Leslie Haddon

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Conference Item

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Development of Household Technologies

by

Dr Leslie Haddon

Graduate Research Centre in
Culture and Communications
University of Sussex
Falmer
Brighton BN1 9QN
England

Various histories of consumer technologies, both new and old, have employed if not directly the idea of paradigms then at least something akin to it. Sometimes the researchers concerned have talked of analogies, concepts, doubles lives or constructs, perhaps due to coming from different intellectual traditions or else wanting to avoid some of the other intellectual baggage that has come to be associated with the word 'paradigm'. Nevertheless, the examples given below suggest that something like that concept of a paradigm has repeatedly proved to be useful and attractive in accounting for technological development. The aim of this paper is explore and sometimes problematise the nature of this concept and its utility as a research tool based on involvement in several projects which have tried to grapple this and related terms. This has been by no means an easy process and goal here is to share some of issues with which a researcher might have to cope. The first half of the paper examines the examples of the telephone, radio and then more recently the VCR and home computer in order to illustrate and investigate how the 'same' technologies can be seen as developing according to different paradigms. The second half of the paper explores how a something related to a paradigm can be occupied by different product configurations. However, in recent research the paradigm that has been referred to as a 'product space', which can be sometimes a little less clearly defined than some of the historical paradigms discussed below - the exact functionalities and role of any products filling this space can be a little vaguer and subject to negotiation. The issues around these product spaces are exemplified through case studies of home automation, compact disc based interactive multimedia and electronic messaging.

Paradigms

Several theorists of the technological innovation process have borrowed the idea of paradigms from Kuhn's work on the history and philosophy of science. Dosi refers to 'technological paradigms' and Teece to 'design paradigms' (Dosi, 1984, Teece, 1986). Both are using the concept in accounting for how social shaping of technology can occur. Technical possibilities and constraints may set some limits to what is possible, but a selection process takes place whereby certain technical trajectories rather than others are followed. Those developing technologies work with a set of shared assumptions and goals concerning what they are working towards and what technical problems they need to overcome. Resources and efforts are devoted to those areas, or as Teece would say, to particular technological products, while other possible directions of research and development are neglected. This is not only a framework for thinking about what happens in technology labs. Certainly existing research shows the central importance of these technical staff in formulating ideas about products for the home (Cawson et al, 1985), others, both within and outside hardware firms, can influence in varying ways the innovation process. These may include software producers, industrial designers, marketers and advertisers, retailers, trade and other press and conference promoters and Government bodies (Haddon 1991; Silverstone and Haddon, 1993). While this notion of paradigms helps to account for patterns of incremental change, Dosi and other writers have noted, also in the spirit of Kuhn, that more radical changes in technical trajectory are possible. These can occur when allegiance to paradigms is disrupted by what have been called 'critical events' and which again can include the activities of those other than technologists (Heimer, 1995, p.110)

One issue, which also applied to Kuhn's original formulation, concerns what level of analysis to talk about 'paradigms'. For example, in the case of the VCR, JVC's VHS standard came to dominate the industry and in the case of compact disc technology Philips managed to ensure that its configuration became an industry standard from the

start. If such standards can be considered as paradigms perhaps it might be appropriate to name them separately as design paradigms. But what is of interest in this paper might be better thought of as conceptual paradigms, broader than the details of mere technical configuration. This includes a technology's general functionality, but also its role in the home, its identity, and its place in everyday life (Cawson et al, 1995; Silverstone and Haddon, 1993). At this point it would be best to turn to particular histories to demonstrate what this term can mean in practice.

Telephone technology, conveying sound at a distance over wires, originated alongside other innovations in telegraphy. In fact, telephony was first developed to send music rather than voice, but the telegraph companies showed no interest in the experiments since the telephone's output left no permanent record which was deemed an essential and desirable feature of telegraphy (Aronson, 1977). For a while the phone was regarded as a toy, but there were efforts to use the technology to convey concert music and news mainly to public spaces in what Aronson calls the 'radio concept or telephony', or we might call the paradigm of broadcasting. It was only after some years of campaigning by Bell that the practices and institutions which we now call telephony - real time one-to-one or point-to-point voice messaging - started to emerge and eventually become the dominant paradigm for the role of the domestic phone.

Radio too was initially developed as an adjunct to telegraphy - for reaching ships at sea since they had no possible wired connection to land (Douglas, 1986). Apart from this application, radio was largely rejected by the business community as having few potential commercial uses but within a short time amateur enthusiasts had adopted the technology for point-to-point communication. Although a radio message could be picked up by anyone, when contact was established it was mainly used within a telephonic paradigm. After a few years, some radio hams began experimenting with broadcast music, advertising and news and only then did corporate interests take over and develop this paradigm so that for most people radio came to mean the reception of broadcast material - which over the years was further shaped in terms of schedules and genres. TV later took over the broadcast practices established for radio. However, the older paradigm in which radio had operated lived on as a minority pursuit in the form of amateur radio and, for a while, CB radio. In fact, some early mobile phone systems were called 'mobile land radio' but later any reference to radio was dropped.

Turning now to the first more contemporary example, VCR technology was initially developed for professional broadcasters so that they could broadcast material recorded at an earlier time (Keen, 1987). But when machines were first developed for the home, publishers, music companies and film and television producers and distributors saw its potential primarily as a software player for pre-recorded, pre-packaged material. Here was a machine which would enable a new form of distribution of software, and in fact some hardware producers manufactured playback-only machines to cater for this interest, or else geared their efforts to producing high-quality playback rather than recording facilities. Only after the early industry faltered did Sony promote its new Betamax machine essentially to time-shift television programmes and so give end users more control over TV. Such a paradigm was not only unattractive to software producers. It seen as threatening their interests by allowing piracy of copyright broadcast material and hence there was some initial and unsuccessful opposition via legal suits. Finally, it is worth adding that another paradigm for video use was as a player for material recorded by the end-users' own video camera or, nowadays, by their camcorder. Some manufacturers had seen this as being actually the central role for home video in the early

years of its development (Keen, personal communication). Although never a major role for the VCR, this usage has grown steadily. The point to stress though is that this history appears to indicate something more substantial than merely alternative applications for a technology. In those early days different paradigms existed. There were different visions guiding technical development and marketing, which have subsequently managed to co-exist in what has become a multi-purpose technology.

Lastly we have the home computer. After some years when companies saw no use, and later no domestic use, for a small computer, some companies started to wake up to the possibilities that the microcomputer could become a consumer electronic (Haddon, 1988a). Many of these companies saw a home computer as an 'infrastructural' machine: a device which could have multiple uses, be used by different household members on a daily, routine basis as a familiar and established part of technological infrastructure of the home. This not only fitted in with the visions of enthusiasts concerning how the computer was going to change everyday life but also promised a large after-sales potential as end-users were expected to buy a range of software and peripherals for their machine. However, certainly in Britain, computers were first marketed to the public as 'self-referential' machines: technologies that allowed consumers to explore the world of computer technology, to try out programming and find out how computers worked. This was partly an attempt by Clive Sinclair to pick up sales from a hobbyist market, but a wider audience was also invited to learn about computing. Some of that sentiment still lingers on, but as the home computers of the 1980s were mainly used for playing games, and some, especially cheaper, brands were even technically optimised and promoted for games playing, it could be argued that these products adopted the identity of 'games machines'. Many in the industry and public perceived those early products in this way. This has started to change. In the UK, word-processing has more recently started to catch up with games-playing as a major use.

Such varied histories suggest no simple theories or models and there is limited opportunity in this paper to explore in more detail why and how some paradigms came to pre-dominate. But the examples suffice to provide a basis for making some observations about the nature of paradigms and the methodological issues which a researcher has to confront when referring to them.

First, such short summaries can imply that it is easy to detect paradigms. As always when searching for structures which might underlie a range of phenomena, there can be problems in detecting and then characterising paradigms. Judgement is involved, which provides the possibility for different researchers to disagree. From my own study of home computers it was clear that interviewees from the industry operated with varying degrees of clarity concerning what they hoped to achieve. Sometimes their overviews were vague, and they could only be partially articulated. In some cases, drawing any conclusions from the evidence of overt marketing material would have been misleading. For instance, the one product manager pointed out how the advertising copy for the company's machines portrayed it as an infrastructural machine, but this was merely a tactic to win over the parents who purchased the computer for their children. Really the machines technical features were very limited and the company expected it to be used for games, to which end they secretly promoted the development of compatible games software.

Some of those in the industry simply tried to keep more than one option open, copying and monitoring the success of others rather than following their own 'technological

trajectory' in a single-minded manner. Finally, many were ambivalent about the games machine trajectory which early machines were taking. Catering to games players provided a way to sell the hardware, and so many manufactures felt that they could ignore the games market. They even sought software support, optimised some of the hardware for games-playing and strongly advertised the games potential. Yet the paradigm of games machine always threatened to limit and devalue the product. Such an identity was seen as inhibiting other applications, and hence sales, while relegating early home computers to the status of being toys. The key point from all these observations is that although I felt that there was enough evidence to justify the decision to refer to a concept like underlying paradigms, that decision was by no means a straightforward one.

Second, to the extent that paradigms can be discerned and prove to be useful in accounting for development, it is possible to make observations about how we might conceive of their nature. It is possible to think of paradigms evolving over time. We saw how 'broadcasting' in the sense of one-to-many transmission of sound or images was a fairly early concept. But as radio and television institutions emerged which standardised broadcasting's form, flow and content and gave these media an established role in national and international life, broadcasting has come to mean something far richer and complex. Arguably, paradigms can also be re-visited, sometimes in slightly new guises and after the passage of a considerable amount of time. Before the telephone became the familiar two-way technological link between homes and the outside world, some visionaries had foreseen the day when all homes might have telegraph for delivering and sending text via wires (Aronson, 1977). As we shall see later, this telegraphic paradigm, not in electronic rather than electrical form, has been resurrected with the notion of home E-mail and fax. Finally, we might suggest that paradigms can co-exist as the same technology can have competing identities. This was best evidenced in the case of the VCR, but also in early experiments with the telephone. Furthermore, such co-existence can sometimes be structured in dominance: the main meaning of radio for most people has been that of a broadcasting technology, but amateur radio has nevertheless continued as a fringe activity.

The third issue concerning paradigms relates to the role of end-users in the whole innovation process. Consumers can provide important feedback while products are under development - indeed, in the form of pressure groups, consumers can lobby for some changes. In addition, end-users sometimes invent new applications, or simply use or perceive products in ways unintended by producers (Cawson et al, 1995; Silverstone and Haddon, 1993). The point to add in this paper is that consumers may also have a bearing upon the paradigms within which products develop. We saw the prominent role that hobbyists in particular played in the case of the case of radio and of home computers. In fact, they were also important in the history of interactive games in general (Haddon, 1988b), E-mail messaging on Minitel and in developing the Internet Theories of how firm innovate often fail to do justice to their input into the development of products. In addition, such 'grassroots' initiatives can come from the more general public. The appropriation of early home computers for games may eventually have been supported by manufacturers, but the latter were often reacting to end-user practices and to some extent losing control over the future of their own product. The same occurred in the early days of CD-*i*. Philip's product was supposed to be a new form of infrastructural machine, but the company subsequently discovered that the machine had mainly been treated as a better games playing device by early adopters (Silverstone and Haddon, 1993).

<u>Product Spaces</u>

The above discussion has examined how a technology or technique can emerge and be developed within more than one framework. The emphasis now shifts to asking how similar technologies, configured as products in different ways and with slightly different functions and roles, could nevertheless fit into what has been termed a product space (Cawson et al, 1995). For example, at one stage in the early 1980s the video console industry boomed but then, especially but not solely in the UK, collapsed as computers took over the product space of 'games machine' (Haddon, 1988b). In more recent years, the fight-back by Nintendo and others have meant that dedicate consoles once more command this space, although home computers and products such as CD-*i* can be and are used for this purpose. We now turn to research on a range of other product spaces to explore the concept more fully (Cawson et al, 1995).

Home automation, known by a variety of others names such as the intelligent homes smart house and domotique, entails enhanced forms of linking and controlling existing home appliances and systems such as those for heating and security. In its broadest terms, this control can be in the form of increasingly sophisticated programmability, sometimes where several appliances operate at once, the use of various sensors to initiate pre-planned sequences, and remote control of appliances either within the building from handsets or wall-sets or else from outside the home. A range of industries have taken an interest in this product space including consumer electronics, white goods producers, telephone companies, installer organisations, heating and lighting companies, security firms and companies already producing a form of home systems for the disability market, where it is known as 'environmental controls'. There are a number of competing bus systems (where appliances sit on a local area network), star systems (where appliances are connected individually to a central controller) and systems involving just a few appliances.

Interactive multimedia was originally defined in relation to compact disc technology and so this technological platform remained the focus of our study - although there are now discussions of telecoms based multimedia. The core idea here is one of constructing some form of text from a combination of audio, written and visual material, the latter including still pictures, video and animation. The interactivity comes from options to search within and find individual routes through such texts as opposed to experiencing them in fixed and linear fashion. Products already exist from consumer electronics firms (e.g. Philips *CD-i*) computer companies (offering CD-ROM add-ons for PCs) and video console manufacturers.

We already noted how electronic messaging could be seen as descendent of the telegraphic paradigm in that it involves electronically delivering textual messages into the home which are not necessarily read at the moment of sending - i.e. they can be stored. This product space could include electronic-mail, but also a range of other services which involved messages - such a bulletin boards, conferencing, even multi-player games. Telecoms companies have been significant actors here, although other bodies can host some of these network products. One very different example of an electronic messaging device is the fax machine. Finally, some cable equipment producers have also considered developing TV set-top boxes which could have this facility.

The concept of product spaces proved to be useful where it highlighted the existence of shared communities of interest and networks of actors who could mutually influence each other. Sometimes institutions emerged around product spaces where various actors negotiated questions such as how the product space might evolve, over what time scales,

through what routes to market and how the boundaries of that product space might change (Haddon, 1995). In the case of multimedia there were discussions concerning what count as competing products. For instance, are CD-*i*, CD-ROM for PCs or multimedia games really separate enough products with different potential roles to play that they can all co-exist in the home rather than compete to find a place there? In the case of home automation, various firms together with other bodies have jointly promoted the product space per se, trying to attract the interest of other constituencies and also of end-users. But negotiation and collaboration do not inevitably lead to positive results. We also see in relation to that particular product periodic moments of doubt about its future, leading firms to put their projects on a back-burner and reduce developmental resources.

A second reason why the concept of product space can be useful is that it draws attention to products which share similar properties. This helps to define what count as potentially competing product configurations and to examine how their strategies to introduce products into the home may differ. We might also ask whether one product configuration, such as electronic mail or *CD-i* in the home might help to establish end user familiarity and practices which might later provide a basis for other product configuration to enter the home - in this case, fax and CD-ROMs respectively.

However, there are a number of issues to consider concerning the nature of different product spaces. The first issue involves the degree to which the existence of distinct and discrete product spaces are articulated by producers, with the related question of how much we can speak of 'community' or 'network' based around these paradigms. Certainly the field of home automation and multimedia have been constructed in public discourses, through informal contact and collaboration. There have been conferences, informal meetings, associations, publications and European Commission funded projects relating to both product spaces. This was not so in the case of electronic messaging. There has never been a specific community based solely on this concept, no meeting of fax producers and network operators to discuss its future, and in fact the term itself was constructed by us as researchers rather than by the industry.

It is worth pursuing this example further. In the business world, E-mail exists as a separate service although it can be integrated with other facilities, especially within office automation packages. Business fax machines are also separate product, although computers can also now have fax cards. While manufacturers of fax machines have started to consider the home as a target market, all attempts to introduce electronic mail into the home have packaged 'messaging' with other services such as access to information and transaction services. In fact, the early product space packaging messaging with other features which as defined by the telecoms industry was actually called 'Videotex'. Here, messaging between end-users was a subsidiary service compared to access to databases and transactions. More recently 'electronic highways' are perhaps the latest form to combine messaging with other services, one particular product configuration with a high profile being the Internet. In our research on the above fields we persevered with defining electronic messaging as a product space in its own right, mainly because of the second reasons discussed above. But on reflection doing so may have been more problematic than appeared in our report.

This example points to further possible research questions of why historically some areas come to be publicly defined as relatively distinct product spaces by commercial interests and other actors while other theoretically possible ones are not recognised as such by

industry. It also raises, still unresolved, questions of how much the researchers' constructs should relate to industry ones, and what exactly that relationship should be.

The case of electronic messaging also raises a second question of where to draw boundaries around product spaces. This is not only an issue for researchers trying to establish their object of study. Even where a product space like home automation has been defined by industrial actors there are disputes concerning what does or not count as an intelligent home - given a continuum from very simple single controls up to elaborate multi-functional home systems. Among the network of industrial actors there are also claims about boundaries within the product space, in the case of home automation distinguishing whether or not a system is based on a bus or not, or whether it should be considered only a sub-system compared to a more comprehensive products.

The third issue concerning the nature of product spaces relates to their centrality and peripherality for different industrial actors. For example, home automation presented clear opportunities in terms of adding functionality and value to the products of consumer electronics companies and other appliance manufacturers. It also provided installers with the option of offering new higher value installation packages. Therefore, both groups have taken initiatives at developing both standards and products. But other actors have an interest only in a very specific aspects or functions within the product space. The electrical utilities are interested mainly in its potential for the management of consumer energy demands. Meanwhile, those offering repair services see the potential for home systems in assisting fault diagnosis. Cable companies are interested in possibly sharing the same modem link between the home and outside world, and possibly the human interface, as are the utilities because it might provide a cheaper way to enable remote meter reading. In other words, there are some parts of a home automation technology or its functionality which can be shared resources used both by those for whom intelligent homes are a more central concern and by companies with other interests. In one sense, this product space in general is not the main concern of these other companies, but it can still be important to them. Indeed their involvement has been encouraged by those at the centre of intelligent home initiatives since other interests such as the utilities have the potential partly to finance some of the technology or else add value to the product in the eyes of consumers.

Relevance

The purpose of this paper has been to explore how in practice how a theoretical tools of paradigms and product spaces have been utilised in practice and to discuss some of the problems and issues that have arisen. The aim has been less on the rigorous defence of these concepts, especially given their problematic nature, but to provide a stimulus for further discussion of their potential through the use of suggestive examples. These have been based on the author's experience of in-depth empirical research on a range of consumer technologies combined with an awareness of historical research on older technologies. In general, the concepts of paradigms and product spaces appear to have some promise and are worth pursuing, but with considerable care and reservations. To finish, though, it is worth pointing to two further implications.

1) What bearing might paradigms and product spaces have on how we conceptualise what our objects of study should be? For instance, the histories of radio and telephone outlined earlier followed the fortunes of these particular technologies. But it might have been equally fruitful to chart a history of broadcasting and telephony across various technologies. To take a more detailed and recent example, when constructing a history of

interactive games and games-playing it became necessary to look beyond the more obvious games machines: arcade machines and home video consoles. This is because other products, principally home computers, had also occupied the product space of 'games machine'. Any account of the whole phenomenon of games-playing and games products would have been incomplete without taking this fact into account. For example, many consumer practices grew up around computer games - such as copying them or altering them - which had not existed with console technology. And many game innovations occurred through amateurs being able to experiment on their own computers.

2) What bearing might paradigms and product spaces have on how we measure phenomena such as diffusion rates? What is being diffused? For instance, given the debates about the boundaries around the product space of home automation, we might anticipate some disputes over how many 'real' intelligent homes exist at any one time. Or to return to the computer for one last example, some market researchers considered every product calling itself a home computer to be a computer and produced statistics of household penetration based on this. Others were more discerning and would only consider brands above a certain price point or with certain technical features as being computers. Once again, they operated with a paradigm of what counted as a 'real' computer and dismissed other offerings as being merely games machines, despite their name.

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