of monitoring device on her and she plugs this monitor into her cell-phone and to her land line, and it gives her all the readings, everything they have been looking for last three weeks. So she is doing that now for almost a year. So technology is here and she is 80 years old now. She has a cell phone so it is easy for her to adapt and use it."*

However we saw that such situations are highly isolated instances. The general perception of elderly people toward the health care technology is some thing else, our research gives us a different picture.

> *"I am right now working with older adults and again I have to again say that there is certain percentage of people who would use* [technology] *but there are certain percentage like my parents who would go to the doctor and do only what the doctor told them. But when the baby boomers hit, they will go and look for the information."*

Designers will play a very important role in the design and deployment of such systems. However as a word of caution, they have to be very careful about the kind of information that needs to be delivered to the user. For example if the device finds a serious abnormalities, says "you will die in 30 minutes" that could be very dangerous. Therefore the technology needs to be unobtrusive, calm and intelligent.

> *"Sometime people might not want to know or get information about them self."*

"Elderly people get little bit obsessed while getting information about their health and when you talk about that a lot."

Our participants suggested the following guidelines for such designs:

1. a calm technology which can provide accurate information to the health care provider
2. "toned down" information like "good", "bad" or "need to consult" is better than more contextual and detailed information
3. Information which is not essential should be avoided from the main menu.

Privacy and trust

Once the computer disappears and becomes invisible it brings several new issues like privacy and trust. It can also put people in horror that technology is taking hold of their house. Here are some of the findings that we got from the study:

"My mother won't use the ATM she says "somebody might take my money"

"I won't like my sister watching me."

My parents would say nothing to do with that, they don't want someone to watch them.

"You have to make people agree that, we have lots of monitoring going on right now, but it's not working because the patients are not sharing their information. When I go to a patient and ask him "Did you smoke today? You have cancer and the doctor has told you if you smoke you are going to die"... he is dying anyway and you can smell cigarettes and see cigarettes all over his body. If you ask him if he smoked that day, he would say "ohhh no, I have not smoked today", but yes he has already had five cigarettes. He does not want monitoring. We have lots of monitoring now but the people don't want to be..."

"I don't think technology can take the place of a phone call where you can hear the voice of the person that they are alright…this you can't know from a data screen. My mom stays alone and when I talk with her over phone I know if she is having a good day or not…"

"I think it is a good thing to have an interface where the health care provider or care-giver can go to the internet and check the health status if their patients. But privacy and security concerns should not be overlooked."

Future healthcare models

With the increase in elderly population, growing demand for health care professionals especially trained in geriatrics and a heavy shortage of active physician is going to create a healthcare crisis in rural areas. Moreover there is a constant migration of retired people to rural areas. As rural areas attract more people to such retirement communities, there will be more number of elderly people in rural areas as compared to its urban counterparts. In the present healthcare model the elderly person has to be admitted to a hospital or nursing home for non-essential long term medical care, but this system will not be able to take care of such a large elderly baby boomer population. An alternative solution to the present system is paramount. One solution could be the use of technology to deliver long term care right at the person's home eventually helping them stay independently in their home.

Here are some of the remarks that our participants made while discussing this matter:

"Four out of ten admitted to a hospital is not needed; they end up in hospital for 5 to 10 days while spending 4 -5 thousand a day - "not needed"

"I think this can save a lot of money."

"I think it will help definitely but nothing can replace another person being there".

"Specially in rural area where there is a geographical issue, transportation issue, cultural issue, where they don't want to go visit the physician can work very well."

Future robotic technology (iCAT)

There are several questions that arise about the type of technology that could be used in home automation which could decrease the cognitive load of the elderly person and assist them in their daily living. Pervasive computing could be a possible solution where technology integrated into the fabric of architecture can connect each device of the home to a central intelligent system which can control the home by itself or assist the user to control the home. But several questions arise like, how people will interact with an invisible computing system. Such systems also raise several privacy and security concerns.

One of proposed solution is to use robotic devices that are tangible and visible. Such devices can also assist the user to take control of the entire computing system embedded into the house.

To initiate discussion a robotic device called iCat was shown to the participants. The idea was to know their perception towards this technology. Below are some of the findings that we got during the focus group discussion:

"The animated or comic look may or may not appeal to the person."

"I think they might like the funny looking creature"

"It is a cute thing, my mother will probably respond to it well. It could also remind her because she does not remember, like time to eat etc…"

Future housing for senior citizens

The increase in the use of technology and increase in dependency on technology has created several new challenges and opportunities for the future housing market. One of the big demands of the future housing market will be technology enabled houses or "smart" homes. Such homes could help elderly people age and live independently in their own natural home setting. While discussing this matter we got this:

> *"I think from listening and from experience, as people gets older, their children and friends start disappearing. It is a psychological thing… technology could be great to handle it and do it, but they want that one-to-one relation… some will go to consult some one and have a talk with that person. I have friends who are doctors, they tell me that some people come to them "just to have a talk"…*

> "[On housing market or housing developers for older adults]… *I went to a workshop that has designed housing for older adults, where this kind of technology could be used and they need not have to go to nursing home for a long term care…where you have retirement communities this might be a selling point in the future… like to say "here is a house that has been designed for elderly people and will help you to stay independently here". If you have all the monitoring system built into the floor as actually part of the building project that is something new… this will help in developing housing for senior adults in large communities. "*

> *"My husband is going to retire and we are looking forward to move to New Mexico. When we look at the housing market we found that most of the housings that have been built are not meant for senior adults. There are four to five bedroom apartment built in four to five floors. I want everything in one floor so that we don't have to go upstairs. So if you build this monitoring system into an existing house that might be expensive but if you build that into a new house that might be very helpful."*

Comparative analysis

In a paper published by assistant professor in the College of Architecture, Art and Design, Mississippi State University, Anijo Mathew at ACADIA 2005, he described several concerns that a rural person might have when exposed to ubiquitous computing technologies designed into their homes. In order to validate our research,

we analyzed these concerns and looked at our focus group for evidence for or against these claims. The followings are our findings from the focus group study.

I don't want to leave my house

Mathew in his paper stated this: One solution to the problem is to move the elderly to some assisted living centers and nursing homes; while other solutions include the diversification of hospital services. The "swing bed" program allows patients to stay in the hospital beyond the end of their acute stay and receive nursing services they need. However, in the following study conducted by Forrester Research in 2003, it was found that although nursing homes house almost 1.5 million seniors and one-third of those have been there for more than three years, 77% of American consumers say that nursing homes are the last resort for themselves and their family members (Boehm et al., 2004).

The above statistics echo concerns that the current clinical model of healthcare is not working at an optimal level. As a result, it is an ideal time to initiate changes within people's lifestyles and homes to help augment the current model of healthcare. One suggested alternative is the prevention rather than crisis management approach. Research has shown the significance of moving the focus of attention from the health centers and hospitals to the working home through technology interventions (Intille et al., 2003).

Our focus group shows that there are indeed many seniors in rural areas and they want to live in their own house as long as possible. In some instances they have

requested their children to let them live in their own house and get medical attention right at their place.

> *"I have a 92.5 years old grand mother who still live in a two story old farm house apartment in Indiana, she had some incidents and accidents but is able to go home and still does, and you know... she wants to live there as long as possible"*

> *"My mother requested not to go to nursing home… she stayed at home, we took care of her till the end."*

I don't know how to use it

Mathew has stated in his paper that in early days of the computer, system administrators were an important part of the everyday running of the system. As computer systems became more ubiquitous the role of the system administrator shifted to the user. But rural America is still not tech-savvy enough. More often new technologies, common in the cities, have not reached these rural communities. When they do, people don't always know or want to know how to use them. It is important thus to make these systems as uncomplicated as possible. One method is to shift the intelligence from the device to the network. Traditional appliances, like telephones or televisions are commonly accepted because the intelligence of the system lies in the network and not the device. The home only contains the most simple and minimal "front end" functionality needed to access the network (Edwards and Grinter, 2001). It is paramount that future designs also be able to scale as well as degrade gracefully. A component that fails should not bring the rest of the system down. In addition to the workability of these systems, insurance companies may also demand to see

certain levels of safety (meeting regulations and codes, seismic tolerance etc.). In short, the "smart" home of the future must also be a reliable home of the future.

Our focus group study shows that even tech-savvy adults find themselves frustrated with current computers and technology. In the earlier days the system administrator took care of all computers and networking. Now this job has come down to the user and the user is supposed to take care of one's own system. In this scenario it is impossible for the elderly people living in remote area to adapt to new technology. We found people describing how, even a remote control was difficult to use, (small written text and buttons). Older people find lots of difficulties in seeing/feeling the button - in several instances they feel frustrated after pressing a wrong button and have no way to fix it.

So for an elderly living alone in a remote rural area with virtually no one to help them, it is impossible to think of using present technology in their homes.

Elderly people find new technology alien and very difficult to adopt. In our study we have found that many of the seniors using cell phone often receive text messages from their children and grand children. But they never sent any text messages back; they say "I cannot do it".

Moreover there are several cultural and social biases which take precedence over aesthetics and technical biases. In several cases they just hate technology because they think it is this new technology that has separated their children, friends and relatives from them. We have also found senior people saying "I don't need internet; if I want I can just call some one". There are others who use the internet but

only to send and receive emails. Therefore the adoption of the new technology is a big challenge. Changing technology is another problem - it becomes very difficult for seniors to accept these rapid changes. In several occasions they just stick to the older technology instead of adopting a new one.

Our study has shown isolated incidents where new technologies have been accepted by the rural people but still there are areas where they don't have any cell phone coverage. Most rural homes often have accessibility issues – it may not be possible for a technician to make a round to check the component of a smart home. It is also contradictory to assume that, users who do not have proper access to health centers will have access to large stores that can service these technologies and devices. In this circumstance it is very difficult to convince anyone to use these technologies in a remote place.

Will it interfere with my life?

Mathew stated that one of the most important challenges of stitching ubiquitous computing into architecture is to create a non-disruptive environment. The problem of today's technology is that it conflicts with the real world which is of "highly analog" environment (Edwards and Grinter, 2001), presenting a great deal of ambiguity and unpredictability. These technologies must not only accommodate differences across the individuals but also differences across the house holds.

Rural "smart" homes must present information attuned to the lifestyle of the user. The challenge is to design according to the rural lifestyle: what works in the city may not work in the village. Current emergency response systems works fine if you

fall in the house, but if you fall in the garden while watering your tomatoes, you may have a problem (Coughlin, 2001). Elderly people also live differently from younger people. Morris and Lundell's study showed that the elders seemed to designate "command centers" (a kitchen chair, a bed) that served as a base for entertainment, eating, work, and socializing. Unless the technologies are designed within easy reach of these command centers, they may not be used at all (Morris and Lundell, 2003). Designers must understand that in the rural home, cultural and social biases will take precedence over the technical and aesthetic biases. It is important then to re-analyze the designs built for rural households; asking questions of whether it will work with the lifestyle of the user or not.

Our studies show that people feel insecure and out of control when computer takes the decision. It also brings several broader issues like privacy and security. Home video monitoring and several other monitoring devices installed in nursing home and care home have failed. One reason behind this is that people don't want others to monitor them. There are several instances where seniors have shown strong disagreement towards any kind of video or other form of monitoring.

Where do I buy it?

Mathew in his paper stated that while new homes may eventually be built for such smart applications, existing homes are not designed as such (Edwards and Grinter, 2001). It would also be presumptuous to assume that someone who does not want to move to a nursing home will consider moving out of a house that holds their

past. An acceptable alternative is to develop another (retiree) home that in some way resonates with their earlier home. In both situations it is important for us to understand that most "smart" technologies used in the homes will be bought piecemeal from a local convenience store or a large specialty store. The challenge for the architect is to anticipate change in the designs of their spaces when these technologies are brought together gradually. It is also important that affordances are made for old devices to be removed and new devices to be added without the inconvenience of changing the basic design. What designers must also assure is the impromptu operability as well as interoperability of these technologies. Architects must eventually design spaces that will not end up as islands of functionality but connect seamlessly as a whole. One way to ensure such a design is to draw on the way people use spaces and designs currently; another is to study the behavior of people in natural settings informing us the best configuration of space and technology.

The focus group study show that this is indeed a challenge – today's ubiquitous technologies are available only for people who can afford it. The rural population is significantly poorer as compared to its urban counterparts. At best, people who are migrating from urban areas to rural areas may be able to pay for it. The wealthier baby boomer generation might also be able to take advantage of the new technology to live independently. However when we ask the question about the amount of money they would be willing to spend for such technology, we got this answer: "people spend about 4 to 5 thousand dollar just to stay in hospitals to get

long-term care and sometime they stay there for more than 10 years till their death. Therefore they may not mind spending money to get healthcare delivered at their home. But it is still a big question how much they will be willing to spend".

Will it take over my life?

Mathew has stated in is paper that science fiction movies and books have ingrained into the minds of people that when computers reach our homes, they will be in control. Real research however takes a very different route. People feel strongly when a computer takes all the decision; it makes them feel insecure and out of control. The best method is to abandon the "shut up and eat your mush" approach and take a more "here are your options" approach. Leave all control for decision making to with the user but instead provide just-in-time information highlighting the benefits of engaging in particular behaviors. Instead of trying to wrench control from the user, the computer should reward a behavior using powerful motivational strategy of positive reinforcement operant conditioning (Intille, 2004). Such long term rewards to the user will ensure that the behavior change should be sustained even on the removal of the interface. The designer must make the choice between persuasive (indicating that it is time to take medication) and coercive mechanisms (forcing the person to take medications). Most "smart" home technologies also have severe privacy implications. Even the most subtle design may be too intrusive for a rural family. Using sensors and cameras to monitor a user may not be acceptable by certain communities, even though such a solution would be the most apt for the problem they face. If "smart" technologies have to be accepted by the larger rural community, it

must eventually be designed for them and with them. Without the involvement of the end user, these technologies may never find use off the store shelf.

The focus group research shows that people feel insecure when technology takes control of activities related to financial transaction. There are some instances where people have preferred to go to the bank and do financial transaction instead of using ATM machine.

Adoption

Mathew has clamed that that the American population is more receptive of technology solutions and health monitoring systems than ever before. A major reason for this shift is perhaps the wide acceptance of congruent technology (internet, cable television, cell phones) by the American consumer. In one such study, Forrester Research shows: Since we are primarily looking at a rural population, it is also important to consider adoption of new technologies in these areas. In our own ethnographic studies we charted the following biases that rural populations carry:

Economic bias: Most of the current rural population has little or no access to any sort of computing, leave alone ubiquitous devices. Much of the population does not even have access to common house hold devices. Even if they did have the facility to buy these devices and were willing to do, they may not have the economic resources to do so.

Cultural bias: Culturally rural areas are not accustomed to the use of technology solutions to solve problems. Due to problems of availability and accessibility, a rural person would consider technology as his/her last resort.

Lifestyle bias: The lifestyle of rural America is significantly different from that of the urban. Current designs are usually created with the largest user base in mind– the urban buyer. Hence, some of these solutions may not be suitable for to be used in rural areas or even if they are, they may not be used in the same manner by rural users.

Our focus group study reinforce these findings, we found that there are strong economic biases in the rural areas. They say that, they can not afford it. Then there are people who hate technology claiming that it is the technology that has separated them from their children. They feel that people are getting dependent on technology which is not essential. There are other instances where they have said that the present technology is terrible for elderly people. Furthermore the lifestyle of elderly people are very different and they feel like technology is moving very fast and what ever we have today is not going to remain tomorrow. So they claim that they would rather stay where they are now.

Barriers to technology

There are several barriers playing important role in the acceptance and penetration of technology in rural home-healthcare model.

Design issues

The study of History of technology and appliance industries shows that people have rejected technology which does not fit well to the space and life style of the user. New technologies are usually designed by engineers with little knowledge of

space plan and human factor in design. Therefore new design has often faced difficulty in mainstream acceptance.

Perception

Perception towards technology varies widely from place, gender, geographical location and culture. Therefore it is very difficult to understand and design a single technology that can be accepted by all segments of the society. In several cases, we found that people may not accept technology.

Changing technology

Technology available today won't be there tomorrow. It will be replaced with better and more sophisticated technology. In this technology run it becomes impossible for elderly people and people living in rural places with little access to new technology to adapt.

Privacy and trust

In several occasions people do not accept technology because they do not trust it. They feel it as a direct intrusion to their privacy. Moreover security issue is also a big concern in the mainstream acceptance of smart technology integrated into the home.

Economic biases

The current computing systems are expensive and it is difficult to assume that the rural population can afford it. Therefore for the initial penetration of these

technologies into rural population government intervention is needed. Subsidies on these technologies will help in initial penetration into rural population and this will result in mass acceptance. Eventually it will drive the price down.

Cultural and social biases

Rural populations are not as techno savvy as compared to their urban counterparts. Moreover rural populations have never been exposed to high-tech devices to help them in their daily living. From the focus group study we saw people preferring to visit the doctor personally and get medication, rather than getting medication from a distance.

Medical reimbursement system

The current medical reimbursement system does not allow everybody to get reimbursed for getting remote healthcare assistance. Only five states – California, Kentucky, Louisiana, Oklahoma, and Texas – have passed legislation mandating eimbursement of tele-medical consults that would be covered if treatment occurred in the traditional face-to-face mode.

Collaboration issues

As this new healthcare model involves science, arts and technology, a coherent collaboration among scientists, social scientists, healthcare provider, designers and policy makers is needed. This is contrary to the current scenario where these individual segments are working independent of each other.

Summary

In sum we found that a substantial amount of technology penetration in to the rural areas but the present technology is very complicated and people feel frustrated while using these new technologies. We also found that although there is an attitude towards technology acceptance, actual acceptance may be lower. Because of this, adaptation could be slow but once people start using such systems in their homes, there is a big possibility that it will solve the major problem in the healthcare domain.

CHAPTER VIII

CONCLUSION

The primary idea behind this research was to define the problem and provide guide lines to designers and researchers. It may be difficult to find a single solution for anything, but it is very important to state the problem clearly. In future research, each problem can be studied very carefully which would eventually lead to concrete solutions for the problem. Following are the guidelines for future research and design that was derived from our study:

Technology

1. One of the biggest mistakes that designers do is that they make design complicated. Most devices and interfaces have multiple options and sub-options. People often tend to reject complex designs especially that they cannot use or which do not make sense to them.

   Therefore make the design as simple as possible. Give the user exactly what she wants.

2. If we take the design of a clock, the design has been so ingrained in our life that any change in it makes it difficult to understand it. Therefore any attempt

3. To bring in a new interface, however good, will lead to an immediate rejection of that change. A better way of working is to introduce the change within existing technology and slowly work upwards.

   Do not change technologies completely. Use a bottom up approach instead of a top down.

4. A picture frame, which actually connects our present with a past experience, person or place. The basic idea of a picture frame is "*connection*". We can use this idea to connect people round the world instead of designing a completely new system. People feel frustrated with new technologies because they can not associate the new technology with their past experiences. They expect new media to have a semblance to the old media that they have been using. Moreover as per the last point, it is paramount that these new systems are as uncomplicated as possible.

   In short, existing user experiences and media semblance should be used, wherever possible, in the development of future technology.

5. In order to make the front end interface as simple as possible, it is important that the device is functional, simple and repairable. Traditional appliances like television, radio and telephone are commonly accepted because the intelligence of the system lies on the network and not in the interface.

   Shift the intelligence from device to the network, in turn creating simple usable front end interfaces.

6. Researchers in cell phone technology are exploring the possibility of using cell phones to accomplish multiple tasks that aid cognitively impaired and elderly people with activity limitation. But increasing the number of features and changing the interface to add new features can leave people frustrated. Younger generation may be more attuned to such innovations and may be able to adopt it. However elderly people find such interfaces cumbersome and very difficult to use. Therefore keep the interface as simple as possible and use device intelligence to work in context and understand the user's need. To ensure simplicity, the designer should provide only those features which the user needs.

   In other words, design customizable options into technologies which allow users to choose only those options which they feel a need for.

7. Decision making should always be left to the user and be based on past experience with user behavior.

   Technology should only guide the user in decision making process, not make it for them.

8. The biggest problem in rural area is the repair of technology if something goes wrong. The best technology is the one which lasts longer, for example the old radio or the battery operated clock. They work for years without much complication (only requirement is change of battery once every few months). In case of complex technology like computing, the failure of one technology should not lead to complete failure of the system.

Design robust technology - If one technology fails another one should take control of the task till it gets fixed.

Information

9. In the design of such systems a designer should be concerned about the *kind* of information that is presented to the elderly care recipient. Elderly people get little bit obsessed with getting information about their health especially when they are continuously discussing such issues. So instead of giving numerical information one can look towards more graphical information. What is essential is to provide them summarized data – describing the status as "good", "bad" or "need for concern". Additional information should be available only as an optional feature for those want detailed information about the issue. However detailed information about their health should be parsed to the care givers or the healthcare provider who can in turn review the health of the care recipient.

   Data visualization afforded to the elderly care recipient should be designed so that they only see the thinnest layer of information required to inform them of their health status.

Privacy and security

10. Privacy and security are concerns while designing ubiquitous technology for home health care domain. Many times we saw that people do not like to be watched or monitored. In lieu of video or continuous monitoring, we suggest

the use of contextual clues in determining position or activities of a person. For example the heat of the stove could tell us they are cooking, the running water of the bathroom tab could tell us they are taking a bath or the shoes removed from the wardrobe can inform us that there may be some outdoor activity. The combination of many such contextual cues may lead to an assured decision. Such cues can also be translated into relational data, like whether they have taken their breakfast or not; or if they have taken a shower or not. However such a system needs much testing before deployment in order to ascertain accuracy.

Use of contextual cues instead of direct monitoring may find greater acceptance with the care recipient, allowing a more in depth use based monitoring.

11. Decision making should be left to the user and the technology should not assume something without taking the user into consideration. People feel insecure and out of control when computer takes the decision.

In a proactive environment technology should provide non-intrusive audio or visual clues to aid in decision making giving the user a greater sense of control.

Adoption

12. The focus group study also show us that the American population is (i.e. age group 50-60) are more receptive of technology solutions and health monitoring device. The main reason for this shift is perhaps the wide use of

congruent technology (internet, cable television, cell phones) by the current baby boomer consumer. But in a rural area there are several biases which affect the adoption of technology. In the last chapter we described several biases - economic biases, cultural biases and technology biases that may affect the adoption of technology by a rural user. Therefore the acceptance of technology may be slow in perspective of the rural poor. However people who are wealthier and willing to pay for these technologies can start using these technology and get immediate benefits from it. This will help in mass production which will eventually bring the price down. Another option is for the government to recognize the importance of such technology and subsidize it for rural users (like the subsidies afforded to electricity in its early phases). As more people start using these technologies they will feel and see the changes in their lifestyle. Dissemination of such information will attract other people to take advantage of technology. Ultimately, like electricity, these technologies could become a part of their daily life.

Deployment

Integrating of these technologies in a remote place with little access to any technician or system administrator to take care of these technologies is impossible. “Mass smart housing” within retirement communities may be a more viable solution, that can be developed immediately. Developed around a central hub with smart homes that can be connected in a radial and linear pattern.

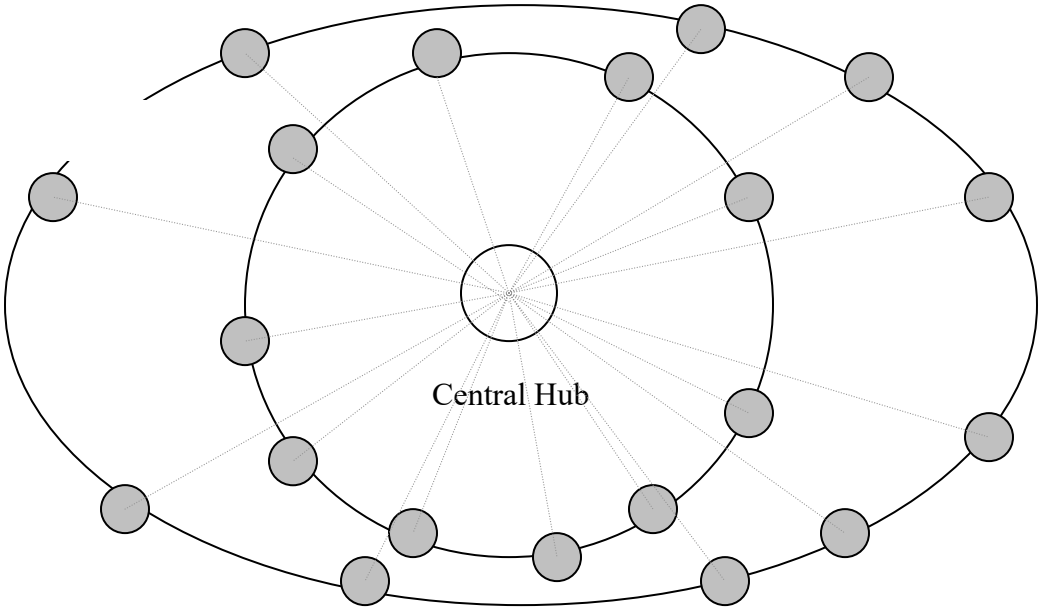


Figure 8.1 A proposed conceptual smart home housing around a central hub for elderly people to aid age-in-place.

The use of a central hub can take care of technology failure and operation in these smart homes. In the event of a failure, people will not need to go to an electronic store to buy anything; instead this hub can provide and maintain all the necessary smart devices and appliances required in these homes. This will help in the building confidence in users because they know there is some one there to fix it if something goes wrong. This will also help other people on the vicinity of these communities to see the benefit of technology and use these technologies. This could ultimately spread to the other parts of the rural area. Again a "Major Central Hub" can be formed to monitor all the central hubs. They can work as a backup and provide assistance to the local central hub.

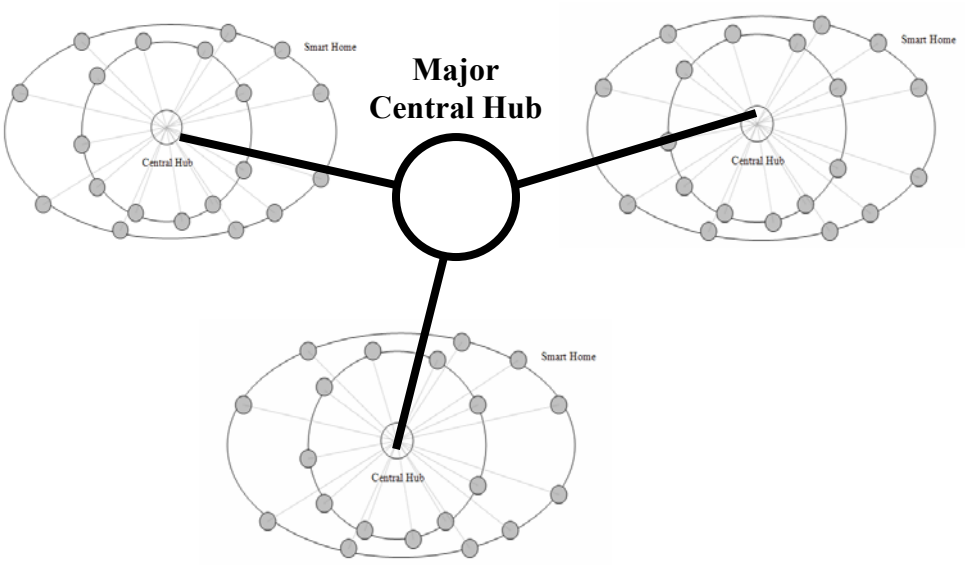


Figure 8.2 A proposed conceptual smart home housing around a major central hub for elderly people to aid age-in-place.

13. Involvement of government agencies is very important in the ultimate acceptance of such technologies. One way that these technologies can reach the rural poor is if the government mandates legislation to include them as part of the medical insurance system or subsidize the technology to enable initial penetration. Similar subsidies were available to the rural public with new technologies like the telephone and electricity. Initial subsidies allowed the rural owner to purchase these technologies; drive the price down; thus make the technology an essential commodity. However, only five states – California, Kentucky, Louisiana, Oklahoma, and Texas – have passed

legislation mandating reimbursement of tele-medical consults that would be covered if treatment occurred in the traditional face-to-face mode. Forrester Researcher estimates that only beyond 2010 will third party payments be initiated for preventive healthcare technologies in the house (Boehm et al., 2004). The challenge for us designers is to work with government agencies in order to introduce these technologies into rural architecture. The initiative may begin with population centers and finally trickle down to the rural poor. As more people begin to use these technologies government will realize the importance of such designs and mandate legislations to make them insurable.

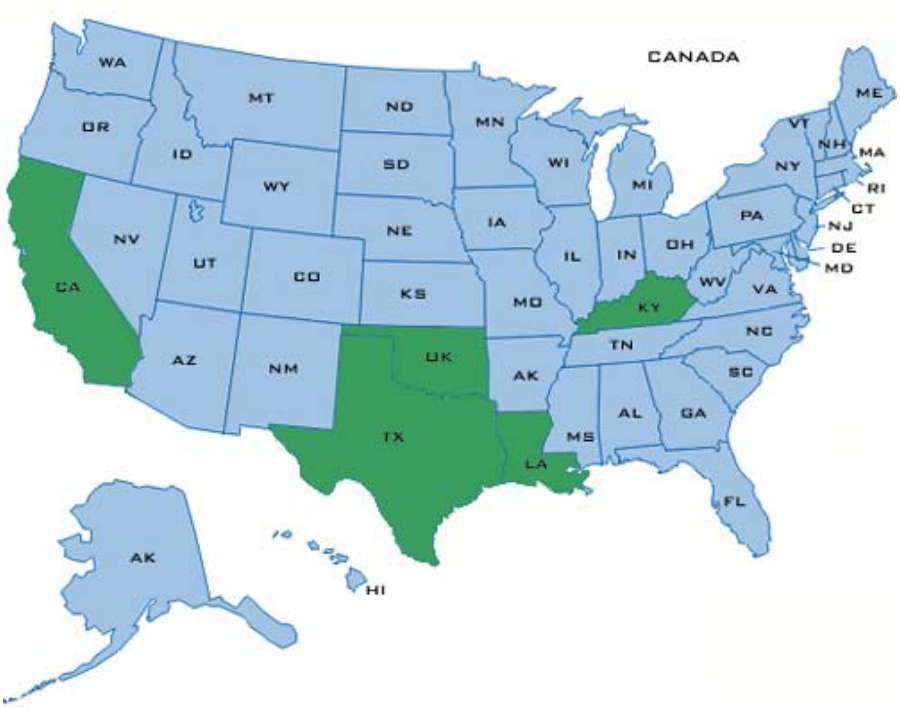


Figure 8.3 Figure showing five states (marked green) that have passed legislation mandating reimbursement of tele-medical consults.

14. Smart homes mean the integration of the physical (home) with the virtual (smartness). Hence, it requires the involvement of architects, artists and designers in *collaboration* with engineers, social scientists and health care providers. Mainstream acceptance can only be achieved when each of these segments of research contribute to a common pool of knowledge that can help develop the larger picture. However the research today is fragmented and discrete. There is general consensus that in order for these technologies to find common acceptance, design initiatives should shift from the level of the product to the level of the space plan. But computer technologies develop independent of architects and designers. Developers and health care providers develop policies independent of academic researchers. It then becomes paramount that a strong research initiative is developed that will allow all disciplines to work together in achieving the common goal to help people to live independently.

It is our belief that only through the careful mediation of technical aspects of design with the phenomenological and the aesthetic, can we dream of using ubiquitous computing in our homes. Elegant and usable design will be achieved only through conversations between researchers in various disciplines and through widespread awareness of current literature and research in this realm. It is our hope that the above discussion will help us initiate a dialogue– to understand both the problems and the opportunities of designing rural homes of the future and to work together to find a common solution or set of solutions.

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APPENDIX A

DATA AND FINDINGS

This figure shows the gradual demographic shift of 16.5% by the year 2020of old aged population and a sharp increase to 20.5% by the year 2040. Moreover the increase in 85+ age groups will be almost twice by 2040 as compared to 2020 and this demographic shift will be prevalent in the entire US landscape.

Table A.1 Distribution of population by age, 2000 & 2020 (Projected)

Source: AARP survey 2004.

		50-64	65-74	75-84	85+	Total Population
2000 (%)	State	14.6	6.5	4.0	1.5	2,844,658
	US	14.9	6.5	4.4	1.5	281,421,906
2020 (%)	State	18.0	8.7	4.3	1.7	3,123,811
	US	18.7	9.7	4.7	1.9	327,909,900
% Change in Population # *	State	35.0	46.7	17.9	24.5	9.8
	US	46.6	72.3	25.5	48.9	16.5

If we compare US vs. Mississippi this situation is almost the same, with a 1.7% increase in population growth of 85+ age-groups as compared to 1.9% in US.

Table A.2 Population characteristics

Source: AARP survey 2004.

Select Population Characteristics	State	Rank	US
Minority/Ethnic Population Age 65+ (%), 2000	26.3	7	16.4
Minority/Ethnic Population Age 65+ (% change), 1990-2000	-1.8	49	39.2
Rural Population Age 65+ (%), 2000	50.8	5	21.7
Bachelor Level Education or Higher Age 65+ (%), 2000	10.9	38	14.9
Family Income Age 65+ (median), 2000	$30,127	49	$38,155
Poverty Status Age 65+ (%), 1999			
At/Below Poverty Level	17.4	2	10.9
101-200% of Poverty Level	28.5	5	23.7

Mississippi ranks 5th in entire US in terms of rural population and 7th in terms of minority/Ethnic population Age 65+ as per 2000 US census. Moreover in terms of family income age 65+ it ranks 49th among 50 states in US.

It can be clearly infered that more people of 65+ age group are living alone.This is due to younger generation going out to the urban places for better education and job and inflow of older people to the rural areas. Due to this reason the health care problem is increasing.

Table A.3 Need of Long-term care services

Source: AARP survey 2004.

Need for Long-Term Care Services	State	Rank	US
Population Age 85+ (% change), 1990-2000	32.6	29	37.6
Men per 100 Women Age 85+ (#), 2000	37.9	31	40.7
Women Age 85+ At/Below Poverty Level (%), 1999	19.3	25	17.8
Persons Age 65+ Living Alone (%), 2000	32.2	13	30.1
Persons Age 65+ with Activity Limitations, 2000			
Self-Care Limitations (%)	11.6	3	8.9
Mobility Limitations (%)	21.7	3	18.1
Self-Care or Mobility Limitations (%)	24.4	2	19.8
Sensory Limitations (%)	23.8	2	16.0
Cognitive/Mental Limitations (%)	16.4	1	10.2

With age people tend to loose activities and gets mobility limitations. Furthermore US census 2000 shows that Mississippi ranks 3rd in self-care limitation and mobility limitation for agre 65+. Furthermore it ranks 2nd in selfcare or mobility limitation and sensory limitation with almost 24% population having mobility limitation.

Table A.4 Need of long-term care services

Source: AARP survey 2004.

Select Community Characteristics	State	Rank	US
Homeownership Rate Age 65+ (%), 2000	85.5	4	79.4
Housing Over 40 Years Old (%), 2000	40.2	36	45.3
Persons Age 75+ with Driver's License (%), 2000	64.6	34	68.3
Persons Age 70+ without a Vehicle (%), 2000	11.3	26	14.6
Grandchildren Living with Grandparents Age 65+ (%), 2000	4.8	10	4.4

Table A.5 Use of home and community based services

Source: AARP survey 2004.

Use of Home and Community-Based Services	State	Rank	US
Medicaid Beneficiaries Age 65+ Receiving Home Health Services (%), 1999	2.5	26	5.6
Medicare Beneficiaries Receiving Home Health Services (%), 2000	9.6	2	6.5
Medicare Home Health Visits per User (average), 2000	63	2	36

Mississippi ranks 4th in US in terms of home ownership with 85.5% people over age 65 live at their own home. It is also interesting to see that it ranks 26th in persons Age 75+ with driving license with 35% people don't have a driver's license. This can be put in a different way that 35% people over age 75+ has difficulties in transportation and 11.3% even don't have a vehicle.

From this figure we can infer that Mississippi ranks 26th in US and has only 2.5% population having Medicaid beneficiaries age 65+ receiving home health services as per US census 1999, but it ranks 2nd for Medicare beneficiaries receiving home health services.

Note: What is Medicaid? Medicaid is a federal-funded, state-run program that provides medical assistance for individual and families with limited income and resources. It pays for their health care cost including doctor's visit and eye care.

Note: What is Medicare? Medicare is a two part federally funded program that provided health insurance to the elderly. It may cover people who have had kidney transplant or are being treated through dialysis or who have disabilities. Medicare only cavers if the person is sick or injured. It does not covers most prescription drugs, regular check-ups, dental care or dentures, cosmetic surgery, routine foot-care, hearing aids, or glasses.

These figures shows that Mississippi ranks 3rd in residents with physical restraints with 15% old aged population having physical restrains. Moreover it ranks 5th with 9% old aged population with pressure (Bed) sores. If we compare the pie graph 81.5% population has Medicaid assistance as compared to 67% in the US.

Note: Elderly and disabled waiver: This waiver allows persons aged 21+ who meet the nursing facility level of care to remain living at home and in the community. Services offered under this waiver include: adult day health care, home-delivered meals, home maker services, escorted transportation, respite and home health services.

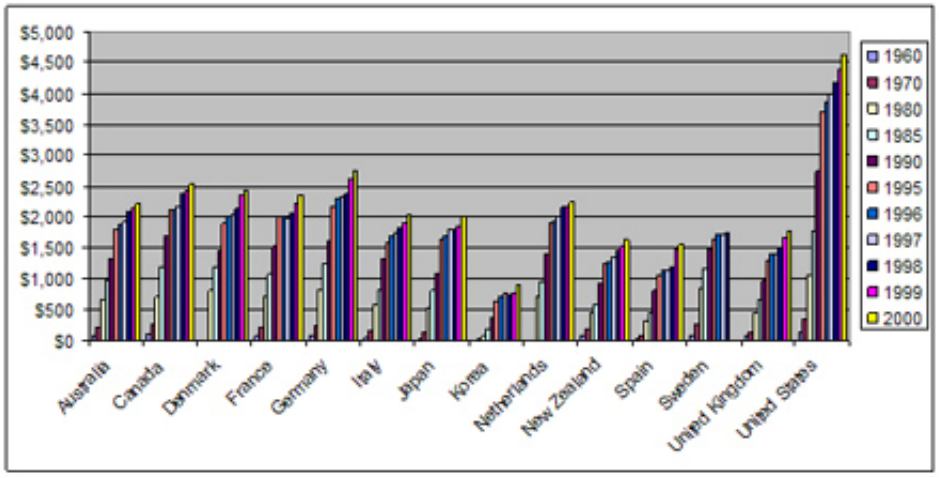


Figure A.1 Total per capita health expenditure in dollars, selected countries and years (1960-2000).

United States is spending the highest per capita in health care as compared to the rest of the world.

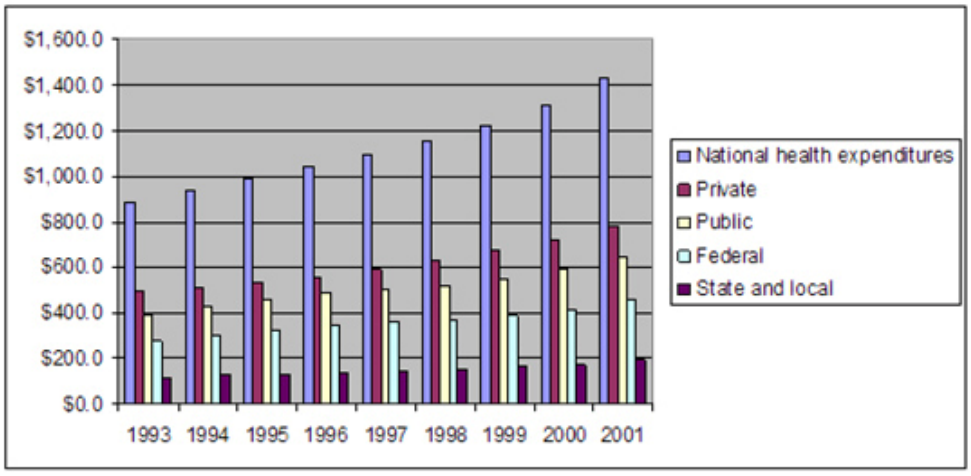
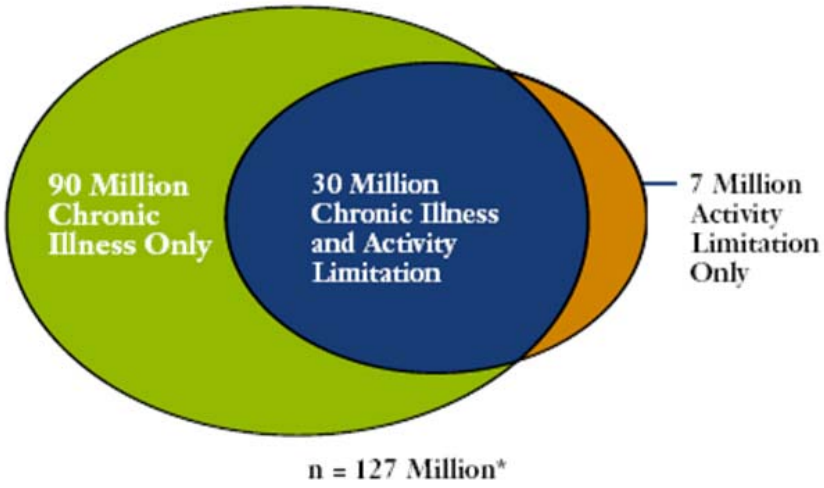


Figure A.2. National health expenditure source of funds in US



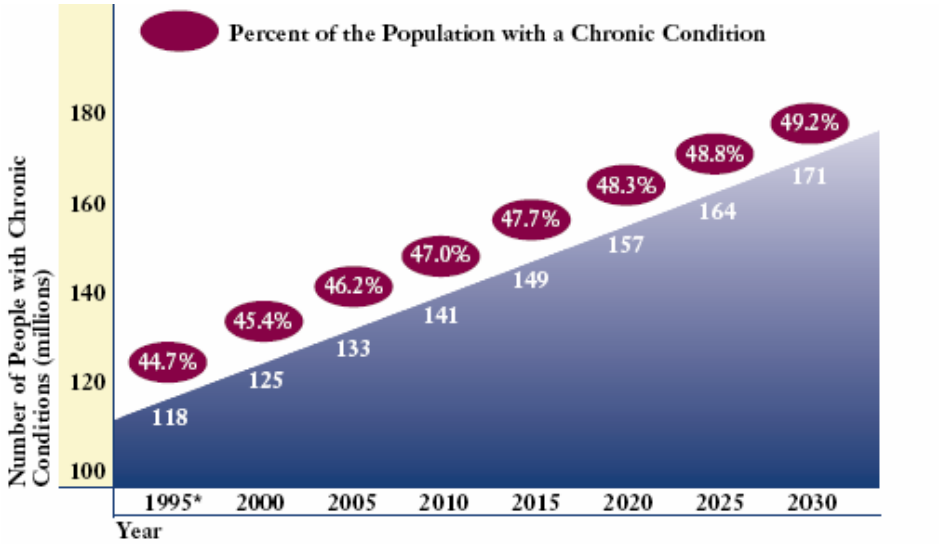
Source: Chronic Conditions: making the case for ongoing care
by Johns Hopkins University, Dec 2002.
"The Medical Expenditure Survey 1998"

Figure A.3 The number of people with chronic illness
along with activity limitations

The Medical Expenditure Survey 1998 shows that there are 30 million chronic illness and activity limitation in US. From the figure below it can be clearly inferred that 50% of 70+ age-groups need some type of assistance in their daily activities with one or more chronic illness like arthritis. Women are more likely than men to have chronic conditions. In part, this is because women have longer life expectancies than men and so, over time, we can expect to see a rise in the
number of older women living with chronic conditions, many with multiple health concerns. Often these women are also caregivers to chronically ill or disabled spouses, other relatives, or friends.

"Twenty-five percent of people with chronic conditions have some type of activity limitation. Activity limitations include having difficulty walking, needing

help with personal tasks such as dressing or bathing, or being restricted in the ability to work or attend school. Many people with activity limitations need personal assistance or long-term care, and their care would likely be improved by coordination between the acute and long-term care systems."



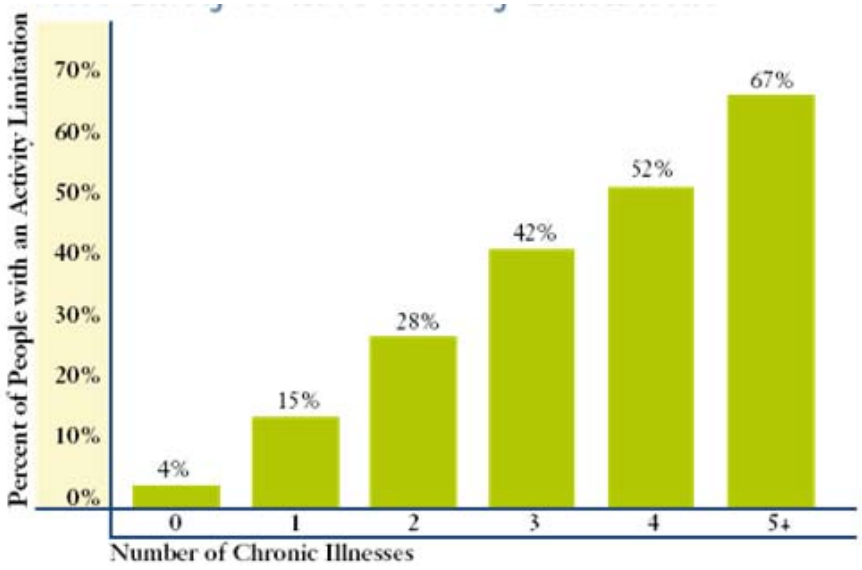
Source: Chronic Conditions: making the case for ongoing care
by Johns Hopkins University, Dec 2002.
"The Medical Expenditure Survey 1998"

Figure A.4 The number of people with chronic conditions

"Chronic conditions affect people's physical and mental health, their social life, and employment status in radically different ways. Some chronic conditions are highly disabling, others less so. Some chronic conditions, especially diabetes, may not disable a person currently, but may lead to severely disabling effects if not treated early and effectively. Some people return to former levels of daily activity after recovering from a heart attack, stroke, trauma, or other acute episode; others don't. Some individuals with chronic conditions live full, productive, and rewarding lives;

for others, isolation, depression, and physical pain are the consequences of severe chronic illness."

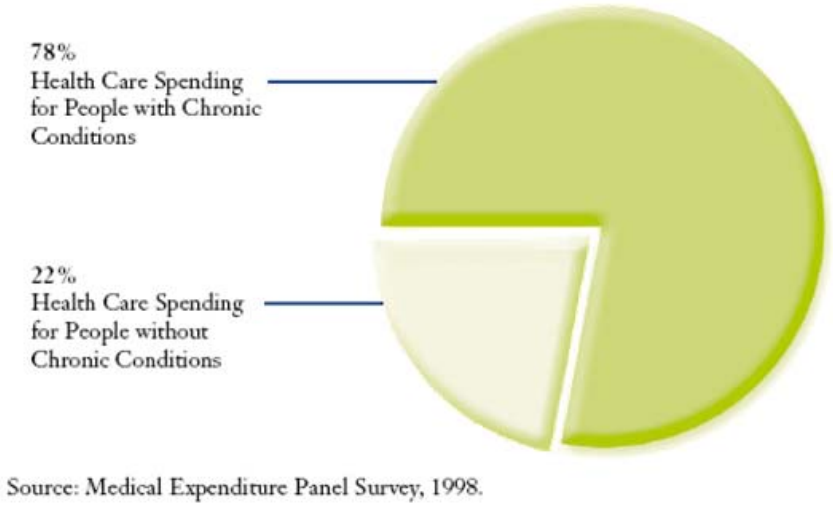
Limitation in daily activities is mostly a result of one or more chronic condition. 2000-2002 US censuses shows that population group of 55-64 has more limitation in activity due to one or more chronic conditions. Again percentage of limitation in activities in African American is more as compared to the white population. This also shows that Limitation in daily activities is more incase of female as compared to male.



Source: Chronic Conditions: making the case for ongoing care
by Johns Hopkins University, Dec 2002.
"The Medical Expenditure Survey 1998"

Figure A.5 People with multiple chronic conditions.

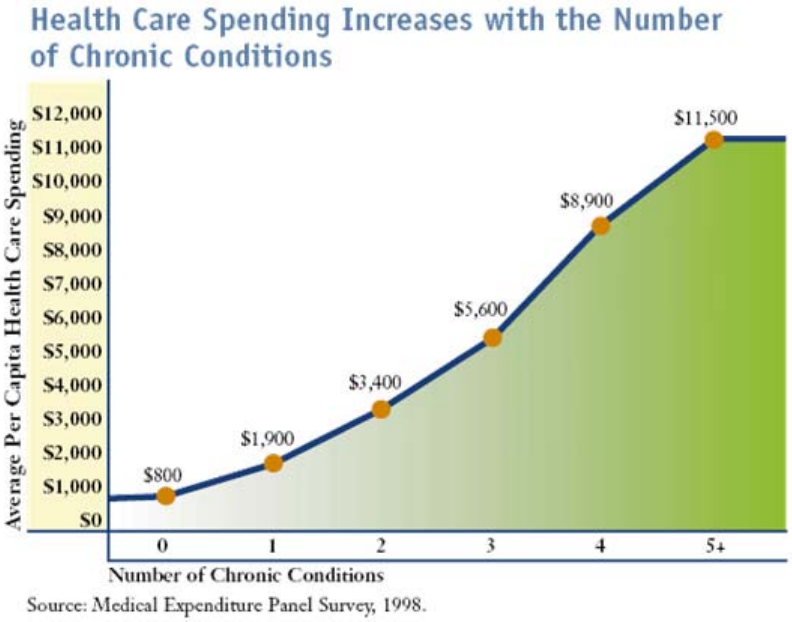
The Medical Expenditure Panel Survey, 1998 shows that people with more number of chronic conditions are more likely to have limitation activities as compared to people with less or number of chronic illness. This figure shows that 67% of population with five and more chronic condition has limitation in activity. There are various types of chronic diseases like arthritis, Diabetics, Asthma, Hypertension, Chronic mental condition, Heart diseases, Eye disorders, Cholesterols Disorder etc.



Source: Chronic Conditions: making the case for ongoing care
by Johns Hopkins University, Dec 2002.
"The Medical Expenditure Survey 1998"

Figure A.6 Chronic condition and medical expenditure

78 percent of health care spending goes for the population with one or more chronic condition.



Source: Chronic Conditions: making the case for ongoing care
by Johns Hopkins University, Dec 2002.
"The Medical Expenditure Survey 1998"

Figure A.7 Healthcare spending and chronic conditions

"What Are Ambulatory Care Sensitive Conditions? Ambulatory care sensitive conditions (ACSCs) are conditions for which timely and effective outpatient primary care may help to reduce the risks of hospitalizations. Appropriate outpatient care can prevent the onset of an acute illness, control an acute episodic illness, or help manage a chronic condition."

APPENDIX B

IRB FORM

BEFORE SUBMITTING YOUR PROTOCOL FOR IRB REVIEW, MAKE SURE YOU HAVE INCLUDED THE FOLLOWING (IF APPLICABLE):

__X__Survey, Questionnaire or Interview Questions

__X__Consent and Assent forms

__N/A__Recruiting materials

__N/A __Permission letters from participating institutions

__X_Signed Investigator Assurance form

__N/A__Clear, concise description of procedures to be used (Feel free to also attach any proposals that may further explain your project.)

Additionally, these assurances must be made:

__X__All personnel listed must have completed IRB/Human Subjects Training. If not, your application cannot be approved until the training has been completed. See our website for training dates and times.
http://www.msstate.edu/dept/compliance/irb/irbregistration.htm

__X__If applicable, the advisor has thoroughly reviewed this application to ensure readability and accuracy.

PLEASE NOTE:

- **THE DETERMINATION OF THE IRB WILL BE COMMUNICATED TO YOU IN WRITING. SUBMISSION OF AN APPLICATION TO THE IRB DOES NOT EQUAL IRB APPROVAL. YOU MAY NOT BEGIN THIS RESEARCH UNTIL YOU HAVE IRB APPROVAL.**

- **IF YOUR RESEARCH HAS NOT YET RECEIVED FUNDING NEEDED TO CREATE INSTRUMENTS AND OTHER ASSOCIATED MATERIALS, PROVIDE A TIMELINE OF WHEN THOSE ITEMS WILL BE DEVELOPED. YOUR APPLICATION WILL BE REVIEWED FOR "118 DESIGNATION"(SEE http://www.msstate.edu/dept/compliance/irb/irbawardchanges.htm FOR MORE DETAILS).**

If you have any questions, please feel free to contact our office at 325-5220 or by email at jmiller@research.msstate.edu or tarwood@research.msstate.edu.

Send to:
IRB

Campus Mailstop 9563
PO Box 6223, Mississippi State, MS 39762
8A Morgan Street

INVESTIGATOR'S ASSURANCE
Mississippi State University
Institutional Review Board

Project Title:
"Old Adults at Risk: Can Technology Augment Healthy Living in Natural Home Setting?"

As Primary Investigator, I have ultimate responsibility for the performance of this study, the protection of the rights and welfare of the human subjects, and strict adherence by all co-investigators and research personnel to all Institutional Review Board (IRB) requirements, federal regulations, and state statutes for human subjects research. I hereby assure the following:

The information provided in this application is accurate to the best of my knowledge.

All named individuals on this project have been given a copy of the protocol and have acknowledged an understanding of the procedures outlined in the application.

All experiments and procedures involving human subjects will be performed under my supervision or that of another qualified professional listed on this protocol.

I understand that, should I use the project described in this application as a basis for a proposal for funding (either intramural or extramural), it is my responsibility to ensure that the description of human subjects use in the funding proposal(s) is identical in principle to that contained in this application. I will submit modifications and/or changes to the IRB as necessary to ensure these are identical.

I and all the co-investigators and research personnel in this study agree to comply with all applicable requirements for the protection of human subjects in research including, but not limited to, the following:

- **Obtaining the legally effective informed consent of all human subjects or their legally authorized representatives, and using only the currently approved, consent form (if applicable); and**
- **Making no changes to the approved protocol or consent form without first having submitted those changes for review and approval by the Institutional Review Board; and**
- **Reporting serious and unexpected adverse effects to IRB Administration verbally within 48 hours and in writing within 10 days of occurrence, and all other unexpected adverse events in writing within 10 days of occurrence; and**
- **Promptly providing the IRB with any information requested relative to the project; and**
- **Promptly and completely complying with an IRB decision to suspend or withdraw its approval for the project; and**
- **Obtaining continuing review prior to the date approval for this study expires. I understand if I fail to apply for continuing review, approval for the study will automatically expire, and study activity must cease until IRB current approval is obtained.**
- **Your study and any associated records may be audited by the IRB to ensure compliance with the approved protocol.**

Name of Primary Investigator / Researcher: Lalatendu Satpathy

Signature:

I assume responsibility for ensuring the competence, integrity and ethical conduct of the investigator(s) for this research project. The investigator(s) is/are fully competent to accomplish the goals and techniques stated in the attached proposal. Further, I certify that I have thoroughly reviewed this application for readability and accuracy and the study is clearly described herein.

Name of Advisor: Anijo Punnen Mathew

Signature:

THE MISSISSIPPI STATE UNIVERSITY INSTITUTIONAL REVIEW BOARD
FOR THE PROTECTION OF HUMAN SUBJECTS IN RESEARCH

Protocol Submission Form

PRINCIPAL INVESTIGATOR / RESEARCHER INFORMATION
Name: Mr. Lalatendu Satpathy
MSU Net ID: ls241
Daytime Phone Number: 662-312-4542
Mailing Address: 1120 East Lee Blvd., Apt. 185
If on-campus, provide Mailstop

City/State/Zip: Starkville, MS 39759
E-Mail Address: ls241@msstate.edu
Department: Architecture
IRB and Human Subjects Protections Education completed on 08/26/2004

FACULTY ADVISOR (Faculty member supervising the student for this project)
If you are a student, you must have an advisor for this project.
Advisor: Anijo Punnen Mathew
MSU Net ID: apm41
Daytime Phone Number: 662-325-2523
Advisor=s E-Mail Address: amathew@coa.msstate.edu
Department: Architecture
Campus Mail Stop: 9633
IRB and Human Subjects Protections Education completed on 08/26/2004

ADDITIONAL INVESTIGATOR / RESEARCHER INFORMATION
Name: Mr. Vikash Kumar Singh
MSU Net ID: vks20
Daytime Phone Number: 662-312-1061
Mailing Address: 1120 East Lee Blvd., Apt. 159
If on-campus, provide Mailstop

City/State/Zip: Starkville, MS 39759
E-Mail Address: vks20@msstate.edu

Department: Architecture
IRB and Human Subjects Protections Education completed on 10/17/2005

ADDITIONAL INVESTIGATORS / RESEARCHERS
Will additional researchers be involved with this project? If so, list them along with their ***Net ID, phone number, address, and email address****. Indicate the date in which they completed IRB and Human Subjects Education.*

***TITLE* of project:** Old Adults at Risk: Can Technology Augment Healthy Living in Natural Home Setting?

Is this an original submission or a revision? Original

If this is a revised application, please list the docket number assigned to the first submission of the study.

***PROJECT PERIOD*:** **from** 03/01/2006 **to** 04/026/2006
Includes both data collection and data analysis
**NOTE: Beginning date cannot predate IRB approval date. If you intend to begin immediately upon IRB approval, list beginning date as "upon IRB approval".*

STUDY FUNDING
Provide information about how the study costs will be supported

____Department funds ____Personal Funds __X__No cost study ____Other, specify:
____External Funding

Agency:
SPA Proposal or Fund/Account Number:
PI of Award (if different than Principal Investigator/Researcher listed above):

ADDRESS EACH OF THE FOLLOWING ITEMS IN YOUR WRITTEN PROTOCOL.

I. Personnel & Qualifications

NOTE:

- **In this section, the principal investigator is to describe the qualifications of all researchers involved in the study to perform the responsibilities assigned.**

- **As principal investigator, it is your responsibility to ensure that all individuals conducting procedures described in this application are adequately trained prior to involving human participants.**
- **All personnel listed on this application are required to successfully complete the MSU IRB & Human Subjects training course or an MSU IRB approved alternative. APPROVAL WILL NOT BE GRANTED UNTIL ALL INDIVIDUALS HAVE COMPLETED THIS TRAINING.**
- **As personnel change, you must submit a modification request to the IRB for approval before they can work with human subjects or identifiable or confidential information.**

A. Including **yourself**, provide the name of each individual who will be responsible for the design or conduct of the study, have access to human participants, or have access to identifying or confidential information.
* Lalatendu Satpathy
* Vikash Kumar Singh
* Anijo Punnen Mathew

B. For each person identified above, identify his/her role in the project and clearly state the procedures or techniques he/she will be performing.
* Lalatendu Satpathy – Principal Investigator
The study will involve randomly recruited people with personal invitation to join a focus group to understand the technology acceptance in rural area.

* Vikash Kumar Singh– Supporting Investigator
Data Analysis and tech. support.

* Anijo Punnen Mathew – Faculty Advisor
Data analysis, work presentation + advisory role.

C. For each person identified above, describe his/her level of experience with the procedures or techniques he/she will be performing.
* Lalatendu Satpathy – has performed questionnaire based surveys and interview before.

* Vikash Kumar Singh – has performed questionnaire based surveys and interview before.

* Anijo Punnen Mathew – has performed questionnaire based surveys and interview before.

D. Indicate where each of the personnel listed received training to perform the identified procedures and who supervised or provided the training.
* Lalatendu Satpathy – through coursework and research in the Interactive Media Course (College of Architecture, Mississippi State University) and at the Design Research & Informatics Lab

* Vikash Kumar Singh – through coursework and research in the Interactive Media Course (College of Architecture, Mississippi State University) and at the Design Research & Informatics Lab

* Anijo Punnen Mathew – trained through research and coursework in the graduate program (MDesS) at Harvard University Graduate School of Design

E. Explain how these skills/abilities will be periodically reviewed.
* Lalatendu Satpathy – through periodic review in coursework and lab supervised by faculty advisor

* Vikash Kumar Singh – through periodic review in coursework and lab supervised by faculty advisor

* Anijo Punnen Mathew – annual review and evaluation

II. Research Protocol

1. ***SITE OF WORK*:**
Meridian, Mississippi State

2. **Brief description of the *GENERAL PURPOSE of the project*.**
This study will help us to understand the technology penetration and technology acceptance in rural area of the United States.

3. **In your view, what *BENEFITS* may result from the study that would justify asking the subjects to participate?**
This study will inform us about the acceptance of technologies and provide us design guideline to suggest technologies that could be used for future smart home.

4. **Give details of the *PROCEDURES* that relate to the subjects' participation.**
Part 1 – questionnaire (attached) (Appendix 1)
Part 2 – focus group study questionnaire attached (Appendix 2)

5. **List ALL vulnerable subject populations to be included and additional precautions being taken to ensure their protection.**
Selected participants from Meridian and Starkville, Mississippi– Identity will be kept confidential and will not be disclosed at any circumstances.
Healthcare professional of Meridian and Starkville, Mississippi - Identity will be kept confidential and will not be disclosed at any circumstances.

6. **How will the subjects be selected and recruited?**

Personal invitation through request- Invitation letter attached (APPENDIX 4).
The senior citizens and health care providers will be asked if they are interested and willing to participate in the above study -

7. **What inducement will be offered?**
None

8. **How many subjects will be used? List any salient characteristics of subjects (e.g.., age range, sex, institutional affiliation, other pertinent characterizations.)**
Four focus groups will be conducted with each group consisting of 7-9 participants.

9. **Number of times researchers will interact with each subject?**
One

10. **What will the subjects do, or what will be done to them, in the study?**
Part 1 – Subject will be asked to answer the first set of questions.
Part 2 – A focus group will be conducted. Before the discussion questions (Appendix 1) will be given to the participants to answer. During the discussion videos and images (Appendix 3) of existing smart technologies will be shown to help them understand the technology and questions (Appendix 2) will be asked based to initiate discussion. The entire group discussion will be recorded on a tape with prior approval of the participants.

11. **How do you intend to obtain the subjects' *INFORMED CONSENT*?**
Yes. Form attached.

12. **Assessment of *RISK***
Do you see any chance that subjects might be harmed in any way?
No

Do you deceive them in any way?
No

Are there any physical risks?
No

Psychological? (Might a subject feel demeaned or embarrassed or worried or upset?)
No

Social? (Possible loss of status, privacy, reputation?)
No

How will you control for the risks you've identified?
No risks in either questionnaire or study.

13. **How do you ensure *CONFIDENTIALITY* of information collected?**
Identity will be kept confidential and will not be disclosed at any circumstances.

<u>At a minimum, provide the following information</u>:
Who will have access to the data?
Principal Investigator, supporting investigator and faculty advisor.

Where will data be stored?
Design Research & Informatics Lab

Where will signed consent forms be stored (be specific regarding location)?
Design Research & Informatics Lab

What identifiers (direct or indirect) will be collected?
Age Group, gender and occupation

What purpose do the identifiers serve?
Age group and gender will inform us abut the perception of technology by different age group and gender. Where as occupation will help us to evaluate the background knowledge of the participant.

When will identifiers be removed or "de-linked" from the data? (Identifiers include a code number, which may be linked to another document containing names or other identifying information). The results will be in the form of relational data and qualitative analysis will be made from the obtained data.

Will the data be retained or destroyed?
Destroyed

If the data will be destroyed, how and at what point in time (be as specific as possible)?
05.06.06

14. **Are approvals needed from another MSU regulatory committee (i.e. IACUC for animals or IBC for infectious agents or recombinant DNA)? If so, please attach approval letter(s) from appropriate committee(s). If approval has not yet been obtained, where are you at in the approval process?**
No.

APPENDIX C

PARTICIPANT CONSENT FORM

Dear Participant,
This is regarding a study that we (researchers: Lalatendu Satpathy and Vikash Singh, from Graduate program of College of Architecture, Art and Design, MSU) wish to perform to understand the technology penetration and technology perception by the senior citizens (65 and above age group), care providers (friends and family members having caregiving experience) and healthcare providers of Meridian Mississippi. This study will be performed (per your approval) under the guidance of Anijo Mathew (Assistant Professor, School of Architecture, MSU).

The study will be conducted in two parts. In part one the participants will be given one set of questionnaires (Appendix 1) and will be asked to answer them, in part two the focus group study will be conducted with the second set of questionnaires (Appendix 2). The group discussion will be recorded on a tape recorder for further analysis. There are no foreseeable risks involved in their participation. But this study will help us in providing guidelines for the designers while designing smart home for elderly people in rural settings.

Please note that these records will be held by a state entity and therefore are subject to disclosure if required by law. If you have any questions about this research project, please feel free to contact Lalatendu Satpathy or Anijo Mathew at 662.-325-0725. For additional information regarding your rights as a research subject, please feel free to contact the MSU Regulatory Compliance Office at 662-325-5220.

Please understand that your **participation is voluntary**, your **refusal to participate will involve no penalty or loss** of benefits to which you are otherwise entitled, and you **may discontinue your participation** at any time without penalty or loss of benefits.

You will be given a copy of this form for your records. If to participate please sign below.

_____ _____
Participant's Signature Date

_____ _____
Investigator 1 Signature Date

_____ _____
Investigator 2 Signature Date

APPENDIX D

LETTER OF INVITATION

TO PARTICIPATE IN THE FOCUS GROUP

Subject: Invitation letter to participate in a focus group study.

Title of the Project: Old Adults at Risk: Can Technology Augment Healthy Living in Natural Home Setting?

Dear X,
The Design Research and Informatics Laboratory (Mississippi State University) is conducting a focus group study. This study will help the researcher to understand the technology penetration and technology perception by the senior citizens (65 and above age group), care providers (friends and family members having care giving experience) and healthcare providers of Meridian Mississippi. The study will be performed (per your approval) under the guidance of Anijo Mathew (Assistant Professor, School of Architecture, MSU). You have been selected at random to participate in this study. Would you be willing to meet for two hour group discussion with other 4 – 8 participants? We are interested in your honest impression towards the acceptance of new technologies – what works and what doesn't work. Please be assured that your participation and identity in the focus group will remain confidential.

Please reply to this e-mail message, and check the appropriate boxes below. We thank you for your consideration.

Sincerely,
Lalatendu Satpathy

Design Research and Informatics Lab
(Mississippi State University).

____ I would like to participate in the focus group. I am able to meet at any one of the following times: (Please check as many as are convenient. We will schedule a meeting
at one of your preferred times.)

___ 4:00 PM, Wednesday, Dec. 8
___ 7:00 PM, Wednesday, Dec. 8

____ I do not wish to participate in the focus group.

APPENDIX E

QUESTIONNAIRES FOR FOCUS GROUP DISCUSSION

1: Questionnaires for care recipients and caregivers:

1. **Opening**: Please tell us your name and tell us how long you have been working as a caregiver or health care provider in this city.

2. **Introductory**: Do you have an aging family member whose health you are concerned about? Please tell us about your caregiving experience or describe a healthy life style.

3. **Transition**: Think back when there was no internet, cell phone or even computer and see now when you are almost living with the technology. How do you feel about this change?

4. Do you use internet to get health related information? If yes; how often do you use in a month or in a year? If no, where do you find yourself in this world of internet?

5. **Key questions**: What do you think about getting health related messages on your cell phone or on any other another household electronics to remain informed about your or a family member's health?

6. What kind of information you would like to get? Will it make you more confident and feel comfortable to stay independently at your own home?

7. Have you ever used any health monitoring devices to monitor your health or of any of your family member? If yes, how do you feel about these technologies? And if no, why are you not using any such device?

10: **Image1**: Projected health care model (Figure 7.1)

What do you think about this internet based personal health care services? Can this new health care model provide similar or better health care as compared to the current health care system?

11: **Video**: iCAT. (Figure 7.2)

What did you like and dislike about this assistive device? What is your opinion on similar devices providing health care service?

8. **Image2**: (Figure 7.3, 7.4, 7.5, 7.6, 7.7 and 7.8)
   What is your opinion about these technologies?

9. If you get a chance to make your existing home a "smart" home what are the things you would like to change and how much you wont mind to spend for the same?

   OR

10. How do you feel about renovating your home and integrating the new health care technologies to help you or any of your family members to get health delivered at home?

11. **Ending questions**: If you had a chance to give advice to the designers and scientists involved in designing the new health care model or technology. What advice would you give?

12. We wanted you to help us evaluate improve these services. We want to know how to improve the service and what difference these services could makes to you or any of your family members.

13. Is there anything we missed? Is there anything you wanted to say that you didn't get a chance to say?

2: Questionnaires for healthcare providers:

1. **Opening**: Please tell us your name and tell us how long you have been working as a health care provider in this city.

2. **Introductory**: Do you have an aging family member or do you have any geriatrics related patient whose health you are concerned about? Please tell us about your caregiving experience.

3. **Transition**: Think back when there was no internet, cell phone or even computer and see now when you are almost living with the technology. How do you feel about this change?

4. Do you use internet to get health related information? If yes; how often do you use in a month or in a year? If no, for what other purposes you use internet?

5. **Key questions**: What do you think about getting health related messages on your patients cell phone or on any other another household electronics to help them remain informed about their health?

6. What kind of information you would like be helpful? Will it make them more confident and feel comfortable to stay independently at their own home?

7. Have you ever used any health monitoring devices or suggested any to your patients to get health related information? If yes, how do you feel about these

technologies? And if no, why are you not using any such technologies?

8. **Image1**: Projected health care model (Figure 7.1)
   What do you think about this internet based personal health care services? Can this new health care model provide similar or better health care as compared to the current health care system?

9. **Video**: iCAT. (Figure 7.2)
   What did you like and dislike about this assistive device? What is your opinion on similar devices providing health care service?

10. **Image2**: (Figure 7.3, 7.4, 7.5, 7.6, 7.7 and 7.8)
What is you opinion about these technologies?

11. If you get a chance to make your existing home a "smart" home what are the things you would like to change and how much you wont mind to spend for the same?

    OR

12. How do you feel about renovating your home and integrating the new health care technologies to help you or any of your family members to get health delivered at home?

13. **Ending questions**: If you had a chance to give advice to the designers and scientists involved in designing the new health care model or technology. What advice would you give?

14. We wanted you to help us evaluate improve these services. We want to know how to improve the service and what difference these services could makes to you or any of your family members.

15. Is there anything we missed? Is there anything you wanted to say that you didn't get a chance to say?

APPENDIX F

PRE-FOCUS GROUP QUESTIONNAIRES

Pre-focus group questions:

Which of the following technologies do you use regularly? Please check all that apply.

Digital technologies/appliances

- ☐ TV
- ☐ Remote controller
- ☐ Desktop PC
- ☐ Laptop PC
- ☐ Broadband Internet
- ☐ Dial-up internet
- ☐ PDA/ Pocket PC
- ☐ Digital still camera
- ☐ Digital video camera
- ☐ Radio
- ☐ Music sound system
- ☐ DVD
- ☐ iPod/MP3 player
- ☐ Home Telephone
- ☐ Cell phone

Home security system

- ☐ Personal Emergency Alert System (Keychain, pendant etc)
- ☐ Home Security (ADT, Brinks etc.)
- ☐ Health Monitoring System

Home kitchen appliances

- ☐ Refrigerator
- ☐ Electronic toaster
- ☐ Electric cooker/Crock-pot/Slow cooker
- ☐ Microwave
- ☐ Vacuum cleaner
- ☐ Food processor
- ☐ Electric oven/Stove
- ☐ Coffee maker
- ☐ Food mixer
- ☐ Washing machine
- ☐ Cloth dryer
- ☐ Electric sewing machine

APPENDIX G

IMAGES SHOWN DURING FOCUS

GROUP DISCUSSION

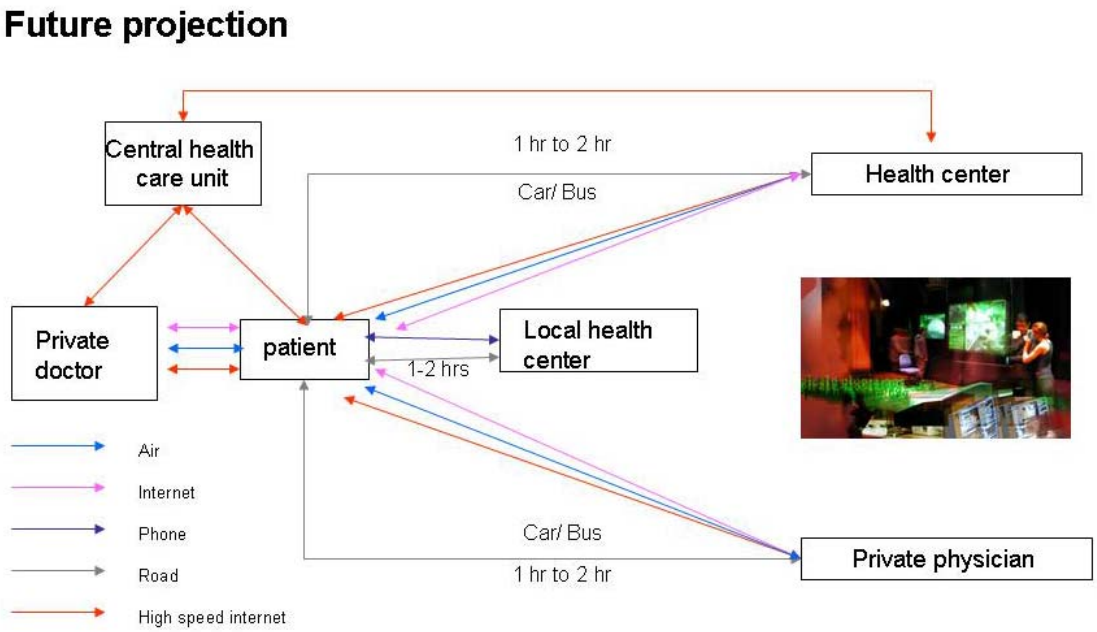


Figure G.1 Projected health care model

Figure G.2 iCAT by Philips Lab

Figure G.3 Video conferencing by MIT MediaLab

Figure G.4 Passage project by MIT Media Lab

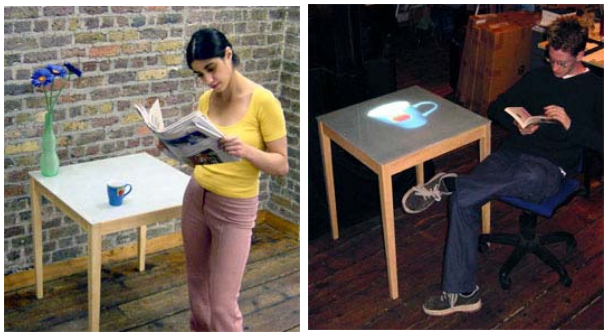


Figure G.5 Habitat project by MIT Media Lab

Figure G.6 Whispiral project by MIT Media Lab

Figure G.7 HelloWall by MIT Media Lab

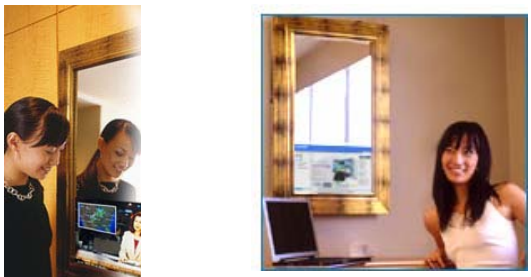


Figure G.8 iMirror by Philips Lab