The Networked Home: An Analysis of Current Developments and Future Trends

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(CRITO Working Paper 2001)

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1. Introduction

The concept of home networking has grown in prominence lately (Magid 2000, Ruhling 2000).[1] With the emergence of mobile telephony and other personal communication technologies, the concept of networking through new technologies will shift dramatically to new levels of practice. A related concept to the Networked Home is the Automated Home or the Smart Home. Many of the R&D or prototype developments are based on the availability of PC/Intenet based technolgies that are already part of the home technology scene (Harper 2000). In this research report we address various issues concerning the relevant concepts. Table 1 gives a picture of the concepts we are working with. In this connection, the significant questions are:

-What is a Networked Home?
-Why has the concept gained in importance? What is its significance?
-How is the current emphasis on the Networked home different from the home as it is currently or conventionally understood?
-What conceptual models exist to view the home as a Networked Home?
-What are some of the technological issues concerning the Network Home?
-How can the Networked Home relate to the concept of the Automated Home and how are they related to internal and external networks?
-What are the questions that concern us in the future?
-How will families adopt to the Networked Home? Or, what is the future of the Networked Home?

[1] Magid, Lawrence, "Home Networking Next Big Thing for Families With Multiple PC," LosAngeles Times, June 26, 2000, pC3; Ruhling, Nancy A. "Home Is Where the Office is," American Demographics, June 2000, 54-60.

Table 1. Basic Concepts of the Networked Home

Concepts	Characteristics	Elaboration
1. Networked Home	Internal Networks	Family/Relatives/Friends Time Connection (e.g. messages in absentia) Social/Physical/Technological spaces connected People connected
	External Networks	Work School Shopping/Banking
2. Automated Home (Smart Home)	Machhine Connectivity Human Interactivity Programmability	Efficiency Convenience Ease of use Remote access Security
3. Domesticated Home	Meal Preparation Family Health Family Rituals Child Rearing Every day activities	Family interactions Family values/norms
4. Structural Configuration of the Home.	Home as Living space	Social space Technological Space Physical Space
5. Oragnic View of the Home	Home as Networked Center	Entertainment Center Work center Information Center Communication Center Shopping Center Learning Center

Background

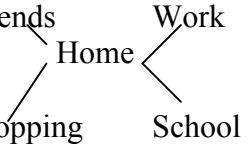
The evolution of technology in the home is presented in Figure 1. We have identified four stages in the evolution of technology through time: the electrification stage, the automation stage (smart home 1), the intelligentification stage (smart home 2) , and the human substitution (robotics) stage (smart home 3). Evidence suggests that the home technology transformation began with the introduction of electricity and electrically powered appliances in to the home (Cowan, 1976). Roughly this started at the beginning of the 20th century. In the next stage, simple programmable and automated machines were introduced. In the third stage, which is the current stage, intelligent and programmable machines are being introduced. This is also the stage during which home

communication systems are developing fast. In the next stage, we will be seeing new technologies based on robotics. Clearly, the home is transforming quite rapidly—technologically speaking. How is the home being transferred socially? This is described in Figure 2. In many urban environments, networks are moving away from physical access to friends and neighborhoods to virtual contexts. Interactions are becoming becoming multi-way instead of one-way. Home is becoming the center of gravity because of its evolution from an isolated social entity into a socially connected virtual organization.

Figure 1 Home Technology Evolution

Home Electrification	**Home Automation/ Communication** ***(Smart Home 1)***	**Human Intelligentification** ***(Smart Home 2)***	**Human Substitution** ***(Smart Home 3)***
World of Energy	World of Simple Programmable Machines	World of Thinking Machines	World Of Artificial Intelligence and Artifcial Life
Appliances	Telephone TV/Radio Security Remote Sensors	Smart Appliances Computers FAX PCS	BioTech (Robotics)
	Prosthetics	***Networking/Intelligence***	

Figure 2. Home (Social) Network Evolution

1. Friends Neighborhoods Physical Neighborhoods	2. Friends, Relatives Work Distance Neighborhoods (limited access)	3.All Virtual Entities (extensive access)
Physical Distance Transportation	Simple Electronic Communication	Complex Virtual Communication
One-way Interaction	Two-way Interaction	Multi-way Interaction
Home –> Friends Home –> Work Home –> Shopping Home –> School	Home <-->Friends Home <-->Work Home <-->Shopping Home <-->School	

What is a Networked Home?

We define the networked home in terms of two major components: An internal household network which primarily consists of network relationships with family and friends and social circles, and an external network connecting the home to outside agencies such as schools, shopping centers, work/office, and other civic/community centers.
(see Figures 3 and 4).

The concepts and issues relating to social or community networks (Scott 1991, Wellman and Leighton 1979) or, more specifically, family networks (Bott 1957, Milardo 1988) are well researched by scholars over time. While the idea of network itself is not new, it is the technological advances that have changed the character of the networks and have introduced greater complexity and variety into the home life (Kiessler 1997). After all, anthropologists have shown that, no community, and nowhere in the world can function without social networks. Networks can exist in the absence of technology. However, modern networks are highly technological based.

Networks can be described in terms of their social, physical and technological configurations. The social networks through physical space can generate quite complex interactions if technology begins to act on them.

Figure 3. Home Networks

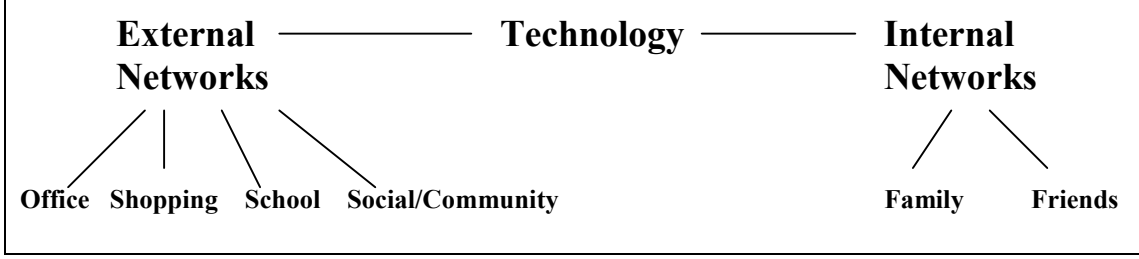
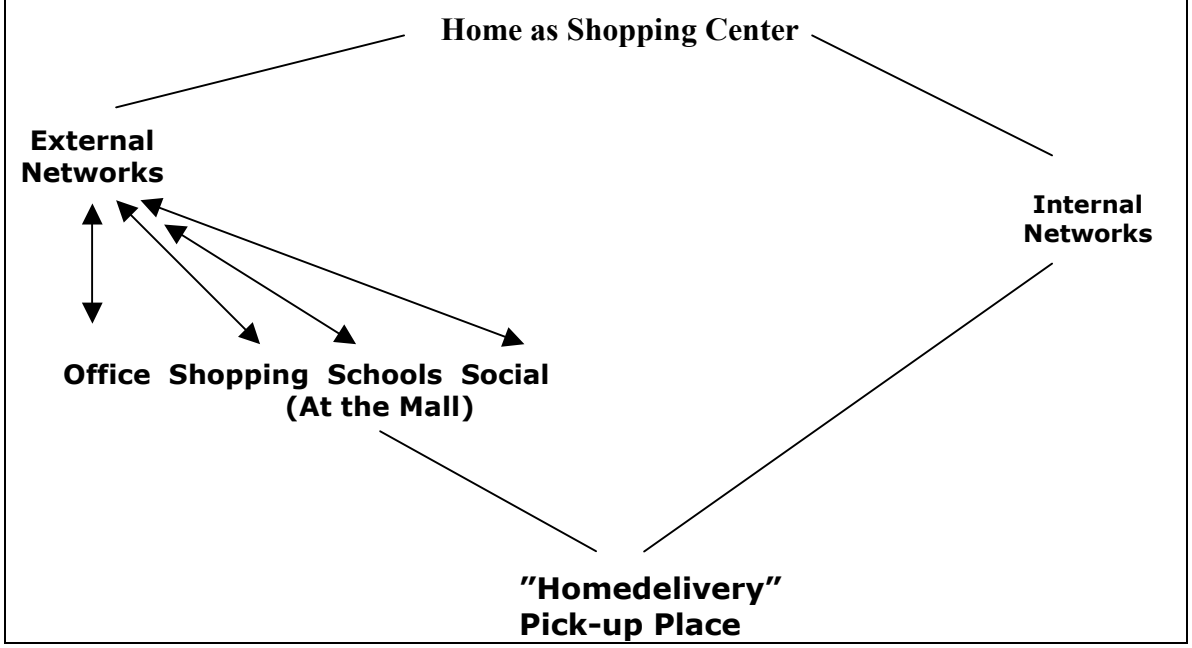


Figure 4– Home-networks and Shopping



Why has the concept gained in importance? What is its significance?

There are two major initiatives that we see. One is the technology centered initiative and the other is the marketing initiative. The *technological initiative* indicates that in today's fast paced electronic world technologies are available that connect people to people, people to machines, and machines to machines. For a long time the average citizen had only the house telephone which as the primary technology of communication. Even today, for the most part, it is true. In the last few years, there have been dramatic developments in the area of communication technologies, especially in the area of mobile telephony where advanced technologies have made communications easier and most efficient. The communication landscape has been transformed with the rise of wireless telephony, satellite communication, mobile telephony, the Internet to name the important ones. The communication revolution that we are witnessing now is reaching ordinary

masses and now for the first time the most complex technologies have entered everyday life.

The *marketing initiative* raises the question of how these different technologies can be made available to the consumer or the household. However advanced the technology might be and whatever be its desirable qualities, the success of any technology finally depends on how much market acceptance it gains.

The two initiatives, the technology initiative and the marketing initiative, are in the final analysis concerned with the same question. What are the current needs of the consumers, what would be their future preferences and what would motivate them to buy new technologies as the are introduced into the market place. A related issue not discussed here is the nature of competition and the strength of the competition in the market place. There are also several other issues concerning standards, customer service, government regulation, which are outside the purview of our discussion here. Our focus here is how to conceptualize the home as a user of network related technologies and what issues emerge in this context.

Consequently, the question facing various producers of technology is the following: Now that the technologies are available, are people going to use them? This is an important question and much research remains to be done in relation to the needs of the users, and their perceptions and preferences. Our focus here is how these new technologies enhance the value of home networks and what trends can we foresee in this regard.

How is the current emphasis on the Networked home different from the home as it is currently or conventionally understood?

As mentioned earlier, the concept of networked family is not entirely new. Historically, families have always been a part of community and kinship networks. Networks are systems of infrastructure which perform two important related functions: a Communication function and an Information Exchange function. In addition, networks also play a supra-social role. For example, many human networks have evolved and developed over centuries as institutions of support based on psychological, social, financial, economic, political, and educational factors. Many of these networks have attained global status (Wellman 1999). With the onset of the industrial age, some of these networks have weakened while others have grown in strength. The industrial age is marked by physical and social mobility, urban transformation, migration to suburbia, and a host of other factors that have contributed to the decline of some traditional forms of networks and emergence of new types networks—as for example, professional or work-related networks and friendship networks. Not only have we seen new forms of people-to-people networks, we have also begun to see transformation in the character of networks with the introduction of communication technologies. Suffice it to say that the technologies contributing to the transformation of networks and networking are the communication and information technologies. In the last one hundred years or so, we have seen the emergence of one way and two-way communication technologies. The

radio and TV are basically one way communication technologies while the telephone is a two-way technology. For a major part of the twentieth century these were the main technologies that found their way into the homes. In the last few years, we have seen a veritable avalanche of technologies coming into the home and this has created new forms of networking possibilities. One of the key technologies that we have concerned with within the last decade or so is the home computer as a networking tool (Venkatesh 1996). More recently, the computer has enhanced its networking value primarily due to the Internet. Other factors contributing to the networking capabilities in the home are the convergence of communication and information technologies.

What conceptual models exist to view the home as a Networked Home?

Two main conceptual schemes motivate our thinking in terms of the Networked Home. First the networked home should be embedded in the overall concept of "home as living space." Second, the Networked should be conceptualized on its own terms. We shall first discuss the concept of the home as living space and then examine the Networked home as an entity in itself.

The conceptual scheme consists of three parts: the idea of a networked home; the structural composition of the home based on a typology of *spaces*; and the organic elements of the home based on the typology of *centers* of home life. Although the discussion of spaces would be relevant to the overarching concept of the home as living space, that will not be our main concern and our main attention will focus on the links between the networked home and the organic elements of the home as centers.

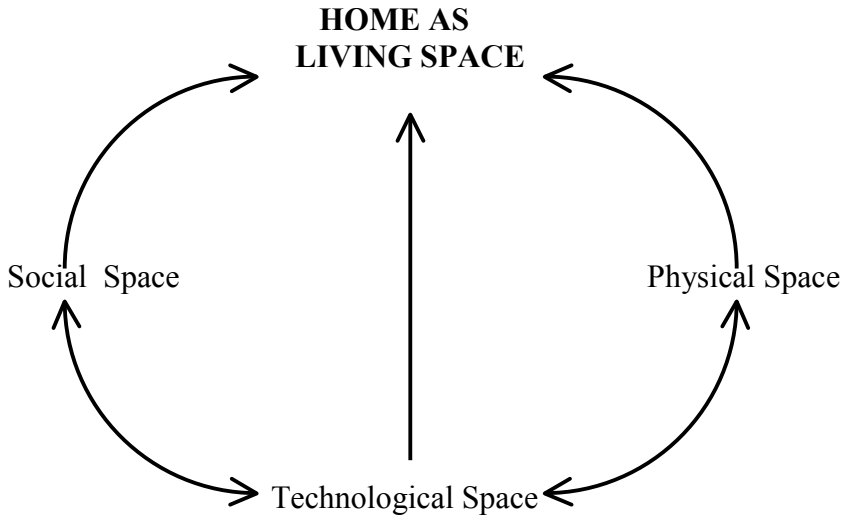
The Networked Home

We have already defined the networked home in terms of two major components (Figure 3). Just to repeat it consists of an internal household network, which emphasizes network relationships with family and friends and social circles, and an external network connecting the home to outside agencies such as schools, shopping environments, work/office, and other civic/community establishments. Networks can be described in terms of their social, physical, and technological configurations.

Structural Configuration –Home As Living Space:

For our purposes, we configure the home in terms of a "living space.' (for an earlier development of the concept, see Venkatesh and Mazumdar 1999) The living space (Figure 5) consists of three structural components: the *social space*, the *physical space* and the *technological* space. The social space consists of the members of the household, the activities performed by them in the home, the time spent on those activities, and the interactions between the members of the family. The physical space refers to the physical layout of the home and its constituent parts (kitchen, bedrooms, bathrooms etc.) The technological space consists of the household technologies that are embedded in the physical space and used by the members of the family as part of the social space. The structural concept of the home does not exist in vacuum. It is related to the organic aspects of the home.

Figure 5



The home, as a manifestation of living space caters to the variety of needs of the members of the family, emotional, social, educational, recreational. In designing the home as living space, these various needs are taken into account. As a living space, the home varies from time to time; that is, historically it has changed its character. As living space, the home also varies from culture to culture. In this paper, one particular concern is how technologies fit into home as living space

We divide the living space into three components—the social space, the technological space, and the physical space. These three spaces are not mutually exclusive. The meeting point of these three define how families live within the home. For the purposes of marketing, the living space constitutes the technology based product environment. In designing the products that spatial configuration is taken into account. It is however important to remember that the technological product environment (or the elements of living space) is not the same for all technological products. That is, the product environment for a refrigerator is not the same as the product environment for television. What is common to both is that each has a particular configuration profile of social/technological/physical space that needs to be taken into account. In the rest of the paper, we develop these ideas much more cogently, and systematically.

Time

While we conceptualize the home in terms of the three spaces, we also introduce a new element that is very important. This is the notion of time. That is, the living space is not only constituted by the social/technological and physical space it is also constituted by how much time each member of the family spends within the living space. One way to handle time is to make it part of the social space, that is, to make it part of the social

space, that is, how people use the technological space and physical space temporally. Another way to handle this is to create a new element called "temporality." That is, time is introduced as a separate dimension.

We shall discuss each of these spaces in some detail. We will later discuss how the spaces interact with each other. That is, how life is lived in the nexus of these three spaces.

Physical space:

Relative to other spatial concepts (technological and social) physical space is likely to change less frequently during the course of family life. In one sense, the space is a "given" in that it is not easily alterable. For our purposes, we define the physical space is the total space configured in square feet or square meters, the organization of the space into sub-categories based on the functionality assigned to each space (kitchen for cooking, bedroom for sleeping, bath-room for personal bodily care, living-room for family time etc.), and the size of each sub-category and its orientation to another sub-category (bath room next to bed-room). The physical space not only contains the interiors but the adjacent exteriors such as the deck, patio, the garden, the garage, the drive way etc.

The relationship of the physical space to the other space may be obvious. In designing the physical space consideration is given to how families live, and what activities they perform in terms of the family life. That is, kitchen is where cooking/meal preparation takes place so the physical space must be organized in such a way that cooking/meal preparation is possible. Similarly, the kitchen should be organized to install the refrigerator, stove etc. In these two examples, one visualizes the physical space and its essential link to the social and the technological spaces.

Technological Space:
We define technological space as the total configuration of technologies in the home and the organization of various technologies within the physical space and in reference to the social space. Although the technological and social spaces have the term, "space" inscribed in them, this space is not measured as the physical space is but identified and observed from the nature of their components. The technological space consists of the number of technologies in the home, the density of the technologies relative to the size of the home and people in the home, the marginal contribution of additional technology to the overall home life. Thus, the home may not only have standard kitchen appliances but more than one TV, more than one telephone, more than one computer and so on. Its density measures the cumulative presence of the technology within the physical space, and relative to the number of family members, and the relative levels of use of the technology for home use.

The technological space has gained particular importance recently because of the emerging notion of the "smart home." The smart home idea has been around at least for a decade we have known about its potential possibility even in the mid-eighties from the

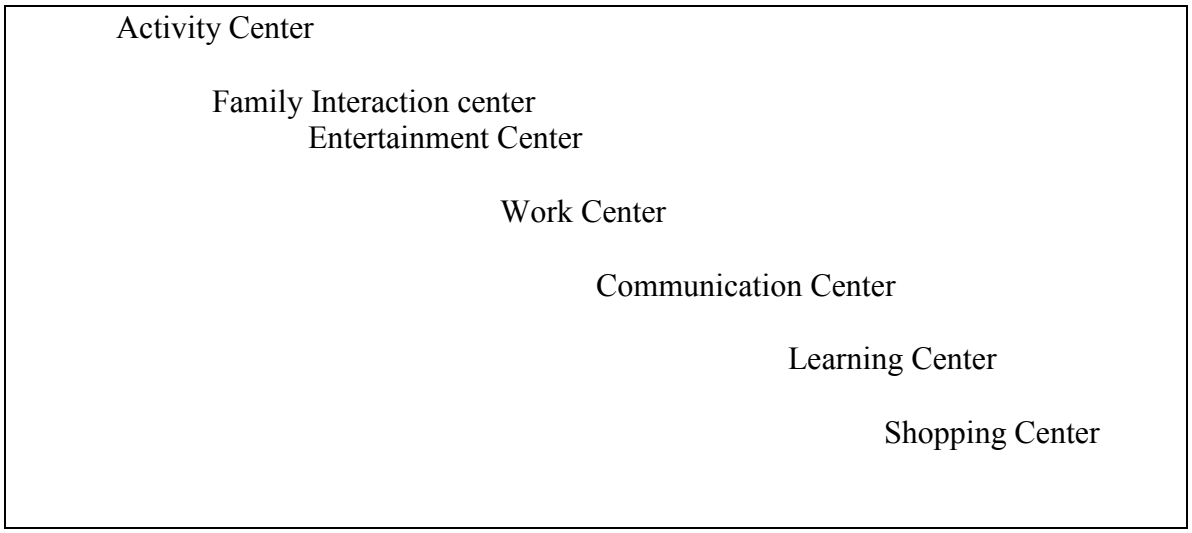
prototypes built in the US and in Scandinavia. However, its implementation has not been very successful and has been a little slow. Coupled with the concept of smart home are smart appliances which manifest basic qualities of machine intelligence.

The Social Space:
The social space is a significant component of the living space because it defines the latter much more intimately. The social space establishes a direct link to the context of family life, the needs of the family, the various household activities that are performed on a daily or weekly basis, the time spent on the activities by family members, and the goals of the family. The social space is the most complex of all the three spaces for it involves elements that can vary, and it is where the family members not only perform activities but are engaged in various social actions, tensions, and emotions. The social space is not a "given" as the physical or technological space is and by its very nature displays ebbs and flows.

What is the relationship between these three spaces? How are they coordinated? Does the family maintain a balance in negotiating these spaces? How so? These are questions that need both theoretical arguments and empirical insights for on these two aspects, rest the design considerations for home technology development. In a recent paper, Wai on Lee (2000), a Microsoft scientist, used the three space model to investigate the adoption of WebTV and the level of its acceptance among a small sample of households. In his preliminary research, the author found interesting family dynamics within the living space and degrees of conflict as well as accord between the spaces. His findings confirm the validity of the three-space model for designing and testing new products.

***Organic Elements of the Home*:**
The living space can also be viewed organically in terms of what we call **centers** (see Figure 6). We have identified eight centers where home life is possible: *the activity center, the entertainment center, the work center, the shopping/financial center, the family interaction center, the information center, the communication center, and the learning center*. The centers are presented in a chronological fashion to demonstrate why the home has become a very important and significant site for technological development. In the 1950s, the concept of the home was in terms of the *activity center*. Most early technologies into the home were targeted toward specific household activities relating to cleaning, meal preparation, washing clothes, and other various household activities. These technologies were primarily labor or time saving devices. With the introduction of the television in the mid to late sixties, the home became an *entertainment center*. In the eighties, with the arrival of computers in the home, it became possible for people to work at home and we see the beginnings of the *work center*. In the nineties, new media and information technologies and in particular, the Internet have begun to transform the home even more dramatically. The home is now viewed as a *shopping center* as in in-home shopping, the *communication center*, *the information center* and a *learning center*. It is these new developments that have contributed significantly to reconfiguring the home in terms of networks.

Figure 6. The Networked Home and the Concept of Centers



Home As Activity Center

One can visualize the home as a place where several activities go on. In our previous work (Venkatesh 1996), we conceptualized the activities in terms of the activity spaces in which these activities are performed. These activity spaces are identified as food management, home management, house cleaning, entertainment/recreation; work-job related activities, educational/family development, vacation travel and shopping. We can add a couple of more to this list. We developed a structural representation of the household-technology interaction as shown in Figure 7.

Figure 7

A Representation of the Internal Structure of the Household-Technology Interaction

	A.2 Social-Space**					
	Food Management 1	**Household Maintenance/ Finance** 2	**Leisure/ Recreation Entertain-ment** 3	**Social/Family Communication** 4	**Work/Emp-loyment** 5	**Family/Develop-ment/Well-being** 6
A.1 Family Members (As Adopters & users of technology) **	Primarily adults (parents)	Primarily adults	Whole Family	Whole Family	Primarily adults	Children and adults
A.3 Household Activities Targeted for Technology Use**	Meal Preparation & Consumption. Washing Dishes etc., Grocery Shopping	Family Shopping Cleaning Tax Pre-paration Family Budget	Watching TV Holiday Travel Movies Games	Telephone Conversations Family Communication Holiday Reunion Correspondence	Job-related Activities Telecom-muting	Children's Education Adult Education Family Fitness Dieting Holiday Gathering
B.1 Configuration of Household Technologies #	Kitchen Appliances Automobile ATM Machine Computer Home-shopping (On-Line)	Washer, Dryer Automobile ATM Machine Computer On-line Home-banking	TV, VCR, Stereo Automobile Computer Multi-media On-Line Services	Telephone Answering Machine Fax Computer/email Internet On-Line Services	Telephone Answering Machine Fax Automobile Computer Internet	Typewriter VCR Telephone Computer Internet
Links to Figure 1	**1, 2, 3**	**2, 3, 4, 5**	**2, 3, 6, 7**	**8, 9**	**9, 10**	**11, 12, 13**

**** Elements of Social Space** **# Elements of Technological Space**

9

For each activity we can ask the following questions.

Activity Based Questions:

1. What are the activities that are performed in the home? And in each activity space?
2. Who performs these activities? How much time is spent on them?
3. What resources are needed to perform these activities?
4. How do families obtain these resources?
5. What special skills, if any, required to perform these activities?
6. What training is needed for these activities?
7. What activities are given higher priorities over the others? How does this vary across family members, family life cycle stage?
8. What considerations enter in performing the activities? Social gender structure, dual career situation, and the like.
9. What theories are useful in explaining, understanding the performance of the activities?
10. What are the cultural and cross-cultural issues relating to the activities?

Technology Based Questions:

11. What technologies are associated with the se activities?
12. How can we represent the technologies within the context of the household structure?
13. How can we make technologies "smart" in the context of household activities?
14. What is the meaning of the term "smart" in reference to technologies? (Note: We use the term to refer to people as in "a smart person." Does it have same meaning when referring to technologies?)

In our earlier work, we had developed technology-household structure as shown in Figure 3. Much of our work on home-based technologies by this configuration.

Home As Work center

One of the most important transformations occurring in the home is the nature of job related work performed at home (Venkatesh and Vitalari 1990). This has many implications for home networks. This has particularly become more dramatic with the arrival of the computers in the home. Known as teleworking, telecommuting or remote work, the notion of work at home has gained in significance both due to sociological and technological factors. In the past ten years or so, several studies have shown that work at home has increased due to two main factors. First is the presence of the computers at home. One of the most important reasons why families buy computers is the ability to work at home. Second, the rise of the Internet and e-mail has further intensified work at home because workers can maintain contact with their work environments even from remote locations. In other words, work at home represents one of the best examples of external networking.

It is not simply that the technology has induced work at home. As women have entered the work force, many families have become dual career families. In cases where families have children, there is the additional possibility that one of the adults at home would prefer to stay at home as much as possible while at the same time have the option to participate in the labor force. Obviously, having computers at home makes some of these work arrangements possible.

Finally, because of the computers and communication technologies being so versatile and useful, many individuals are able to set up businesses from the home. In some parts of the industrialized world, self-employed population is increasing in numbers.

All in all, work at home is one of the most important developments of home networking and is bound to rise even more in the future.

Home as Entertainment Center

Perhaps the concept of the home that is receiving the most attention in today's press is the home as the entertainment center. Entertainment is commercially appealing and has a great profit potential. Many companies that cater to the home are entertainment based. Entertainment is not a monolithic idea and one uses the term guardedly. Generally speaking, in the last 35 years or so, the home technology that has created the greatest "buzz" has been the television. So much has been written about television that it bears no repetition here. A few key points are worth mentioning, however. Along with the telephone, and the automobile, the television has become the "link" technology with the external world, and more so than even radio. However, it is also a passive technology in that while both automobile and the telephone are consumer initiated technologies—one drives the automobile to go to places, one does not merely ring a telephone number and remain in a listening mode but carries on a conversation—the television represents a

more passive element and the viewer is constantly receiving images and sounds of one sort or the other. Of course, he/she has to make a decision as to what to view. Except for the minimal effort of turning on the switch and changing the channels, very little of active participation is involved in television.

While TV is a passive technology in terms of consumer or viewer participation, it has the greatest cultural impact on the viewer or collectively o the household. It is also where both the children and the adults learn about the outside world. The TV has become the cultural icon of the modern family. In the US (as perhaps in other countries), the immigrants learn about the newly adopted culture through television more than any other means. The literary skills required of the user for understanding what goes on most of television for the images sounds are minimal and other material can be learned easily with minimum cognitive knowledge.

In spite of the low consumer initiatedness of the technology, or because of it, to the average citizen, television has become the technology that provides the highest exposure to the external world. It is an enabling technology in many different ways. It sends messages from different parts of the world at different times of the day and transmits them to the viewer in a very short notice. In effect, it is a visual/audio window to the world. The television is also at the heart of the entertainment revolution in that it has transformed the society by bringing into the home many facets of the global popular culture.

While TV has played a major role in the entertainment revolution it has also transformed the contemporary society in other major ways. Many children watch the television instead of reading books. Most people have grown up with solid doses of televisual experiences. It has shaped people's minds and their views of the world. With such a potent force in the home, how can we ever think of replacing the television with another medium. It is simply inconceivable. The question is, is it?

Can Internet do everything that the TV does? Or, does it do more? Or, something different? In other words, does the Internet act as an effective replacement of TV, or a complement, or even more plausibly can the TV be incorporated into the Internet such that TV merges easily into the Internet—as is being done with Web-TV.

Home as Communication Center

One of the most powerful features of any network is the communication structures that exist within the family unit. Within the context of the Networked Home we can envision communication in two ways, within the home (internal network) and outside the home (external networks). We can also think of communications in four other possible ways:

Human to human (without technology, e.g. face to face communication)
Human to human (with technology)
Human to machine

Machine to machine

Obviously, as we move closer to the last two types of communication system, as we are entering a new age of communication (Venkatesh, Karababa and Ger 2001).

The concept of communication center is closely related to other centers but more specifically to home as information center.

Home as Information Center

Home as information center addresses the issue of how families acquire knowledge of their external environments. It also examines how families cope with the fast changing world where knowledge is constantly produced and modified. A number of household activities involve gaining information about their surrounding as well as distant communities.

Currently, the local newspapers acts as the main vehicle for a variety of information needs. The newspaper consists of

political news (local and national and international)
business news
cultural news
personal finance
entertainment
local non-political news (celebrities)
sports
medical news
science and knowledge
new products
life style

A second source of news information is the television. Just as the newspaper, it provides similar news but much less. However, if one looks at the entire TV different programs yield different types of information. There are programs relating to

Science
Business
Health
Community Issues

A third source is radio.

The new sources that are developing are based on the Internet related communication technologies. The question we ask is, how does the new source compare to the old source in people's perceptions in terms of following attributes:

Accuracy

Quality of information
Time needed for search
Ease or convenience
Reliability

The evaluation of the Internet on this factors is still uncertain.

However, the new electronic sources (e.g. the Internet) are interactive and two-way and therefore an edge over the previous sources such as the newspaper, TV, radio etc.

Home as Learning Center

The concept of home as learning center has not been fully understood or developed in the literature. There is a close relationship between home as learning center and home as information center and communication center (discussed above). Much learning takes place in the home with the help of information that the household has about its environment. Just imagine the areas where learning might be possible:

News (Politics)	Fashion	Interesting people
Events	Food	Music
Life Style	Sports	Movies
Culture/Art/Theater	Global/Regional	Health
Educational news	Developments	Finance
Everyday culture		

Similarly, learning also takes place through communication within the family networks. There are theories of learning at the individual level and similarly, there are theories of learning at the organizational level. We need to examine the family and its learning mode. It may involve any of the following.

Families accumulate experiences regarding customs, behaviors etc, which are appropriate to the families as functioning units. The learning can occur at various levels, parental learning, gender based learning, generational learning (parent to child and sometimes child to parent), sibling learning (child to child) and external learning (family and school, work place, mass media etc.)

The Everyday Learning:

This is the learning that is needed to run the household on a daily basis. The family needs to have an understanding of everyday issues and how to resolve them. Questions such as the following are quite common: Where do you shop? What to shop? Where is the doctor? What does the family do when there is a medial emergency? Or, other household emergencies (dish washer breaks down)? Where does the family bank? How does the household maintain its physical environment? Who will do the cleaning? In families with children there are countless chores and activities that occur on a daily basis which the families have to deal with on daily basis. There is an obvious connection between

learning how to deal with these questions and obtaining relevant information to do these things.

The Developmental Learning:
The developmental learning takes place when families have to invest in the future of the families, especially in their children, and in their future. That is, one can assume that the families are trying to improve their living conditions, physically, financially, spiritually, and in various other ways.

Such developmental strategies are required to take care of the future, gain financial security, and demonstrate the ability to deal with the world in times of emergencies and crises. Because these are long-term objectives, families need to plan, months and years ahead of time, anticipating events and being prepared for them. Let us take a typical example, a family wishes to own a home in the next couple of years. Currently, the family is living in a rental place. In order to purchase a home, the family needs some capital; some financial backing so that it can qualify for a loan. How does the family learn about it? What sources need to be consulted? How can they make informed judgments? How is this information shared in the home? How do children learn about matters that they will be responsible for when they become adults? This is what we mean by a developmental concept.

How do families acquire this information? How do they learn about the sources of such information?

Questions that we should ask families as part of learning?
What kinds of things do they wish to know on a daily basis?
What are their daily needs?
What are their needs over the week end for the family?
How do they get information on this?
What don't they know?

As informed citizens, families would want to know whom to vote for in the next elections or on a more long term basis, may wish to shape their children's interests in terms of their participation in politics, economics, culture, science and other aspects of civic life. The more the citizens know about these areas, the better equipped they are to deal with the world they live in. Second, knowing one's culture and history in some detail would enable them to understand or build their identity on some solid grounds. Family learning minimizes their vulnerability to external forces, can in fact make external conditions work for them.

As more complex technologies enter the home front, families need to have a good understanding of the everyday technologies, including the old (refrigerators, toasters, vacuum cleaners etc) and the new (pagers, computers, cell-phones, digital camera etc.). Many of these technologies are handled on a daily basis and the learning of the technologies occurs through osmosis and daily use. What do we mean by learning about

the technologies or have a working knowledge of the technology? One can learn about the whole range of issues concerning technologies without having a technical knowledge. Use-based knowledge is different from expertise in technical details. For example, one does not need not know how the engine of a car functions in order to drive it. Thius analogy falls apart if one were to construct situations when knowledge about how technology functions is s important as what its produces.

Home as Shopping Center

One of the growing areas of home based networking relates to on-line shopping. Although it is in its infancy, this is growing at a rapid rate. How does the Internet compare with other technologies in the home for shopping purposes. The technologies that have had some impact on home shopping are the automobile, telephone, and to a limited extent, the television. As families began to adopt the automobile as the main means of transportation, the automobile became an essential technology among a large number of households in the industrialized world. That is, among the other things one can do with an automobile is to use it as a transportation for shopping. But there has not been much discussion of automobile as a "shopping" technology. The reason may be that it is too obvious. The use of telephone for shopping is less extensive than one might imagine. As for the television, it is only recently that it has begun to develop as a shopping medium. Being a one-way communication technology and non-interactive, the television has never been a powerful shopping technology although it has had considerable influence on consumer behavior due to advertising.

Because television, unlike the automobile or telephone, is a major mass media technology, its central role in the development and transformation of the global consumer culture is widely acknowledged. However, as powerful as television's role has been in changing the consumer culture or adding a new dimension to marketing practice, its direct impact on shopping has not been that strong.

The initial impact of the computer on marketing practice, although quite substantial, did not suggest that we should rethink the paradigm itself. Initially, it was positioned as a representation of the information technology and its first incarnation was as an information storage device. Indeed computers were always likened to the human brain, yet they were considered one additional point in the technological spectrum. In the last few years, however, things began to change dramatically. What was considered the technology of information has now become a technology of communication--not communication in the ordinary sense but as a multi-way communication medium. Terms such as interactivity, connectivity have further advanced our notions of what the new technology can do. Computers have also created a new space, the cyberspace and new communities of participants, the virtual communities. In other words, it is the recent convergence of communication and information that have created possibilities unthinkable only a few years ago. Table 2 gives a brief comparison of all the four technologies, the telephone, the automobile, the television and the computer across some key dimensions.

Table 2. A Comparison of Four Technologies

	Symbolism -Personal	Symbolism-Social	Symbolism- Spatial
Telephone	Speech Communication	Time/Space substitution Social participation	Temporal Space
Automobile	Body Motion	Suburban life Life style, Freedom	Physical space
Television	Feelings, Emotion Pleasure	Instant Entertainment Temporal Entertainment Mass medium	Visual Space
Computers	Mind/Pleasure Information Alternative Knowledge	Reasoning Information Processing	Cyberspace

What are some of the technological issues concerning the Network Home?

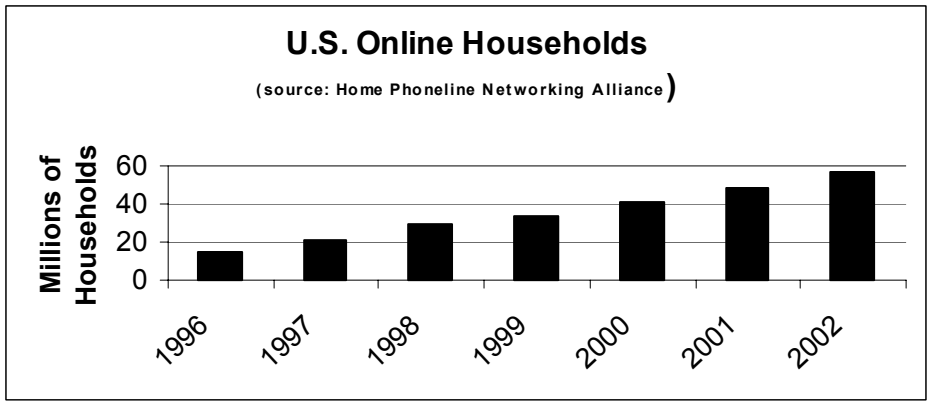
Appliance Convergence

Panasonic Japanese parent company Matsushita Electrical Industry Group is planning to introduce its Home Information Infrastructure (HII) in 2003. Via screens in every room and a wireless terminal, a consumer can use appliances and monitor activities throughout the house—in addition to accessing the Internet. Smart appliances such as the "Interactive Communication Refrigerator" can be accessed remotely. One can check the status of supplies and decide whether to stop on the way home for milk. HII can also monitor family members' health. Measurements such as blood pressure and weight can be collected and stored in a memory bank.[2]

Home networking

By 2002, it is estimated that there will be nearly 60 million U.S. households "online."[3]

[2] http://www.cnn.com/tech/ptech/9904/27/japan.brainyhomes.ap
[3] http://www.homepna.org/docs/wp1.htm



Consumers not only wish to access the Internet, but link multiple household PCs. According to Jupiter Communications by the year 2002, 15.3 million households will depend on their in-home networking connections to enable communications between multiple PCs and other household devices such as security systems, appliances and entertainment centers.[4]

It is clear that there is a trend towards household networking of entertainment devices, appliances, security systems and PCs. In addition to Internet access, this "Home Area Network" (HAN) will allow communication between devices and centralized control. It is not clear whether

Home RF envisions a networked home with data sharing amongst appliances. "The applications we see have nothing to do with Internet-sharing, like laptop or 'fridge pads' for mobile viewing or Web access. Take today's cordless phone and imagine getting short e-mails on an LCD or having it read back to you via text-to-speech engines. That's within our vision, all because everything is getting more digitized via TCP/IP, which will tie all these appliances together."[5]

The Cahners In-Stat Group forecasts that home networking revenues will be $1.4 billion by 2003.[6]

Its growth is dependent upon establishment of standards, pricing, user-friendliness, and availability.

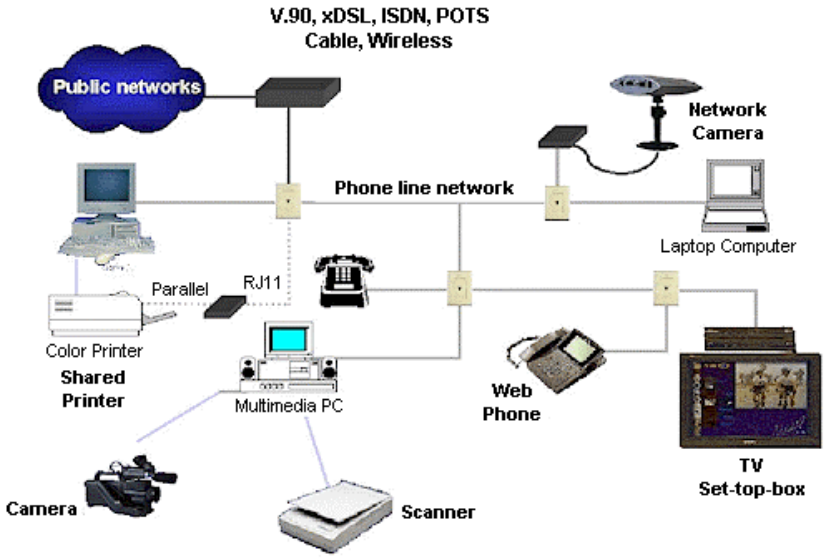
Industry standards evolution and conflicts

[4] http://www.homepna.org/docs/wp1.htm

[5] qtd. in "Wiring the Net To Your Fridge." Wideband, January 1999. 36-39.
[6] "Home Networking in 1999: Ready for Prime Time?" Retailvision, Spring 1999. 100

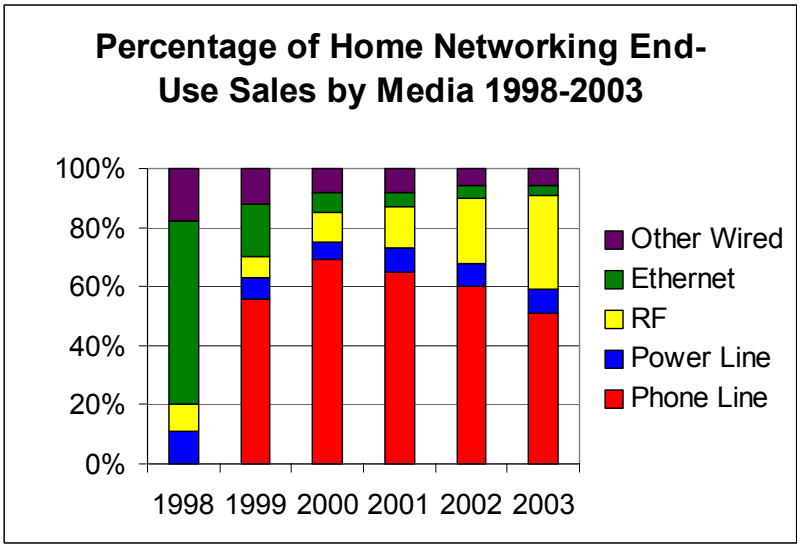
There are four home networking transmission technologies that are being developed: phone lines, power lines, coaxial cable, and wireless. In addition, the consumer electronics industry has proposed a standard to link entertainment devices, appliances and PCs.

- The Home Phone Networking Alliance (HPNA) is promoting its HPNA 1.0 standard which transmits at 1 Mbps over existing home copper phone lines. A typical network is illustrated below.[7]



The HPNA maintains that "home phoneline networking is complementary to other home networking media such as powerline networking and RF wireless. Phoneline home networks can act as a high-speed backbone for powerline networked devices, RF cordless devices, and devices clustered around USB or IEEE1394. Phoneline networking is unique in that it uses the same connection as the most prevalent Internet access method today, the voice band modem, and its broadband successor, Universal ADSL."
The HPNA has enlisted the support of OEMs such as Compaq. If the HPNA's momentum continues, Cahners believe that home phone lines will become the de facto standard. The chart below illustrates the relative projected market shares of home networking technologies.

[7] http://www.homepna.org/docs/wp1.htm



- The Home Frequency Working Group (Home RF) has developed its Shared Action Wireless Protocol (SWAP) 1.0 standard in which wireless devices can transmits at speeds up to 2 Mbps. The mobility of wireless devices as well as the of permanent home wiring would likely make this an attractive option for consumers. Affordability of devices will be the biggest issue with RF.

- There are several competing systems which seek to transmit over existing AC lines. X-10 has a long-standing system which began with low-speed automation. X-10 markets home automation, home entertainment and security products under the brand names X-10 Powerhouse and ActiveHome.[8]

- CEBus is promoting its Powerline Carrier Technology which utilizes "Spread Spectrum technology to overcome communication impediments found within the home's electrical powerline. Spread spectrum signaling works by spreading a transmitted signal over a range of frequencies, rather than using a single frequency. The CEBus Powerline Carrier spreads its signal over a range from 100Hz to 400Hz during each bit in the packet. However, instead of using frequency hopping or direct sequence spreading, CEBus Powerline Carrier sweeps through a range of frequencies as it is transmitted."[9] CEBus has partnered with several OEMs to create networking products, home security devices, entertainment electronics and smart appliance controls which operate on the CEBus standard.

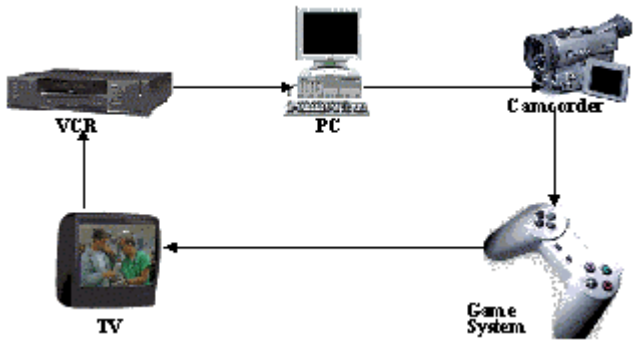
- Microsoft has licensed Intellon's OFDM technology which enables AC line networking at up to 100Mbps. Intellon's technology provides a platform for networking computers, peripherals and consumer products that are capable of delivering voice, data

[8] http://www.x-10.com/backgrounder.htm
[9] http://www.cebus.com/techovw.htm

and Internet access, as well as control and monitoring applications over existing standard electrical wiring. Intellon claims that this technology platform will "establish a new dimension for No New Wires(TM) low-cost networks."[10]

- Ethernet is the current preferred method for home networking; however, the proliferation of lower cost and easier to install technologies will likely render Ethernet a small player.

The consumer electronics industry ha proposed the IEEE 1394 data transmission standard. IEEE-1394 is a hardware and software standard for transporting data at 100 to 400 Mbps.[11] Entertainment devices can be linked and transmit AV signals and control data.



IEEE 1394 Network[12]

Multiple PC households lead the charge. The number of multiple PC households in 2001 will be 45 million, with 12% of these having some form of home network installed. **Single PC households make their mark.** Contrary to the popular belief, home networking growth will come not only from multiple PC households but single PC households as well. The number of single PC homes with some form of network will increase from under 1% in 1999 to 25% in 2003.[13] Currently, 98% of all U.S. households have televisions, 91% had VCRs, 60% have PCs.[14]

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[10] http://www.intellon.com/

[11] Richman, Mark. "Standards Merge Consumer, PC Products." Electronic Engineering Times. Oct 26, 1998. 81

[12] http://www.cebus.org/ihn.htm

[13] http://www.instat.com/pr/1999/homentwk.htm

[14] "U.S. Consumer Electronics Sales & Forecasts." CEMA. September 1998.

How can the Networked Home relate to the concept of the Automated Home and how are they related to Internal and External networks?

Home automation currently focuses on the automation of certain services like security, lighting, home theater. The direction of the new technologies may include smart refrigerator, washing machines, and other technologies enabling us to spend more "free time". We also need to ask in what context do we have this free time. What does the community surrounding this automated home look like, and does it inhibit, complement, support or "synergize" with the technologically enabled home. More specifically is leveraging the technology in the home adding value to the surrounding community?

The models presented here will attempt to describe the characteristics of the surrounding community and to reveal possible relationships of the future home and the community. Major focal areas of the models will be the home and community as education, entertainment, information, and social centers. The models will look at current developments that are attempting to shape the behaviors of the future communities.

What are the questions that concern us in the future?

Home Automation & the Residential Community

Some home developers are addressing the new requirements from increased use of technology. They claim that home communities can be linked to schools and to each other. This new model is linking the physical community with the virtual community created by the technology.

There is plenty of literature available describing the ways we can automate our home. This paper focuses on the possibilities of integrating these systems into the larger community. Some developers in the US have already attempted to do this, such as Sienna Communities (sienna.com) and in Southern California at Ladera Homes. In addition, developments in online shopping, banking and education continue to penetrate their products and services using the Internet as a road into the home.

The foundation for transporting this information on a community level will be the cabling to the homes. While AT&T and MediaOne discuss their merger, we are left trying to anticipate the future of cable, DSL, and telephone lines. Will the autohome become obsolete when new efficiencies can be reached through homeowners associations? Will developers build the automation into the new housing Communities? We will look at patterns that might show allow us to predict the direction of growth and opportunity. Distribution may be the one of the drivers in selecting the products and services that become integrated. The power centers created at the mall have already addressed this.

Interconnectivity

The wiring of the community may be one of the greatest inhibitor or liberator the project. While some networks are in place (LAN RAN WAN TAN), we have yet to see an entire community connected to the "External Community" computers, phone/ fax, cable and

satellite TV. Some drivers for community reorganization and interconnectivity may include the centralized Control of Water (Sprinkler Systems, Sewage), electricity (Power Management), and gas.

Connections to the business services in the geographically local community (1-5 mile radius) could include Travel Agents, Banking (Home Banking) and Weather Stations.

Home Automation/Control -
Climate Control Lighting Heating and Air Conditioning are all prime candidates for automation

Security
Security is one of the major areas of home automation. Many systems attempt to wire tee house for alarms and video equipment. For some this may be one of the greatest benefits, but we must question if the benefit outweighs the cost in certain communities.

For exclusive home, the security systems is part of the value of the hone, and in these communities where privacy is valued, the systems make sense. Cost is also secondary to functionality, and we could estimate the valuables in the home to total more than $500,000. The security companies may not sell the protection of valuables as the major benefit of these systems however. Their value comes from the added protection they give family members, but many times these alarms are triggered in error.

For middle income homes, the cost benefit becomes less clear. These communities also may be gated, therefore already deterring man of the unwanted visitors. We may also want to look at the patterns in crime. For this community, a central security system may be used.

Lower income families who currently use bars on the windows may by not have the financial ability nor the technical education to use the home automation electronics effectively.

Entertainment
Home Theater continues to drive the home automation market. Currently, DVD and other newer technologies allow larger screens and superior sound. Soon we may be able to download music online. We may be able to get video on demand. Like the other services, this may have larger implications in the way we shop, and in distribution channels.

Shopping
The development of entertainment products may be one of the first drivers of change in the availability and distribution of many items, particularly entertainment. We can also expect to find changes in Grocery, Clothing, Banking, Travel, and Personal/Home goods.

Education

New Home Communities such as Sienna are using education as one of the selling points of the new communities. They claim to link the school to the homes via the Intranet, and This area may already have an answer I the Power Centers Created by Costco, Home Deport Toys R US, and Wal-Marts.

Transportation

For a particular integrated community, we can see possibilities for commuting patterns , and for designing new transportation flows. One question will be whether technology will encourage community activities or reduce the social interdependency of community members.

Community Centers as centers for information for the Home.

The Community Centers possess the greatest potential benefit from the technology. This Center not only can be the hub for Community information, but also the *physical location* to provide information. If it is built as the information hub, and through design integrated shopping patterns and local services and businesses, these centers could be the new model in community design, not only for new communities, but the older communities as well. The section will also address how the importance of the roles of the home (shelter, place of information, family center) is influenced by the context o of the community.

General Characteristics of the Home of the Future

Technology & Behavior (Areas of Demand)

To date the home of the future has been the talk of home automation, which is primarily automating tasks inside the home. Some of these features are;

AREAS	EXAMPLES
1) Home Control System	Wiring
2) Security	Video Equipment, Multi Room Video
3) Communications Systems	Telephone, Intercoms
4) Lighting Control	
5) Whole House Music Systems	Multi Room Audio
6) Home Theater	Web TV, DVD, Video.
7) Climate Control	Integrated Systems
8) Home Maintenance	Vacuum Systems, Heating, Air Duct Monitoring, Air Conditioning, Motorized Draperies, Shades , Pool Cleaning, Sprinkler Systems
DESIGN	Touch Panel, Seats for Theater and Controls
POWER SYSTEMS	Power Surge protection
OTHER Applications	HOTELS, FACILITIES MANAGEMENT

How will families adopt to the Networked Home? Or, what is the future of the Networked Home?

It is not very clear how families adopt to the Networked Home. We have only glimpses of these and the trends . (see the appendix for a scenario that appeared in the Fortune magazine sometime ago). However there are some indicators that are both positive and negative.

A recent national study conducted in the United States (Venkatesh 2000) shows that households with computers and Internet connection are more likely to adopt new technologies than households without computers or Internet connection (see Table 3).

Table 3
Ownership of New Technologies Among US Households

	Computer Households		Non-computer Households	
	Freq.	%	Freq.	%
Electronic organizer or Handheld Computer	203	22%	26	9%
Fax or telex machine (separate from PC)	186	20%	11	4%
Pager	329	36%	51	17%
Voice Mail/Voice Message Service/Answering Machine	776	85%	183	61%
Video game console (Nintendo, Sony Playstation, etc.)	407	45%	80	30%
DVD, DIVX, Laser disk player	118	13%	12	4%
Stereo System/CD Player	871	96%	224	74%
Satellite TV	133	15%	41	14%
Cable TV	666	73%	197	66%
Cellular Phone or PCS	580	64%	99	32%

Video Camera	422	46%	79	26%
VCR	885	97%	256	85%
Digital Camera	123	14%	14	5%

In addition, younger households are more likely to be networked than older households. Similarly, children are more prone to adopt networking technologies than adults. There are also some studies that indicate that mobile telephony is diffusing faster in Northern Europe than is the rest of the world.

What this all suggests is that in the near term, we will see greater adoption of specific technologies than a wholesale adoption of new technologies. Secondly, technologies will be adopted in a progressive fashion depending on consumer experiences with similar technologies. For example, the rapid increase in the use of the Internet suggests that the technologies of communication with Internet capabilities are more likely to be adopted.

Networked or Automated Home?
Closely related to the Networked Home is the Automated Home. At the margin the Networked Home becomes the Automated Home because the underlying technological characteristics are very similar. Many industry initiatives are being proposed for the automated home. Let us examine what is being proposed as the Automated Home which is sometimes called the Home of the Future. Here are some scenarios that are being currently discussed:

-The home of the future will be smarter, cleaner, and more serene thanks to new appliances.
-The new appliances talk with each other, recognize the specific needs of the household as well as household members and will respond accordingly.
-A computer in the kitchen will be the command center for the entire home.
-The industry is rolling out appliances, large and small, for nearly every room in the house, assisted by high-tech array of computer chips, computer design techniques, super-efficiency filters, natural spectrum lights, and new robotics.

How is the automated home linked to the networked home. Here is one example:
A home can have its trash compactor and recycling bins connected to the Internet monitoring of family consumption of food and beverages to replenish the food shelves when it detects the supplies are running low. An example of this is the display panel on the refrigerator.

Similar scenarios are being presented throughout the industry and in popular press.

How is the home being viewed by the industry?

Internally, the industry is trying to develop four lifestyle themes: the kitchen, the master bedroom, the entertainment room which may also be the family living room and the home office. Each of these locations is being targeted for new technologies. The purpose of the technologies is to integrate these lifestyles in such a way that the family is able to balance its activities.

In terms of the target segments, the industry is looking for young families who are buying their first house, and to balance its activities.

In terms of the target segments, the industry is looking for young families who are buying their first house, and young people who are growing up with computers. Since there is a high cost factor involved in these technologies, the industry is also targeting the new technologies to families with higher incomes who are looking to upgrade their lifestyles.

What are some realistic scenarios?

Since the cost of these technologies can easily add up, the adoption will be slower than being hoped for. Some smart devices such as smart cell phones, hand held organizers, digital music and video that can be downloaded from the Web are already available. These devices may be the first step toward creating a more full-fledged networked home.

The community that is most apprehensive about the technologies is the architects. The reason is quite simple. As more technologies are introduced into the home, and as more wires and cables have to be built in to the home the architects have the problem of trading off the aesthetics of the home with hard wiring of it. The final shape of the home depends on how the architects design it, however, the introduction of networked technologies makes their work more complex. They have to assume too much responsibility for a house that may be too technological for domestic comfort.

The advancing technologies can easily scare ordinary citizens who may not be ready for such complex technologies. A total integration of the home sounds quite appealing technologically, but it is not clear that families are ready for it. One has to ask the question, do people really want to talk to their microwave ovens? What will they have to say?

Appendix I

A Networked/Automated Home
(FORTUNE Magazine 3-August-1998)

This is a real house in Northern California and here is a description.

A network system consists of a central controller, usually a special-purpose computer that interprets and orchestrates the various devices in the home, computer phones, TVs, stereos, lighting, security, and temperature control. The telephones and Cable TV lines can serve the purpose but only in a limited if not awkward fashion. A more efficient system is so-called star-shaped network with co-axial cable phone lines, category five wire (the kind used for office data networks) running from a central hub to every room. People who don't want to tear down the walls can build a wireless network.
Almost every room has a universal outlet with jacks for electricity, phones, high-speed networking, and cable or satellite TV.

Has five PCs, and a Sun work station scattered throughout the house – in two offices, the kitchen, the music room, the music room, the garage,-- and all are connected.

There is a home computer network which links all computers in the home, can connect all lights, TVs, stereos, security systems, air conditioning, heating, sprinklers, all from a single point.

Networking costs run anywhere from a low of $25.000 up to 250.000.

Social Life in the Household

The real life in the home starts as soon as the autonomous devices are connected.

Mother in the kitchen goes to a kitchen telephone, announces dinner is ready, her face and voice appear on the TV which the children are watching.

Not only is there a transformation of the physical and technological shape of the home but there is transformation of life.

Computers and networks which are characteristics of the modern office and work sites are entering the domestic space.

The technology is entering the spaces where people eat, sleep, play, interact, and work.

In the networked household everybody knows what the schedule of the other person is.

The networked computer helps each member to enter the data on themselves and set up communication patterns.

You can organize get-togethers, feed data about the tastes and preferences of the members, guests, and build personal data bases.

PC in the garage can control automatic sprinklers, can surf the net for gardening, car repair, other electronic needs.

PC in the living room can synthesize music to taste.

While on the road, the household members can check security.

Cameras can be installed along with sensors, the family can log in from a remote location, check household pets, talk to each other.

Home Automation

Can make a house act in harmony with the occupants as they go through their daily routines.

Make appliances intelligent by connecting them so a single action can trigger one or more automated responses.

Arming the security system automatically turns down the thermostat, close the electric blinds, shut power off to all the TVs, stereos and kitchen appliances.

Crawling out of a bed in the morning and stepping on a pressure mat could start the bath water running, boot up a computer, and turn on the TV to a favorite station.

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