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A changing sense of place: are integrated IT systems reshaping the home?

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A changing sense of place: are integrated IT systems reshaping the home?[1]

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James Barlow[2] and David Gann[3]

> Mitch was bored with being Ray Richardson's technical coordinator. He wanted to go back to being an architect, pure and simple. He wanted to design a house, or a school, or maybe a library. Nothing showy, nothing complicated, just attractive buildings that people would like looking at as much as being inside them. One thing was for sure. He had had quite enough of intelligent buildings. There was just too much to organize. (Kerr 1996: 43).

Introduction

Thirty years ago Nicholas Johnson argued that the home will ultimately become a:

> home communication center where a person works, learns, and is entertained, and contributes to society by way of communications techniques we have not yet imagined - incidentally solving commuter traffic jams and much of their air pollution problems in the process. (Johnson 1967, qtd. in Graham and Marvin 1996: 92)

Numerous writers and film makers have speculated about future homes, sometimes in threatening, sometimes in comical terms (Haddon 1996). In many of these visions the home is seen as a physical access node for 'electronic spaces' within advanced communications networks. Typical is Alvin Toffler's notion of the 'electronic cottage' as a locus for employment, production, leisure and consumption (Toffler 1981).[4] Common to many perspectives is a redefinition of the home to allow the household to reassume roles - such

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[4] For example, the 'computer home' (Mason and Jennings 1983), the 'electronic house' (Mason 1983), the 'smart home' (Moran 1993).

as work, education, medical care and entertainment - which have increasingly been externalised. Driving this is a desire by individuals to retreat from the environmental, social and political problems of late twentieth century industrial cities, with - according to Toffler - fundamental economic implications:

> ... if individuals came to own their own electronic terminals and equipment, purchased perhaps on credit, they would become, ... independent entrepreneurs rather than classical employees meaning ... increased ownership of the means of production by the worker. We might also see groups of home-workers organize themselves into small companies to contract their services or ... unite in cooperatives that jointly own the machines. All sorts of new relationships and organizational forms become possible. (Toffler 1981: 223)

The evolution towards the multi-functional home is also, some suggest, a result of changes in the spatial organisation of advanced capitalist society. As Lorente (1996) puts it, 'global houses' are needed if we are to have 'global villages'. He feels that fully inter-connected housing can act as an interface between Castells' (1989) 'flow space' - the increasingly important network of information flows - and physical space, where the experience and daily life of most people takes place. In this way the home can become part of a world of dialogue between people, between people and machines and between machines themselves. The home will not only be a passive receiver, but also an active producer of information and energy, the latter through the generation of solar electricity.

Perspectives which are overly technologically determinist or utopian have been criticised because they reduce what are complex interactions to crude and homogenous models of technologies and their urban impacts (Graham and Marvin 1996; Robins and Hepworth 1988). Furthermore, both tend to ignore the social and political processes through which technologies are actually developed and applied, especially the assumption that local social and political actors have little or no scope to shape developments.

Despite the extensive literature and the hype of organisations with a vested interest in developing products and services, there has been only limited progress towards the introduction of 'smart home' technologies. To some extent the view expressed in 1989 that 'a combination of home computers, consumer electrical goods, videotex services, and home security systems, even in a "smart house", wired with heating and lighting sensors ... hardly add up to a revolution in ways of living' (Forester 1989: 224) holds true today. Nevertheless, change *is* occurring as new communications and information technologies become 'domesticated' (Silverstone 1994).

Our objective in this paper is to provide a status report on the emerging smart homes technologies in Europe and raise some wider social and economic questions about the ways in which they might be introduced. In our view, the late twentieth century is seeing pressure both in the demands placed on the

dwelling stock by demographic change and in the way services to the home are provided. New 'system builders' are seeking to deliver shopping, entertainment, banking and medical services direct to consumers. Furthermore, a set of smart homes technologies is evolving to control domestic functions within the home. These developments reinforce already existing trends in the nature and use of the home. More fundamentally, they raise questions about the control of new technologies and extent of user participation in their introduction.

In the next section we briefly discuss the demographic, economic and attitudinal trends which are shaping housing needs in the UK. These may form the foundation for a future smart homes market. We then explore the emerging smart homes technologies and reasons why a market able to address these trends has so far failed to emerge. Next, we consider the involvement of competing actors such as installation companies, retailers and utilities in shaping a future smart homes industry. There is growing interest in developing 'telecare' or 'telemedicine' solutions for use by elderly or disabled people. These are seen as a way of enabling people to achieve greater independence within their own homes, as well as helping health and social service authorities to save money. We therefore focus on this area in order to raise questions about the extent to which *users* are able to participate in the development of appropriate smart homes solutions to their needs.

Housing demand in the 21st century

Housing demand is often seen as an aspect of needs created through demographic change or the inability of particular social groups to gain access to adequate housing. However, pressure on the housing stock also arises from the way we use the home. This is partly a function of demography, partly shaped by trends within the labour market and partly the result of attitudinal shifts. Additionally, developments in information and communication technologies clearly have the capacity to *create* demands from households for new services.

The British housing market is facing a severe shortfall in housing supply in relation to the projected medium term growth in households. It is estimated that at least 5 million, and possibly as many as 6 million new dwellings will be required during the period 1991- 2016 to account for changing demographic demand. Even before any allowance is made for replacing the worst quality existing stock, this represents a housebuilding rate substantially in excess of recent levels.

Many of the newly forming households will comprise elderly people, but an even larger number will comprise middle-aged single person households. While the latter may well generate a growing demand for new tele-mediated consumer services, as well as having the economic capacity to invest in new smart

homes technologies, it is the rise in the elderly population that is generating particular interest amongst suppliers of smart homes technology and government.

The ageing population

That the population is ageing is incontrovertible. The number of households with members aged 65 or over will rise substantially over the next 20 years.[5] An ageing population impacts on the housing market if the current housing stock is unable to cope with changing social and medical needs. These can be very wide ranging. Experiences of the ageing process and its ensuing social and medical needs can vary widely between the 'young' and 'old' elderly, and between elderly men and elderly women. Distinctions based on social class and ethnic group and on lifestyle may also be important influences on differing social needs (Cullen and Moran 1991; Taylor and Ford 1981).

The increasing prevalence of health impairments and chronic illnesses which go along with old age can cause drastic changes for those affected. This process can make independent living, mobility, and the maintenance of social relationships considerably more difficult (Mollenkopf 1993). Nevertheless, most elderly people welcome the opportunity to remain in their own home (Smith et al. 1993). Together, these suggest there will be a growing demand for appropriate servicing and adaptation of the existing housing stock to allow 'barrier-free' living - maintaining independence within one's own home.

While barrier-free housing can be created by relatively minor design adaptations and the introduction of physical aids, evolving technologies in *telecare* - the provision of health and support services over the new high-speed digital telecommunications infrastructure - also offer possibilities for enabling greater independence in the home and overcoming isolation in the community. The types of activities which could be supported include routine diagnostics, monitoring, screening, basic counselling and advice. Telecare offers a variety of benefits to users who can receive routine treatment almost immediately without travelling to, and waiting in surgeries; they can participate in monitoring and diagnostics which is less intrusive than traditional forms; or they can be assisted in routine treatments, including reminders about taking medication. These benefits can all help people to lead more active and independent lives in an environment of their own choice.

At all levels of dependency the option of elderly people staying at home is considerably cheaper than moving them to specialised accommodation. This increases the likelihood that government and health

[5] In England, the number of 'married person' households is expected to grow by 23.6% between 1996 and 2016, with the average annual increase rising from 43,000 to 272,000. The number of single person households aged 65 and over is expected to grow by 30.7%, with the annual increase rising from 126,000 to 352,000 (figures from DOE 1995).

authorities will seek to introduce telecare services, reinforcing any effective demand for suitable smart homes applications from individuals and households seeking to remain in their own homes.

Changing work patterns

Another area of social change which may impact on the demand for smart homes systems arises from the changing structure of advanced capitalist economies, driven by globalisation and intensified competition. This involves a decline in Fordist modes of economic organisation and a rise in more flexible and responsive networked corporations. Associated with this is the growth of information rich economic activity (Castells 1998; Dicken 1992; Hepworth 1989; Knight and Gappert 1989).

At a macro level it is possible to identify two types of employment decentralisation in the service sector - one geared towards the use of information and telecommunications technology to allow more flexible working for senior executives and professionals and another for routine information processing jobs (Graham and Marvin 1996). These have led to shifts in division of labour between workplace and home, although progress towards mass teleworking has been slower than commentators predicted in the 1970s. Using the home for work activities has certainly grown, but a more realistic view of teleworking involves individuals spending some of their time working at home, some in the office and some whilst travelling or wherever convenient. As Hillman (1993) puts it, teleworking involves a flexible combination of physical and electronic movements and spaces, rather than a total substitution of the physical by the electronic.

Teleworking is attractive to employers because it offers them the chance to shift some of the costs of employing workers onto the home as well as potentially increasing productivity by overcoming the problems of lengthy journeys to work. This is likely to promote the continued rise in teleworking for routine activities where there is only a limited need for physical interactions with the office (Graham and Marvin 1996).

Attitudes towards the home

Changes in attitudes towards the way the home is used are more ambiguous. Some have suggested that the purchase of a home may increasingly be seen as a lifetime investment, with first-time buyers delaying the decision to buy for longer and existing owners remaining in their homes for longer. Most immediately, this stems from a disillusionment over the financial benefits brought by owner-occupation and concern over insecurity in the labour market. More fundamentally, there may be a trend towards the adoption of ‘post-materialist’ values, emphasising freedom to choose lifestyles, the aesthetic improvement of one’s surroundings and desire to enhance intellectual ability (Ingelhart 1990; Abramson and Ingelhart 1995; Hirschman 1982; Wilkinson and Mulgan 1995).

Whether this translates into more home-centred lifestyles - and, consequently, a demand for on-line services - is impossible to predict. However, over the next two decades the large growth in single person households, who have a high propensity to consume new products and services, suggests there may be a growing demand for information and entertainment services and smart homes equipment from this group.

'Smart homes' - unpacking the concept

The terms 'smart homes', 'intelligent homes' and 'home automation' encompass two approaches to classifying the technologies shaping the use of the home. First, the notion of the smart or intelligent house captures the idea that the material environment of the home and domestic tasks can somehow be automated. Automation can range from (1) simple fixed applications with pre-defined and pre-established operations, through (2) programmable applications and devices, to (3) fully flexible and automated applications and networks of devices sharing information and providing it to consumers. Second, there is the idea of an 'informational' home, making use of new external information services to improve the management of family and professional life.

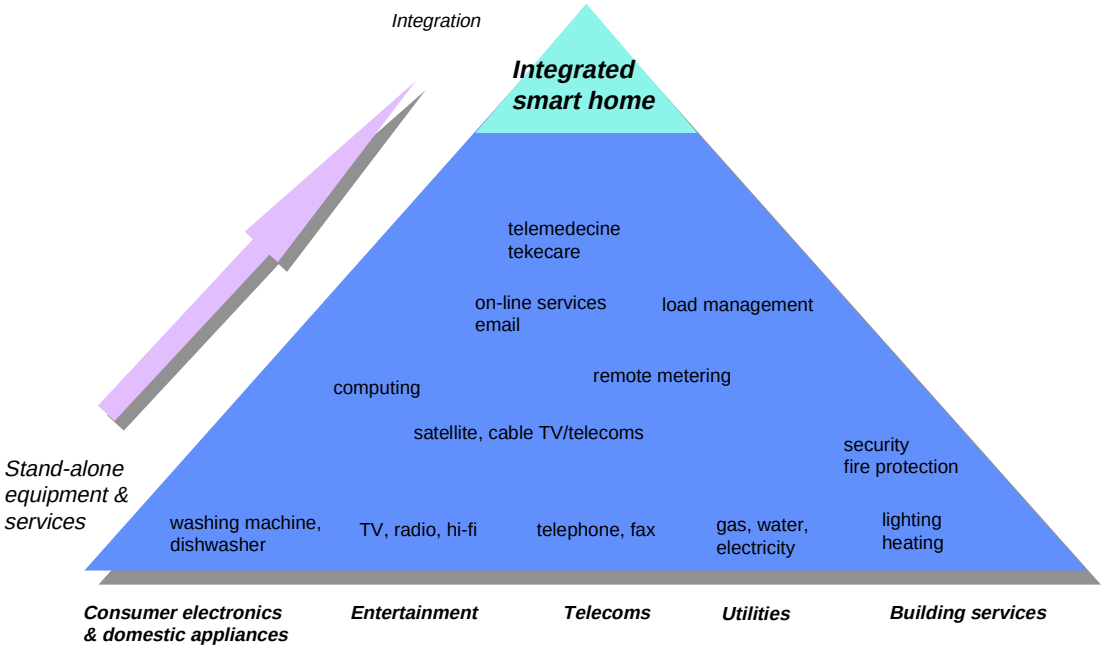
Both approaches rely fundamentally on the development of digital technologies to facilitate the control of a variety of functions, and the ability to integrate systems. There is nothing new about the enabling technologies upon which the notion of the smart home has been developed (Gann 1992). For the past two decades large consumer electronics and electrical equipment manufacturers have been developing digital systems and components for use in housing. Key technological developments include the replacement of electromechanical switching by digital switching, and traditional twisted pair and coaxial cables by optical fibres. Other enabling trends include the establishment of new communication networks (ISDN, internet) which allow bidirectionality (two-way communications) and developments in end devices such as 'web TV' and video phones.

A range of other suppliers - including telecommunication companies, water, gas and electric suppliers and building services firms - are also developing systems to allow greater connectivity and the provision of value added services. These include interactive and multimedia information services, remote energy management, and automated monitoring and control of domestic appliances.

Broadly, these developments allow the integration of household functions within homes and between homes and outside services (see figure 1). Combined in the right way they may achieve the goal of increasing functionality in the home. So far, though, suppliers have generally failed to create the right conditions for the growth of mass-markets for smart home applications.

One of the main reasons for market failure is that most commercially developed technologies are relatively expensive and tend to be aimed at middle and upper income homeowners. The narrow 'technology-push' approach of suppliers, which fails to take adequate account of user needs (Gann et al. 1995), has been another problem. We return to this issue below.

Figure 1. From stand-alone systems and services to integrated smart homes



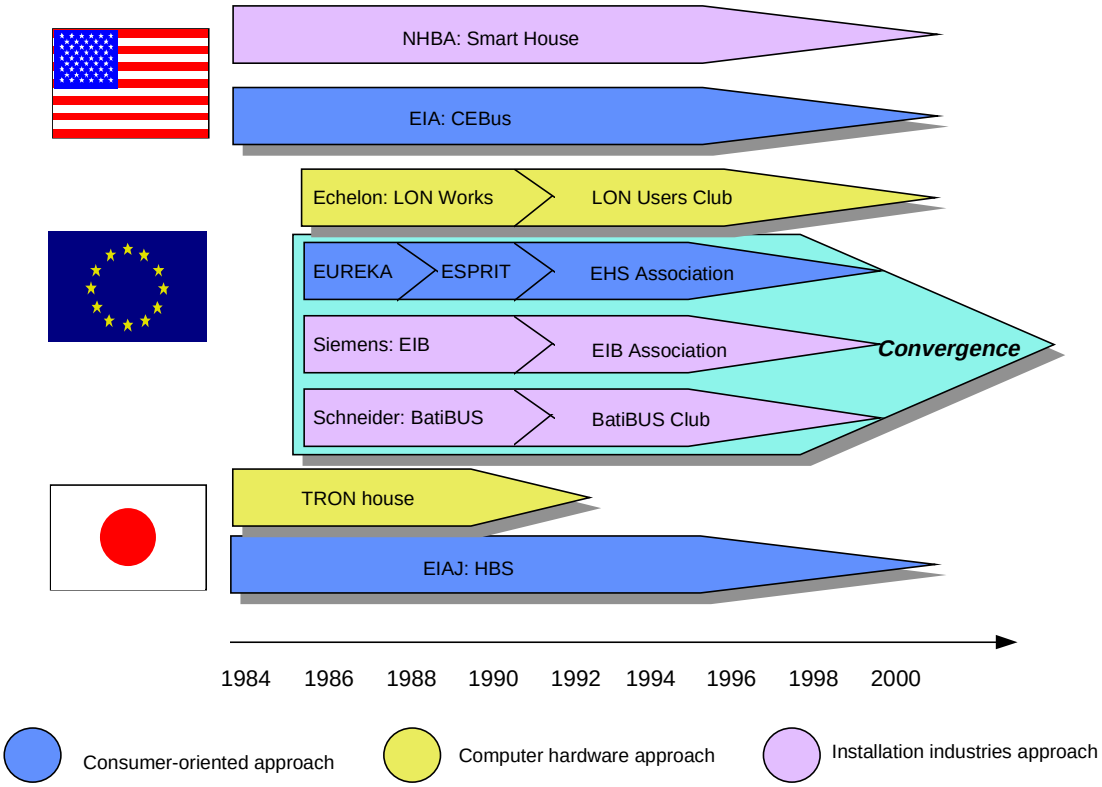
Source: Gann et al. (1995).

More fundamentally, for devices to communicate they must comply with the same communication protocols and speak a common language. There are currently a number of competing standards for protocols and languages, restricting the 'interoperability' of devices and systems. At the European level there is now an agreement to achieve convergence between the three principal systems (EIB, BatiBUS, EHS) by mid 1998. The goal is to establish common standards, a common system platform, compatible products and a unified approach to certification. Whether this will be successful remains to be seen since there are fundamental differences in the basic structure of the protocols and addressing mechanisms (Bromley 1997). Furthermore, other standards operate in the USA and Japan, and the LONWorks standard remains outside the converging model in Europe (see figure 2). It is widely believed that LONWorks will become the *de facto* standard, as many companies are gearing up to provide this as an option to users. This

will operate alongside the EHS system, which has the added advantage of being able to carry video as well as control and information data.

Other ways around the problem of differing standards have been mooted, including adding a 'plug and play' (PnP) layer to existing standards or using the internet as a communications medium. The internet is seen by some as a very simple protocol, although there remain problems since each device needs to be assigned a separate internet address and hardwired into the computer network. Even if suppliers are able to develop these solutions, considerable support for systems integration and maintenance will still be required. Genuine PnP in personal computing remains elusive, despite the emergence of a demand driven market. It will be a considerable time before it is possible for consumers to 'mix and match' components from different manufacturers of smart homes systems.

Figure 2. Smart homes standards in the principal markets



Source: Developed from Jeck (1997), Bromley (1997), Heimer (1995).

Creating a smart homes market

Despite the lack of common standards, technical development has continued apace. However, while technical convergence will stimulate the development of new products, just as important is the extent to which the various players are able to create a market.

So far, the European smart homes industry has tended to focus on:

- simple on-off switching systems for selected applications and requiring no additional network installation (e.g. remote control switching);

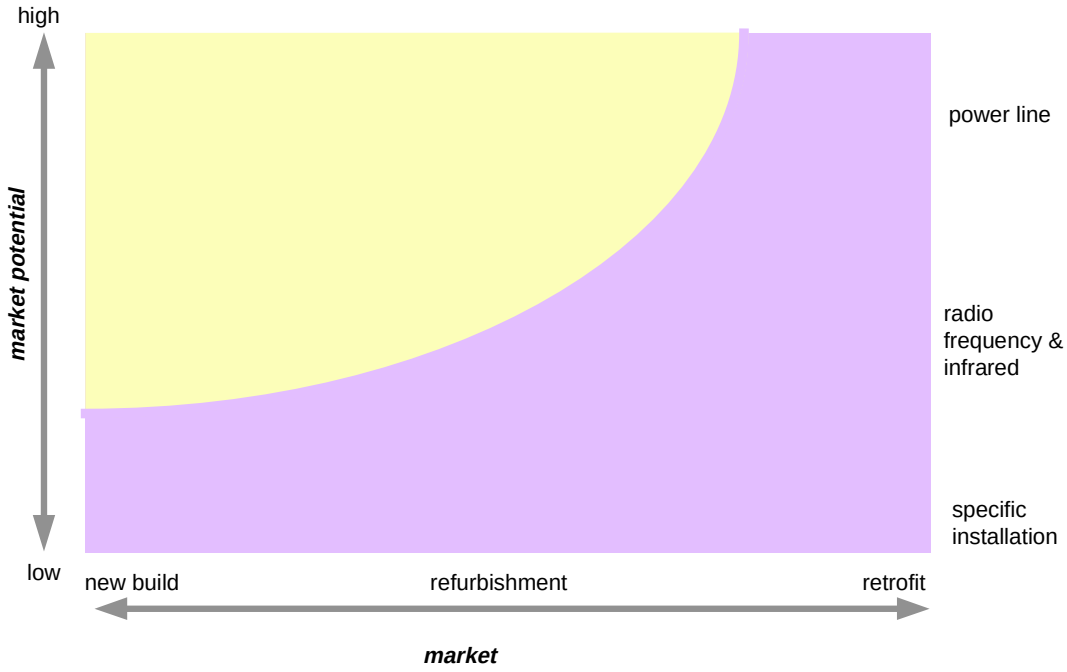
- island systems which also concentrate on selected applications but are wider in their functional scope and require specific network installation (e.g. security and heating systems).

Comprehensive networked systems are now emerging (e.g. Siemens' HES, Bosch's 'Domotik', Honeywell's 'Hometronic' systems). These involve networking devices - which may or may not be 'intelligent' - so that a broad spectrum of integrated applications and services can be provided. In theory, the value-added to the consumer offsets the investment cost.

One important barrier for suppliers is the nature of the housing stock. Device networking within the home can involve the installation of considerable amounts of cabling to carry signals for data, voice and video. While this is relatively straightforward when the dwelling is being built, retrofitting existing dwellings is far more expensive and messy. Nevertheless, the general decline in the construction of new housing across Europe has driven manufacturers to seek solutions for retrofitting existing housing or housing undergoing refurbishment. These involve the use of existing power lines, radio frequency or infrared media for communicating signals (see figure 3).

A more significant problem for suppliers is the need to convey to potential users a set of perceived benefits. For customers, only a comprehensive package of benefits will make-up for large scale initial investment - customer value-added is the *benefit* of the system, not its 'smartness' or 'intelligence'. 'Emotionalising' the concept of smart homes therefore requires suppliers to address clearly the needs of potential consumers to demonstrate additional functional and subjective benefits - consumers need to *feel* they will benefit.

Figure 3. Market potential and technical solutions



Source: Developed from Jeck (1997).

As we have indicated, the technology-driven approach of suppliers has failed to generate any significant awareness amongst domestic consumers. Meyer and Schulze (1996) have investigated the gap between consumers' requirements - essentially for systems which are useful for managing everyday tasks - and the currently available products. Consumers have basic needs which revolve around labour saving and simplification, ease in operation, the remote control of appliances and reductions in costs. The inability of suppliers to fulfil these needs is, they argue, a major barrier to the development of the market.

Not only have suppliers failed to convey the benefits of smart homes systems to individual consumers, even housing providers and landlords have a very restricted perception of what the concept can offer. Gann et al. (1995) found that housing associations specialising in housing for elderly people - an area where there have been some efforts to develop smart homes applications[6] - saw the technology providing only marginal benefits. Nevertheless, given that around 4,000 dwellings for elderly people are built annually by housing associations and private developers, it is clear that the *potential* market is not insubstantial.

[6] See Bjørneby (1994). Suppliers expect the IT market in healthcare to grow by 10% annually over the next five years (*Financial Times*: Information Technology Supplement, 5 February 1997).

Another reason for the failure of suppliers to create a market stems from their limited efforts in evaluating the *usability* of new products. Product usability is a relatively new area in industrial design, which has traditionally been concerned with ergonomics, how people physically use a product (Hix 1993; March 1994; Devries et al. 1994; Preece 1993). User-centred design also needs to encompass the cognitive aspects of using a product - how logical and natural it is to use and how people feel about using it. Designing products to eliminate the fear of using them, and making them engaging to use, involves building in a combination of simplicity and ease of use, as well as offering distinctive value to the customer. Minimally, the process requires manufacturers to acquire knowledge about:

- *Who will use the system* - the physiological and psychological capabilities of users and their socio-cultural characteristics;

- *What it will be used for* - the repetitivity of tasks, variability in their nature and the skill and knowledge requirements;

- *The context and environment in which it will be used* - physical conditions, health and safety considerations;

- *What is technically and logically feasible* - costs, development timescales, manufacturing constraints.

The breadth and diversity of the potential user community, the variable context in which products and services are used, and the need for manufacturers to balance usability and other design goals make the reality of user-centred design complex (Barlow 1997). It is very hard to investigate people's use of products and services that have yet to exist. Another problem is that many available systems and products require the producer to invest in a training or acquaintance programme to help people get the most out of their smart homes.

Even if producers succeed in generating more widespread understanding of smart homes technology, evidence from the early days of the personal computer industry suggests that a number of acceptance barriers will slow its initial adoption. These relate to consumers' concerns about:

- price stability;

- lack of information;

- standards compatibility across applications and when upgrading within specific applications;

- reliability, susceptibility to breakdown and foreseeable servicing costs;

- complexity in use.

Meyer and Schulze (1996) argue that since women remain responsible for the main burden of domestic tasks, the acceptability of smart homes technology is also related to their attitudes towards innovation. Acceptance will therefore vary by household type, notably its size and composition, internal division of labour and stage in the family lifecycle. Certain types of households have the most to gain from implementing integrated smart homes systems. These include households in which both partners are working, highly mobile single-person households, and households containing elderly or disabled people.

To motivate consumers to buy its products, the smart homes industry therefore faces the task of developing solutions that satisfy real user needs. These solutions have to operate as (1) *generic technologies*, providing the basic, standard compatible building blocks for (2) *context-specific systems*, adaptable to a wide variety of dwelling types, and (3) *personalised systems*, tailored to specific individual and household requirements. Furthermore, solutions must satisfy a number of conditions:

- Functionality - the equipment/system must have clear and unambiguous functions;

- Ease of use - clear and simple user interfaces, interactivity and connectivity;

- Affordability - for individuals and housing providers;

- Reliability and maintainability;

- Flexibility, adaptability and upgradability - systems need to develop as user needs change;

- Replicability and ease of installation - systems need to be available as a standard, reproducible product.

An equally important task for suppliers is to signal to potential consumers that their products provide real solutions to their requirements. Table 1 shows the types of activity required to establish a market. At present the primary customer state for the European smart homes industry is one of ‘unconscious inactivity’. It has yet to develop transparent and beneficial applications for the user and there are few signs that the industry has moved towards stage 2. This is partly because there is no single smart homes ‘industry’. Current system developers and installers are unable to open up consumer channels because they do not have the necessary skills in emotionalising the product.

Developing more consumer oriented channels via retailers (as has happened with the inferior X-10 standard in the USA) *may* stimulate greater interest in the medium term. However, at present distribution channels are poorly developed in most countries. Even in the case of products for elderly and disabled people - a more readily identifiable market than the amorphous 'homeowner' market - one study found that housing association staff responsible for purchasing decisions faced severe difficulties in obtaining adequate information (Gann et al. 1995).

In the longer term, therefore, the market will only develop with the growth of a set of specialist smart homes *system integrators* which are able to coordinate the supply chain and various service providers.

Table 1. Market development model

	Primary customer state	*Market state*	*Typical activity required*
Stage 1	Unconscious inactivity	No market	Product development, market research, education, standards
Stage 2	Conscious inactivity	Emerging market	Demonstrations, measurement of benefits, dissemination, supply chain development, education, training
Stage 3	Conscious activity	Growth market	Quality control, market support, training
Stage 4	Unconscious activity	Established market	Consolidation, refinement, monitoring, challenge conventional wisdom

Source: Drage (1997).

The role of systems integrators

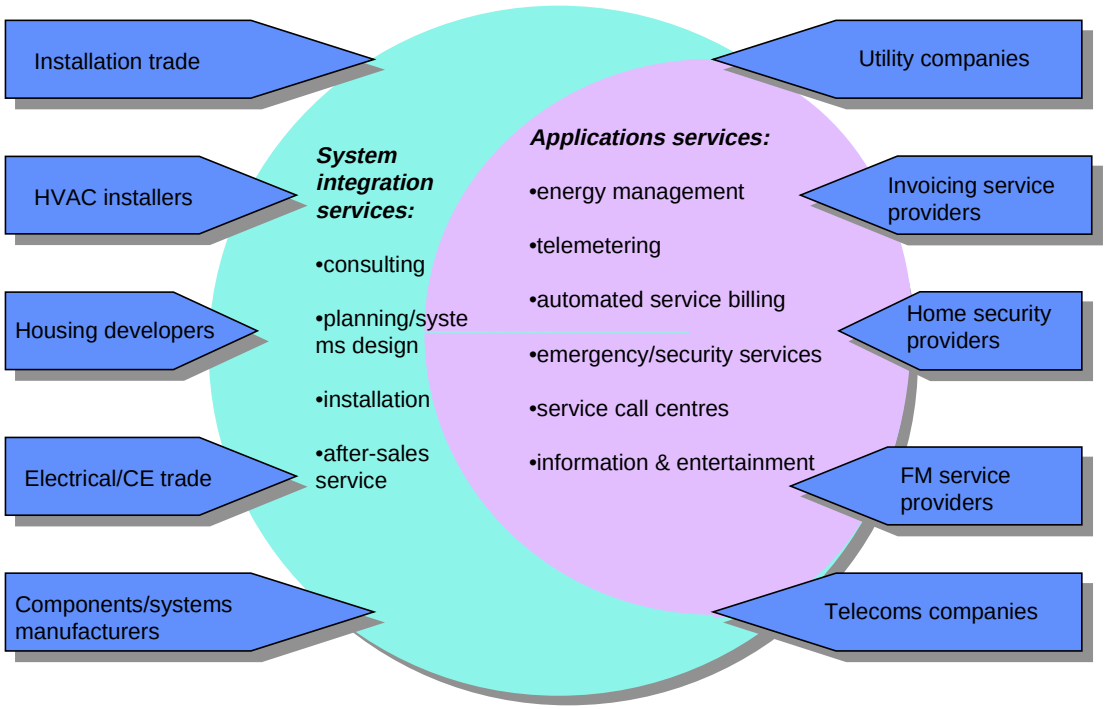
While some basic smart homes devices could be sold via existing channels such as kitchen planners or consumer electronics retailers, more complex applications require specialist installation and integration within wider networks. Specialist systems integrators have yet to emerge, but could be drawn from the retail, installation or housebuilding industries. However, there is not uniform capability in all the required skills amongst these sub-sectors. Retailers, for example, are more skilled at communicating the benefits of smart homes products, and demonstrating and selling them, than installers, who are better able to offer the

installation and commissioning of integrated systems, and provide after-sales service. Systems integrators are needed in order to bridge the gap between each of these players and offer advice on applications, the individual configuration of systems, installation and after-sales service.

Despite recent initiatives such as the INTEGER programme, the housebuilding industry in the UK seems highly unlikely to emerge as a force in smart homes systems integration. Private housing developers have shown little understanding of the smart homes concept and, consequently almost no interest in introducing these technologies as a way of distinguishing their own products. Systems integrators are more likely to emerge via collaborative relationships between installation companies, retailers and manufacturers. In this way improved coordination of supply chain can be achieved, distribution structures developed and investment in training shared between retailers and manufacturers.

Installers, retailers and manufacturers are, however, facing growing competition from ‘system builders’. These are essentially companies who aspire to deliver shopping, entertainment, banking and medical services direct to consumers and may seek to become systems integrators themselves (figure 4). Energy suppliers, for example, are becoming transformed into multi-utilities (Graham and Marvin 1996). Driven partly by a search for new business areas because of competition in their traditional activities, these companies are diversifying into value-added services such as energy consulting, automated invoicing, telecoms and facilities management.

Figure 4. Competition in the emergent smart homes market



Source: Derived from Jeck (1997).

Towards user-centred smart homes - the case of elderly and disabled households

The provision of appropriate information technologies in housing schemes *can* facilitate access to new products and new interactive services which may bring new benefits to users. As we have seen, the smart homes industry has, however, been singularly unsuccessful at creating widespread consumer interest in its products, or interest amongst specialist user groups such as the elderly or people with disabilities. This is partly because suppliers have paid too little attention to understanding real user needs and translating them into well thought out products which satisfy the conditions described above. It is, therefore, vitally important not to see human actors as passive recipients of new technologies. As Robins and Hepworth (1988) put it:

> The computer home scenarios have a narrow and instrumental fixation on technique - the 'evolution' of the household is seen as an expression of some autonomous technological 'progress'. The dream is a domestic machine-utopia cocooned from the outside world in which human agents are passive and infantilized. In such technocratic scripts the household is severed from its surrounding (economic, social and political) contexts.

This perspective is especially pertinent when considering the development of smart homes systems for elderly and disabled people. The use of telecare to continuously monitor people's health can increase the possibility of intercepting changes in health status and automatically trigger an appropriate response from local community services or doctors. This can have benefits for both those with established medical conditions and those without them.

However, smart homes technology, especially telecare, raises a number of fundamental financial and ethical issues.[7] The latter arise from the increased capacity to monitor activities or resources brought by the new technologies. In particular, three types of 'flow' can be monitored (Dard 1996):

- Human flows, such as the supervision of private and collective spaces.

- Energy flows, such as the monitoring of energy consumption.

- Information flows, such as managing the transmission and reception of messages.

Concerns fall into two related areas. First, the extent to which housing providers and health authorities will be tempted to use telecare systems for random monitoring of residents once the technology has been installed. It could be argued that the ethical pitfalls in monitoring people's movements within their home, or recording the frequency of using the toilet or regularity of eating, counteract the advantages of various smart homes technologies for providing independence. Equally, though, electronically tagging a person with dementia may give them increased freedom of movement.

Second, questions have been raised about who benefits the most from telecare and smart homes systems for elderly and disabled people - the reassured relative, the relieved care staff or the person it is designed to help? So far, systems are extremely expensive in relation to the cost of developing a new house or fully refurbishing an existing house. It is possible, therefore, that health authorities or housing providers may be tempted to offset the high costs by replacing medical and care staff with telecare systems, replacing regular visits from carers. In this way telecare and other smart homes applications can represent a substitute for personal attention, leading to increased isolation in the home.

On the other hand, some applications can help to preserve individual dignity - for example when they obviate the need for help in the toilet or bath - and allow carers to provide a better quality of personal contact by removing much of the drudgery of caring. Furthermore, telecare and physical aids offer the possibility of reducing management costs by integrating dispersed homes and thus benefit users indirectly.

[7] Also see *Innovations in Social Housing*, No. 7, March 1994 (Joseph Rowntree Foundation, York) on ethical issues.

Single electronic records that can be held on smartcards usable on telecare equipment in the home can be used as a means of transferring and updating medical records cheaply, as well as providing users with potentially greater control over sensitive information.

Disentangling and weighting the broader cost/benefit indicators has not yet begun[8], but the acid test will be whether these technologies make a difference in preventing people going into care against their wishes. Any indicators must, however, rest on a clear system for evaluating user needs which allows an individual to assess his or her needs and provide informed consent for appropriate smart homes systems.

Conclusions

In his book *City of Bits*, William Mitchell (1995) observed that:

> Once you break the bounds of your bag of skin ... you will also begin to blend into the architecture. In other words, some of your electronic organs may be built into the surroundings. ... So 'inhabitation' will take on a new meaning - one that has less to do with parking your bones in architecturally defined space and more with connecting your nervous system to nearby electronic organs. Your room and your home will become part of you and you will become part of them.

While this may be somewhat overstated, it is undeniable that the advent of the 'information society' has brought with it major changes in the ways in which we live. Housing now supports a much wider variety of activities than previously. One area where the development of smart homes technologies may speed up is telemedicine - over the next two decades it is likely that the home will evolve into an increasingly sophisticated component of the health care system.

We have discussed some of the technical, organisational and social developments that are likely to shape future smart homes markets, including that for telemedicine and telecare. The technologies associated with these trends are potentially liberating, but at the same time raise important ethical issues associated with privacy, consent and security. These are as yet poorly understood. Many of the emerging products and systems are being developed with only limited understanding of user needs and little user participation. This may not be a particular problem in the range of smart homes technologies for general domestic use, except in terms of the failure by manufacturers to develop usable products and create a market. In the field of telemedicine and telecare, though, user participation is critical, but noticeably absent. Moreover, there is

[8] But see Bedrosian and Bedrosian (1994).

insufficient tangible evidence from existing demonstration projects to evaluate the costs and benefits of these technologies in use. A greater research and policy effort is vital.[9]

[9] We are engaged in a project for the Joseph Rowntree Foundation to develop and demonstrate a model smart home for elderly residents which is cost effective and replicable in the social housing and low-cost owner occupied sector. The project is identifying and evaluating existing products and systems on the basis of criteria such as functionality and user-friendliness, cost, reliability, adaptability, installation impact and cabling requirements, bandwidth and interoperability; assessing their feasibility in relation to the needs of providers of housing and care and end users; and developing two demonstration projects (in York and Edinburgh) and incorporating the lessons into a final model specification. Preliminary findings should be available by late 1998.

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