ORIGINAL ARTICLE

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The networked home: an analysis of current developments and future trends

Abstract The paper examines the concept of the networked home as both a social institution and a technological construction. While the concept of networks is not new to family studies, the new technologies of information and communication are requiring us to look at the home as an intersection point of sociology and technology. Fundamental to our analysis is the concept of home as living space that unfolds into a collection of multiple centers – home as activity center, entertainment center, work center, information center, communication center, learning center and shopping center. In our analysis, the living space is subdivided structurally into social, physical and technological spaces in which the centers are embedded as organic elements. The integration of the centers with the living space model is fundamental to understanding the home as a networked home.

Keywords Home automation · Home networking · Living space · Virtual communities

1 Introduction

The concept of home networking has grown in prominence lately (Magid 2000; Ruhling 2000; Business Week 2001; Miyake 2002). With the emergence of mobile telephony and other personal communication technologies targeted for the home use, the concept of home networking is receiving much attention because of

possible dramatic shifts from current levels of practice to new levels. 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/Internet-based technologies that are already part of the home technology scene (Harper 2000)[1]. In this paper we address various issues concerning the networked home. Table 1 gives a picture of the concepts with which we are working that will be elaborated in the remainder of this paper. In terms of home networking, 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?
- 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 adapt to the networked home? Or, what is its future?

2 Background

The evolution of technology in the home is presented in Fig. 1. We have identified four stages of evolution in the course of history (Bergman 2000; Neibauer 1999): the

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[1]The special issue of *Personnel Technologies* edited by Harper (2000) contains several noteworthy articles on domestic computing. The topics discussed include "patterns of home life and designing for domestic environments" (Hughes et al. 2000), "future of the PC at home" (Brown 2000), "computer mediated communication" (Liechti and Ichikawa 2000), "economics of technology consumption" (Hammill 2000), and "interfaces for music appliances" (Rose 2000).

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)	Machine connectivity	Efficiency
	Human interactivity	Convenience
	Programmability	Ease of use
		Remote access
		Security
3. Domesticated home	Meal preparation	Family interactions
	Family health	Family values/norms
	Family rituals	
	Child rearing	
	Everyday activities	
4. Structural configuration of the home	Home as living space	Social space
		Technological space
		Physical space
5. Organic view of the home	Home as networked center	Activity center
		Entertainment center
		Work center
		Interaction center
		Information center
		Communication center
		Shopping/financial center
		Learning center

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 in the early part of the twentieth century with the introduction of electricity and electrically powered appliances in to the home (Cowan 1976). In the next stage, simple programmable and automated machines were introduced. In the third stage, which is the current stage, companies are targeting intelligent and programmable machines (also known as information appliances) for home use. This is also the stage during which home communication systems are developing at a very rapid pace. In the next stage, perhaps not too far into the future, we will be seeing new technologies based on robotics. Clearly, the idea of the "home" is transforming quite dramatically – technologically speaking.

Home Electrification	Home Communication	Home Automation/ Intelligentification	Human Substitution
	(Smart Home 1)	(Smart Home 2)	(Smart Home 3)
World Of Energy	World of Simple Programmable Machines	World of Thinking Machines	World of Artificial Intelligence and Artificial Life
Home Appliances Radio	Telephone TV VCR FAX Machines Security	Computers Smart Appliances Remote Sensors	Bio-Tech Home Robotics

Fig. 1 Home technology evolution

Table 2 captures the meanings of specific technologies targeted for family consumption in the twentieth century.

How is the home being transferred socially? This is captured in Fig. 2. In many urban environments, networks are moving away from physical access to friends and neighborhoods to virtual contexts. Interactions are becoming multi-way instead of one-way. The home is becoming the center of gravity because of its evolution from a condition of social shelterdness to one of social connectivity.

3 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. Networks can be described in terms of their spaces or configurations – terms that will be explained later.

4 Why has the concept gained in importance? What is its significance?
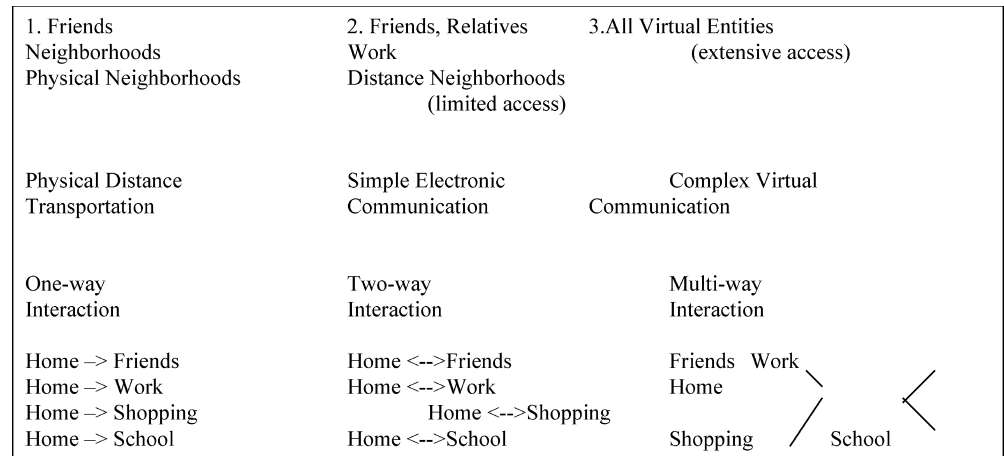
There are two major initiatives that we see.

First, the *technology initiative* suggests that in today's fast-paced, electronic world technologies are available

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 Lifestyle, freedom	Physical space Control of personal space
Television		Feelings, emotion Pleasure	Instant entertainment Temporal entertainment Mass medium	Visual space
Computers		Mind/pleasure Information	Reasoning Information processing Alternative knowledge	Cyber space

Fig. 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	Friends Work Home Shopping School

that connect people to people, people to machines, and machines to machines. For a long time the average citizen had only the house telephone as the primary technology of communication network (Wellman and Tindall 1993). Even today, for the most part, this has not changed. Recent developments in communication technologies have been quite dramatic – especially in regard to wireless telephony, satellite communication, mobile telephony, and the Internet, all resulting in faster and more efficient communications globally. The so-called communication revolution is touching ordinary masses, and highly complex technologies are entering everyday life.

Second, the *community initiative* raises the question of how the citizens and families can access these technologies. In the final analysis, however advanced the technology might be and whatever be its desirable qualities, its success is measured in terms of community acceptance.

The two initiatives, the technology initiative and the community initiative, ultimately deal with the same question. What are the current technological needs of citizens, what would be their future preferences, and what would motivate them to acquire new technologies as they are introduced into the social order? There are also several other issues concerning standards, customer service, and government regulation, which are outside the purview of our discussion here, but which can become quite relevant. Our focus here is how to conceptualize the home as a user of network-related tech-

nologies and to ascertain what issues emerge in this context. Along the same lines, we ask how these new technologies can enhance the value of home networks and what trends are foreseeable in this regard?

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

Network approaches to the study of household or family behavior have a long tradition. The concepts and issues relating to social or community networks (Scott 1991, Wellman and Leighton 1979) or, more specifically, to family networks have been well researched by scholars over the last fifty years (Bott 1957; Milardo 1988). One can say that Elizabeth Bott's (1957) work remains the classic piece in this area. Many other scholars have followed her with a fair amount of sociologically oriented themes. When we speak of networks in the family context, we are referring primarily to social ties that emerge from these networks. To quote Szinovacz:

The themes of social affiliation and integration have been central to sociology and social psychology since their beginnings. We have learned that the specific characteristics of their social ties have important consequences for the individual and larger societal

structures. Among these ties, interactions with and supports from relatives and friends have been and continue to be of primary importance. Whatever impact industrialization and urbanization may have had on nuclear families, they have not erased the social support functions ... (Szinovacz 1988, p. 7)

The more recent developments in the area of family networks point to some new thinking in the structural analysis of social systems. These include patterned interconnections of family members with other families and social groups. The four types of networks widely discussed in the family sociology literature are kin networks, friendship networks, work/professional networks and community networks (Grieco 1987; Milardo and Allan 1997; Roschelle 1997). Very little writing appears on the role of technology in fostering the family networks, although Wellman (1999) and associates have initiated a series of research studies on technology in the context of organizational and personal networks. The question that arises in the present context is whether technology is an enabling agent in fostering family networks or an active promoter of networking practices.

For a major part of the twentieth century the radio, TV (both one-way) and the telephone (two-way) were the main media/communication technologies that found their way into the homes of ordinary citizens. They heralded, in a sense, the first communication revolution. In the last few years, we have seen a veritable avalanche of technologies entering the home and this has created new forms of networking possibilities. One of the key technologies that we have been concerned with within the last decade or so is the home computer (Venkatesh 1996). More recently, the computer's networking value has increased dramatically, primarily due to the Internet. Other factors contributing to the networking possibilities in the home are the rapid convergence of communication and information technologies. As mentioned earlier, Figs 1 and 2 present a graphical description of home network evolution both from a technological perspective and social perspective.

The rise of the Internet, with its attendant social consequences, suggests that traditional network approaches can be viewed in a new (technological) light. However, recent developments in the technological front have caused us to identify the relevant category of inquiry as "networked home" (ref. the title of this paper) rather than "networked family." This may not be just a semantic issue, because it brings to the forefront the fusion of technological networks and social networks. One can argue, therefore, that the emphasis on networked home is inclusive of and an extension to the notion of networked family.

To add greater refinement to the concept of networked home, we integrate the notion of "family" as a sociological group with "home" as a combination of physical and social spaces. Simply put, the distinction between "family" and "home" is that while we regard family as a social institution we view home as the living space.

In sum, while the idea of network itself is not new, it is the technological advances that have changed the character of the family networks and have introduced greater complexity and variety into home life (Kiesler 1997). Further, while networks can exist in the absence of technology, modern networks are highly technologically based.

6 What conceptual models exist to view the home as a networked home?

Three 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." This is demonstrated through the structural composition of the home based on a typology of *spaces*. Second, the networked home should capture the elements of networking in a transparent fashion. Third, the home is viewed simply not as a structure, but as a site of human and social processes central to the functioning of the family. This implies that we identify the organic elements of the home based on the typology of *centers* of home life. We shall discuss these three perspectives in that order[2]. 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 in the paper. Rather, the focus is on the links between the networked home and the centers that are the organic elements of the home.

6.1 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. Also see Hughes et al. 2000, who allude to similar ideas). The living space (Fig. 3) includes 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 a vacuum. It is related to the organic aspects of the home.

The home, as a manifestation of living space, caters to the emotional, social, educational, and recreational

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[2]Our approaches roughly correspond to Giddens' (1979, 1984) notion of structure and structuration. However, unlike Giddens, we use a neo-functionalist approach to the study of micro social structures.
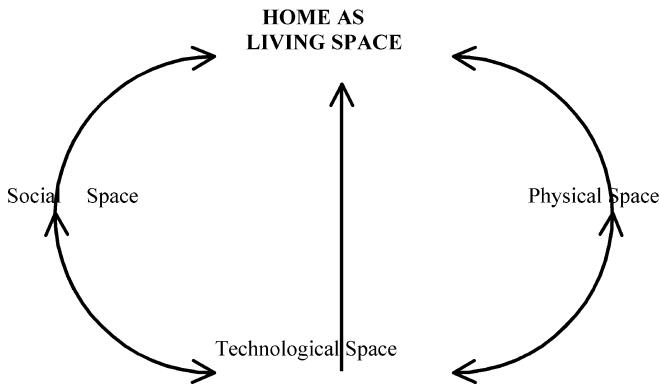
**HOME AS
LIVING SPACE**

Social Space

Physical Space

Technological Space

Fig. 3 Home as living space

needs of the members of the family.. In designing the home as living space, these various needs must be taken into account. As a living space, the home has evolved dynamically over time; that is, historically its character has changed in fundamental ways. As living space, the home can also be differentiated transculturally.

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 and the meeting point of these three define how families carry on their everyday life. We shall now discuss each of these spaces and how they interact with each other.

6.2 The physical space

Relative to other spatial concepts (technological and social) physical space is likely to change less frequently during the life course of a family. In one sense, the space is a ''given'' in that it is not easily alterable. For our purposes, we define the physical space as the total space configured in measured units, the organization of the space into sub-categories based on the functionality assigned to each sub-space (kitchen for cooking, bedroom for sleeping, bathroom for personal bodily care, living-room for family time etc.), and the size of each sub-category and its orientation to another sub-category (e.g., the bathroom should be next to the bedroom). The physical space contains adjacent exterior areas (deck, patio, the garden, the garage, the driveway etc., as applicable).

In designing the physical space, consideration is given to how families live, and what activities they perform in terms of their family life. For example, in designing the kitchen, the physical space must be organized in such a way that cooking/meal preparation is conducted efficiently. Similarly, the kitchen should be organized to permit installation of the refrigerator, stove, and other kichen appliances and technologies. In these two examples, one visualizes the physical space and its essential link to the social and the technological spaces through the concept of living.

6.3 The 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 also in reference to the social space. 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 living in the home, and the marginal contribution of additional technology to the overall quality of home life. Thus, a modern home may not only have standard kitchen appliances but more than one TV set, more than one telephone, more than one computer and so on. Its density is measured in terms of the cumulative presence of the technology within the physical space, relative to the number of family members, as well as to the the relative levels of use of the technology for home/family purposes.

Technological space has gained particular importance recently because of the emerging notion of the ''smart home.'' The smart home idea has been around for at least a decade and we have known about its potential as early as the mid-1980s, when prototypes were built in the USA, UK and Scandinavia. However, its implementation has not been very successful and has been a little slow. Embedded in the concept of smart home are smart appliances which manifest basic qualities of programmable machine intelligence.

6.4 The social space

The social space is a significant component of the living space because it defines the living space in a fundamental way. 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 the three spaces, for it involves variable elements and 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 spaces, but 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 HCI scientist, used the three-space model to investigate the adoption of WebTV and the level of its acceptance into a small sample of households. In his preliminary research, the author found interesting family dynamics within the living space –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.

From the point of view of design, the living space can be viewed as embedding technology-based product environments. In designing products for the home, the spatial configuration may be taken into account. It is important, however, to remember that the product environments (as elements of living space) are not the same for all home-based technologies. For example, 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 in terms of social/technological/physical space that defines its position within the home.

6.5 Time

While we conceptualize the home in terms of the three spaces, we must not lose sight of time as another important element of home life. That is, how much time each family member spends within it also constitutes "living space." One way to handle time 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 introduce time as a separate dimension by creating a new element, called "temporality."

6.6 The living space and the networked home

As shown in Fig. 4, the home network consists of an internal household network, which emphasizes network relationships with family, friends and social circles, and an external network, which connects the home to outside agencies such as schools, shopping environments, work/office, and other civic/community establishments. Collectively, we call these connections social networks. In general, networks can be described in terms of their social, physical, and technological configurations.

The challenge here is to map the technological networks and the social networks on to each other. Two illustrations might elucidate this point.

6.6.1 Illustration 1

A single, working mother wants to leave a message for her teenage daughter (let's call her Neeta) who will be home before the mother arrives. She wants to give Neeta instructions about some minor household chores that need

to be completed within the next few hours before she gets home. One of the chores is to call the home repairman for an appointment the following week. The next is to order some food over the Internet since no dinner has been prepared. The other is a reminder to Neeta about her class project that is due in two days, for which she needs to do library search. Neeta is expected to send her mother back a message to confirm that the chores have been attended to, and, in particular, to let her know if there are any problems with the repairman appointment. The mother uses email to send a message. She calls Neeta over the phone to let her know that she has left detailed instructions on the computer. When she is not able to reach Neeta, who hasn't arrived yet, the mother calls Neeta's cell phone and leaves the same message.

Neeta comes home and turns on the TV, then goes to the computer to check her email messages. During all this she has been on her cell phone talking to her friend whom she left only a few minutes ago. She excuses herself from her friend as she notices some urgency in her mother's note. She carries out the instructions her mother has left her, or at least attempts to do so.

Let us examine the technologies involved in this simple mother-to-daughter transaction. There was the computer (email) for leaving messages. A land telephone was used without success, but an answering machine was used to leave a message. Next, a cell phone was used to leave another message; also a TV that was turned on.

Another way to look at the series of events is to capture it in the context of home as living space. The social space consists of two actors, mother and daughter, plus a set of messages and a list of activities that needed to be performed. The living space also includes the physical space, which is the interior setting of the home. As for the technological space, one can see the configuration in terms of a variety of technologies: the computer, the land telephone, the cell phone, the television and the answering machine.

The flow graph in Fig. 4 illustrates how the social networks are mapped on to technological networks.

6.6.2 Illustration 2

For illustration purposes, we will now try to focus on the computer as a networking tool. In this regard, we refer to a recent study of ours (Venkatesh et al., unpublished monograph, University of California, Irvine, 2002).
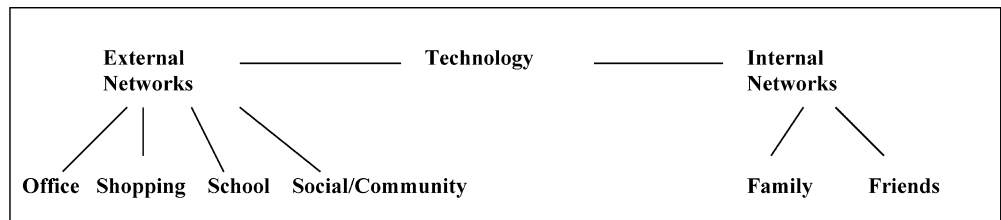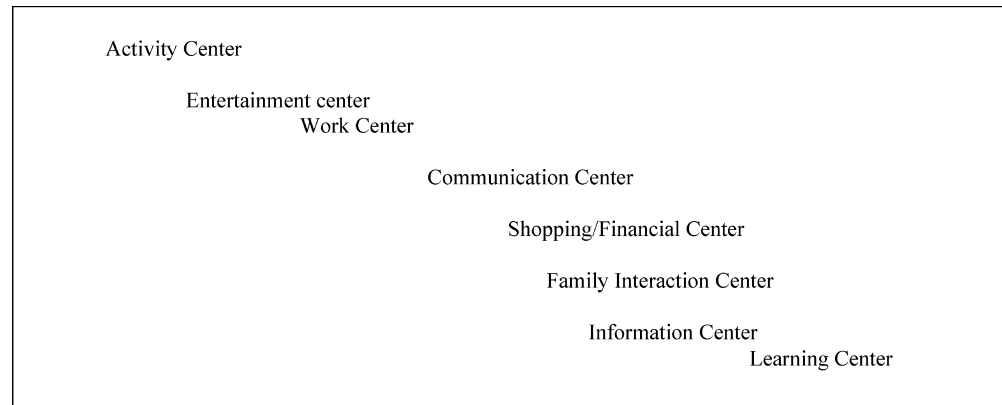
Fig. 4 Home networks (social)

Fig. 5 The networked home and the concept of centers

Activity Center

Entertainment center
Work Center

Communication Center

Shopping/Financial Center

Family Interaction Center

Information Center
Learning Center

Currently, the uses of computers by households are very extensive compared to what they were in the early 1990s. These uses can be categorized under two different sets. The first set covers actual household applications. In descending order the applications under are: email correspondence (personal/family related rather than work related); games/recreation; job-related use; educational use; home management; and shopping. We call this set of categories content based. The second set looks at the uses in a different, more conceptual way: communication, information, learning, and entertainment. These two sets of categories open up networking opportunities that are extensive both in scale and variety. In current parlance, home networking is limited to the home PC, the set-up box and the phone. One can imagine the immense technological possibilities that have transformational capabilities. The two category sets can be combined processually or organically to yield a conceptualization of the household as a collection of centers. We elaborate the concept of centers in the following discussion.

6.7 Organic elements of the home

The living space can be viewed organically in terms of what we call centers (see Fig. 5). The concept of centers is a modification from a previous work by one of the authors (Venkatesh 1996) in which the term used was household "sub-environments." We have identified eight potential centers of home: *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 household activities where labor or time could be saved. With the introduction of television in the late 1950s and early

1960s, the home became an *entertainment center*. In the 1980s, 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 1990s, new media and information technologies and the Internet, in particular, began to transform the home even more dramatically. The home is now viewed as a *shopping center* as in home shopping, a *communication center*, *an information center* and a *learning center*. These new developments have contributed significantly to reconfiguring the home in terms of networks.

7 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, such as security, lighting, and home theater. The direction of the new technologies may include smart refrigerator, smart washing machines, and other smart technologies enabling us to spend more "free time." We also need to ask in what context we have this free time. What does the community surrounding this automated home look like? 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 concepts 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 help us examine current developments that potentially will shape the behaviors of the future communities.

What are the questions that concern us in the future?

7.1 Home automation and the residential community

Some home developers or builders are addressing the new requirements from increased use of technologies.

They claim to link home communities to each other and to schools. This new model links the physical community with the virtual community created by new network technologies.

Plenty of web-based (marketing) literature is available describing the extensive ways we can automate our homes. Some developers in the USA have already attempted to do this, such as Sienna Communities (sienna.com) and Ladera Homes in Southern California. In addition, the products and services available through online shopping, banking and education continue to penetrate into homes via the Internet.

The infrastructure for transporting this information on a community level will be the cabling to the homes. While companies from different industries 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 allow us to predict the direction of growth and opportunity.

7.2 Interconnectivity

The wiring of the community may be one of the greatest inhibitors or liberators of 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 miles radius) could include travel agents, banking (home banking), and weather stations.

7.3 Home automation/control

Climate control, lighting, heating, and air conditioning are all prime candidates for automation.

7.4 Security

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

For an exclusive home, the security system is part of the value of the home, and in those communities where privacy is valued the systems make sense. Cost is also secondary to functionality. 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. 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 not have the financial ability or the technical education to use the home automation electronics effectively.

7.5 Entertainment

Home theater continues to drive the home automation market. Currently, DVD and other newer technologies allow larger screens and superior sound. As with other services, this may have larger implications in the way we shop, and for distribution channels.

7.6 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 shopping for grocery and other household products, banking, travel planning, and the like.

7.7 Education

New home communities such as Sienna are using education benefits as one of the selling points.

7.8 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.

7.9 Community centers as centers for information for the home

The community centers possess the greatest potential benefit from the technology. Such centers 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

Table 3 Ownership of new technologies among US households

	Computer households		Non-computer households	
	n = 906		n = 910	
	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%
Voicemail/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%

design, not only for new communities, but the older communities as well.

8 How will families adopt the concept of the networked home? Or, what is the future of the networked home? Some concluding thoughts

It is not very clear how families will adapt to the concept of technologically oriented networked home. We have only glimpses of their attitudes and behaviors. From what few indications we have, however, their reactions appear to be mixed.

A recent national study conducted in the USA (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).

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

What this all suggests is that, in the near term, we will see greater adoption of specific technologies rather than a wholesale adoption of new technologies. Second, 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 becoming ubiquitous.

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