

Smart homes at the start of the 21st century



In February 2001, Orange, the UK mobile network operator, announced the 'Orange at Home' project, a smart house incorporating the latest technology wizardry built near the old DeHavilland site in Hatfield, Hertfordshire. It was intended to be more than a mere showcase, with plans for real families to move in and live with the smart home. Richard Harper's research establishment, the Digital World Research Centre at the University of Surrey, was commissioned to study how these families reacted to their new home, and to report lessons for the future development of smart homes and smart home technologies.

Why would a mobile network operator want to build a smart house? And what is a smart house anyway? In this article I want to introduce the reader to smart homes by way of a quick history, and then explain just why it is that a mobile operator such as Orange has built one. I will then say something about the kinds of technologies that are being piloted in smart home environments, the problems and outputs of research into their use, and then conclude with some suggestions as to what the future may hold in terms of smart homes and smart technologies.

A history

Although many of us will be vaguely familiar with the term 'smart house', few of us will have a very concrete understanding of what it means. It was first used in an official way as long ago as 1984 by the American Association of House Builders, although the first 'wired homes' were actually built by hobbyists in the early 1960s. And this development is key to what is meant by smart homes. For a home is not smart because of how well it is built, nor how effectively it uses space, nor because it is environmentally friendly –

using solar power and recycling waste water, for example. A smart home may and indeed often does include these things, but what makes it smart is the interactive technologies that it contains.

Now, leaving aside the fact that in the early 1960s there was not much interactive technology about – after all, the famous experiments on the mouse and the pointer at Stanford Research Institute did not take place until 1967 – since that time and right up to the present there has been very little take-up of smart homes. They have not been a hit because they have been too expensive, the housing stock is old, there has been a tendency for little networked connectivity and, finally, there has been too much technology push and little attention given to users or usability.

Now focusing on the last of these, usability, what one finds is that the design of ‘domestic technology’ has been something of a Cinderella science. The principal reasons for this neglect are:

- a lack of motivation to increase productivity in domestic work;
- little involvement of users of the technology in the design process;
- the view held by product designers that domestic technology is unexciting;
- a continued focus on stand-alone appliances in the design of new technology.

This situation does seem to be changing, although there are peculiar problems when trying to design interactive technologies for the home. After all, a home is not like a workplace where there is usually planning, maintenance and – most important of all – technical support. Families, after all, are not structured like organisations. To make matters worse, ‘users’ range from babies to OAPs. And finally, home users are hard to study anyway: what family would want observers hanging around all day and (perhaps) all of the night?



Whatever smart homes will be, it is certain they will involve old housing stock.

This is not to say it is impossible to design effectively for the home. But it is to say that it is hard. Notwithstanding these difficulties, there is a great deal of interest in smart homes at the present time. This is attested to by the Orange at Home project, as well as the increasing amount of commercial and academic research both in the UK and abroad.

Smart homes today

What, then, does a smart house at the start of the 21st century have in it? What makes it smart? Let us take the Orange at Home example. Here, a fifty-year-old house has been wired up with a network, run by a server that operates all of the functions of the house. Lighting, heating, security, audio-visual systems, curtains, baths and numerous other appliances can be controlled through WAP (Wireless Application Protocol), SMS (Short Messaging Service, or ‘texting’ as it is commonly known) or a dial tone on a mobile phone (an Orange one

obviously!); and ‘wirefree’™ technology allows PDAs (Portable Digital Assistants) and webtablets within the house to do the same. There are also ordinary PCs, though what makes these a little out of the ordinary is their



connection to broadband networks. Finally, there are various other technologies like a health monitoring system in the house's 'sport room'.

The purpose of Orange's investment is to provide an opportunity to explore what users may want by giving them as many opportunities as possible with current off-the-shelf technology, even though it was recognised from the outset that some of the technologies would not be well received.

What we learnt when families were put in the Orange at Home environment is that technologies that succeed in work environments sometimes fail in home settings. This is not because they offer the wrong solutions but because what is important is different. There are wall panel units for controlling lighting and other functions, for example, and these are fairly standard in current office settings. But in the home, users find the functions overly complex – if not unnecessary – and are much happier with simpler control devices like the old-fashioned rocker switch. Another finding, again not so surprising, is that issues of conflict show themselves over who controls the systems: kids regularly over-ride their Mum's selection of music on the centrally controlled audio-system, for example.

In many ways these are expected problems and concerns, and have since been dealt with. More interestingly, there are issues to do with where access to such things as on-line shopping services is provided within the house: the kitchen would seem obvious, but the PCs that can provide access to those services are not designed for such an environment, and are located in the smart home's office. They are still used for on-line shopping, but that requires the householder to go to the 'wrong place' for the task. In other words, PC technology may provide all that users need for an office desk top, but in the home certain aspects of the same technology inhibit what might be an ideal solution for users' needs.

Designing PCs for kitchens may seem prosaic, but it is one of the great hopes of smart homes that the technology they provide will achieve a blurring of previously existing barriers and thresholds. In this example, we are thinking of being able to order food when and where the need for it is discovered, and that will most probably be in the kitchen. Other thresholds also come to mind, the most obvious being between home and work.

So the location of the interactive devices needs to be related to the patterns of space usage in the home. But this is not the only important issue in making the technology fit in to home settings. There is also the question of interaction mode. Using hand-held devices allows family members mobility within the smart house, but often 'click throughs' are perceived as overly complex: users prefer to use the volume knob on the hi-fi rather than the stylus input mode on their PDAs (Portable Digital Assistants), for example.

There is also the issue of using novel modes for input: here 'hands-free' commands come to mind, and the possibility of using voice-activated

controls for certain tasks where the hands are 'tied up'. Consider the predicament of wanting to adjust the heat on a hob when one is cutting garlic, for instance: here voice could do (as it were) the talking to the systems. And indeed many of those who stay at the smart home express keen interest in such applications. Orange have been exploring this, but although interactive voice-activated applications are becoming increasingly common, they have a long way to go before they can process the myriad commands that any cook would want. So it will be some time before smart homes provide the kind of solution that the film *2001: A Space Odyssey* brings to mind.

And this leads us on to the distance between users' hopes and reality, even the reality of 20 or 30 years hence. For what one can do with smart technologies is process information, but one cannot undertake all of the mechanics of home life. Dishwashers actually do the washing, but the machines still need loading and unloading; likewise the washing machine. This will not change since it



Kitchens need more interactive technologies than they currently have since they tend to be the real heart of the home.

is very unlikely that automated processes will emerge that will provide solutions that are either practical or cost effective for these kinds of tasks. People might like the idea of home robots doing the laundry, but it is not realistic.

In any case, what our studies do show is that what people want interactive technologies to provide is not automation so much as communication, or as we like to put it, social connectivity. And this is the main reason why a mobile network operator like Orange is investing in smart homes. With the Internet, for example, families spread around the globe can and do set up web conferences, and though the bandwidths currently available may produce pretty grainy and poor quality images, a great deal of value is thereby provided. With new screen and tablet technologies, combined with air-based networks, many interesting new possibilities are opened up for ways in which such needs can be supported. This will be good news for those who provide the networks for such needs, such as Orange, as well as for the so-called terminal manufacturers who will produce the hardware.

The future

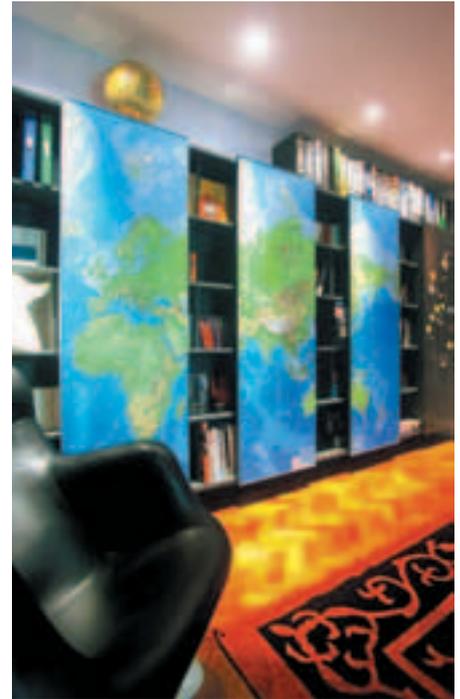
Many designers are now trying to provide social connectivity solutions, and hopefully the Orange at Home project will incorporate them as they appear. But there are some fundamentals that need to be resolved if smart homes of the future are to succeed.

Perhaps most obviously there is a need for industry-wide standards that will allow the exchange of information and commands between various interactive technologies. Currently, most technologies communicate via

proprietary protocols and this inhibits seamless interaction between technologies from different manufacturers. Though there are various ongoing attempts to create standards both for smart homes and for hand-held devices more generally, the likelihood that agreements in this area will be reached soon is doubtful. It is not only that there are large commercial interests at play, but there are also complex technical issues that have yet to be solved.

The failure of Hewlett-Packard's JetSend technology is an instance of a standard that could not get past competitive commercial interests; the current technical difficulties with Bluetooth an instance of the latter. (JetSend is a technology that uses infra-red signalling to communicate between freestanding devices while Bluetooth uses radio frequencies to do the same.) It may be that academics will find a role here, both in terms of brokering standards, and also with technology through inventing something similar to HTML – although this time it will not be to share and read documents within physics laboratories, but for the home. (Just to remind the reader, HTML – HyperText Mark-up Language – is the basic tagging language that has allowed for the emergence of the world wide web. The language was invented by an academic at an EU research lab.)

Related to these issues is the emergence of homes that are wired for sight and sound in much the same way that current homes are wired for electricity. It is worth recalling that when electricity firms first provided access to power, they assumed that householders would only want one point of access. This may seem strange to us now, but there was no realisation that people would want light in every



The blurring of home and work is a continuing goal of smart house technologies.

room and access to power through sockets in each room too. Once this had been realised, consumers of electricity were provided with opportunities to appropriate the power source as they saw fit.

There is a view that smart homes need to provide similar networks for sight and sound, although whether they will utilise fixed wiring or air-based facilities is unimportant. But given what we have said, it would seem unlikely that there will appear a single network solution to this need, and much more probable that the householder will be confronted with hybrid and mixed networks in the future. Consequently, these networks and the technologies they support will not necessarily be able to communicate with all the other technologies in the home, and will probably develop in such a fashion that closely related ones are linked through proprietary controls. There will also be a mix of so-called point solutions and generic ones, all in one way or another reliant on the various networks.

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And at this point, of course, I have to end the story since we are approaching the commercial territory that Orange commissioned us to explore. These limits notwithstanding, what I have wanted to convey is some sense of what smart homes are all about and where they are likely to go. I have wanted to note that designing for the home has its difficulties, one reason for which is that so little effort has been put into understanding what is needed. Most development in ICT (Information and Communication Technologies) has, perhaps not unsurprisingly, focused on office and more generally on work environments. It is only now that the home is catching up. The Orange at Home project is one example of how this is being done. ■

Web site

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Professor Richard Harper is Director of the Digital World Research Centre at the University of Surrey. The DWRC was established in 1998 and now has some dozen researchers working on a wide range of projects for blue-chip companies, including all the mobile phone operators. Throughout the past ten years, Professor Harper has been at the forefront of research into the use of sociological and interdisciplinary techniques for specifying user requirements for new technologies in organisational, mobile and domestic life. He is a regular public speaker, has published extensively and holds several patents.



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The main bedroom.



Water temperature in the bath is digitally controlled.