The Shape of Things to Consume

Delivering Information Technology into the Home

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Preface

The impression is often conveyed in popular writing about electronics and the ‘information revolution’ that the pace of change is break-neck, and that a torrent of innovations is about to swamp us and force us to change the way we go about our daily lives. Many journalists writing about this technology, for example, become excited by its potential, and assume that because something is *technically* possible, it will — almost inevitably — happen. The same excitement can affect company management, and lead to speculative deal-making in anticipation of rapid changes in markets. What can happen later, however, is that newspapers find another set of issues, and that, after an initial flurry of excitement, in which firms seek to ‘position’ themselves in relation to the expected direction of change, it often happens that more realistic views come to the surface, proposed mergers are called off, and expectations of rapidly developing markets are scaled down.

This seems to be exactly what has happened in 1993-4 with the writing about ‘convergence’ and the development of ‘information superhighways.’ The efforts of US vice-president Al Gore to publicise the opportunities for economic growth afforded by information technology (IT) coincided with some important technological advances, notably in the area of digital compression technologies and telecommunications switching. Suddenly major deals were being announced between telecoms companies and cable TV operators in the US, the European Union was setting up an expert committee (the Bangemann Committee) to ensure that Europe was not left behind, and Japanese policy-makers were reportedly worried that the Americans had leap-frogged their previous advances in IT.

But how does anyone *know* that these new markets will develop so quickly? What evidence lies behind the view that consumers will be queuing up to get onto the information superhighway? Will ‘multimedia’ remain as what John Sculley of Apple once called a ‘zero-billion-dollar’ industry, or will it reach the dizzy forecasts produced by the IT consultants?

This book examines in detail, for three new consumer IT product areas, how the producers of technology developed their ideas about consumer preferences, and how this knowledge shaped the design process of the products. We show, in the case of Prestel, for example, how an earlier outbreak of ‘techno-optimism’ led to the view that large numbers of consumers would begin to get their information from computers via the

television screen. Exactly the same arguments heard now about the information superhighway were being made, albeit in more measured language, about the potential of this earlier generation of computer technology. The technology *has* improved considerably in this twenty year period since Prestel was invented, but how far have consumers changed? We look at the early assumption of the designers of Compact Disc-Interactive (CD-i) that many people will want to 'interact' with their television set, rather than simply accept the programmes broadcast in the traditional way. We show, in detail, how *assumptions* about consumer behaviour were treated as proven, in part by extrapolating from previous experience, e.g. with the VCR.

The purpose of this book is not to report the very latest developments, but rather to examine a part of the history of the design of consumer products *before* they reached the market. We chose products which were under development in 1988-90, and interviewed a large number of people involved in shaping the ideas about how these products would be used in the home. We wanted to see how designers and marketers coped with the problems of not having reliable information about consumer preferences. In the case of our three product areas, home automation, electronic messaging, and interactive multimedia, we knew how difficult it is to use reliable market research techniques. Consumers who have never heard of e-mail, for example, cannot be expected to answer sensibly questions about whether they would be likely to buy such products. Engineers develop the technology to make new products and services *possible*, but many others are needed to turn an invention into a widely used product. How do they design such products to appeal to consumers?

It would require another book to examine how the processes we observed have been affected by subsequent developments in the market. It was not our intention to follow through these products to the market, but rather to concentrate on one specific phase in the much longer process of innovation in order to answer the question of how producer views about consumers were formulated. We have done this in considerable detail, and we hope that our work will be helpful to those interested in the history of these particular products areas. In addition we think that there is much in these chapters to interest those seeking to get behind the hype of 'multimedia' and the 'information revolution.' We show how difficult it has been in the past to sell 'information' to households, which should tell us something about the difficulties producers still face in opening up these markets. Finally, we see our work as a contribution to redressing a bias in the innovation literature towards industrial technologies and professional products and services. There is still some prejudice against studying consumer technologies, as if these were less intellectually respectable that industrial ones. Many fewer academics research consumer IT than the telecommunications or computing industries, and innovation theorists know much less than they should do about the significance of consumer electronics for IT in general.

In completing the research we interviewed a large number of people, many of whom

were prepared to give specific information, in confidence, about what were often (at least at the time) commercially sensitive issues. We are grateful to our respondents for their time and frankness, and we have agreed not to identify specific informants by name. Researchers who would like more precise information about sources are welcome to contact us for further information.

The aim of our interviews was to get an understanding of how these producers forged the link between R&D (which defines in some sense the functional boundaries of what is possible with the innovation), product development (which comprises choices within these boundaries) and marketing (where the choices made are related to projections of consumer behaviour and likely purchase patterns). Overall, the study is premised on the belief that innovation as a *process* takes in all of these activities, and that successful innovators work within organisations which are equally attentive to them. Some companies, such as Philips, are often seen by commentators to neglect the marketing dimension of innovation: the company invests heavily in R&D, product design and development, but then often fails effectively to market its new products. In other cases, such as Amstrad's PCW word processor, the innovation lies not in new technologies but in the application of existing technologies to meet particular needs, and of reducing production costs enough to pit the product against electric typewriters rather than other types of computer or word processor.

We wanted, then, to provide a more rounded picture of the innovation process than those arising from studies of R&D labs and to avoid the overly technology-focused view of innovation which arises from concentrating too much on the process of research itself. The discussion of our case studies in Chapter 6 results in a model of the innovation process which reflects these objectives, and embodies the extent to which the common features of the three cases enables a general picture of the innovation process to be drawn.

Interviewees were contacted in a variety of ways, in part depending on the nature of the case study. For the home automation study, we were fortunate in being able to enlist the help of the National Economic Development Office (NEDO), which had commissioned a research study from RMDP. Both organisations were helpful in providing leads to potential informants, many of whom were people who had attended NEDO/RMDP conferences. In the case of interactive multimedia, one firm was involved in developing the major consumer product, CD-i, so that interviewing was concentrated among various members of the R&D, product development and marketing staffs, both in the UK and at Philips headquarters in Eindhoven, the Netherlands. On the software side, many small firms were engaged in early developments, and leads to them were often provided by Philips managers. As in the home automation case, industry conferences were a major source of information, and provided good opportunities for making contact with (and in some cases interviewing) industry informants. The electronic messaging case was slightly different, and involved more historical detective work, since several efforts to

launch consumer products and services had been made in the 1980s, notably and notoriously BT's Prestel, and the research strategy involved locating key players active at the time.

Most of the interviews were conducted in the period from October 1988 to July 1990, although some have been done since then, and we have continued to be actively involved in research and consultancy in this area since completing the fieldwork for this study. The first drafts of the case studies were written in the course of 1990, but have since been revised and updated in the light of developments since then. In the case of CD-i, consumer products were introduced onto the UK market in 1992, reflecting at least the initial resolution of choices still under discussion when the initial interviewing for this book was completed. In the case of home automation there has been no major publicised launch of new products and systems, although products continue to trickle onto the market. Very little has happened since 1990 to change the conclusions drawn from interviews, and most companies expect the market to develop very slowly, if at all. One of the major players, Philips, has put home automation activities onto the back burner. In electronic messaging the picture is a little clearer, in that the strong development of the fax market in the industrial sector has begun to spill over into consumer markets. Thus this study remains one of products for which the future is uncertain: the specific products and services we examine in the following chapters may or may not be successful innovations. We hope that this book will provide the elements for an explanation of which of these products and services succeeded, and which failed, and why. Until then, and perhaps a follow-up study, we have to be content to explain why the actors involved in developing new IT products for the home made the choices that they did, and how those choices can be interpreted within a broader context of technological innovation.

The chapters were revised after intensive discussion, and we see this book as a genuinely collective effort. Alan Cawson researched interactive multimedia and wrote the drafts of Chapters 5 and 6; Leslie Haddon researched home automation and electronic messaging, and wrote the drafts of Chapters 3, 4 and 7; Ian Miles contributed from his extensive knowledge of IT, and drafted Chapters 1 and 2. Alan Cawson took responsibility for the production of the final draft. We are indebted to Alexi Cawson who prepared the manuscript for publication. Brighton, November 1994

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Chapter 1

Technological Innovation and Consumer Products

Introduction

The design and marketing of new consumer products[1] based on technological innovations presents a series of problems or choices for producers. The fundamental features of the design embody a set of assumptions about how the new product will be used, and about why consumers will buy it. Everyone is searching for a winning product, such as the video cassette recorder (VCR) which creates a new market, enormous profits and changes the pattern of everyday life. But for the most part, producers are satisfied with products which ‘succeed’ in terms of gaining acceptance in the market and a return on the investment. The major problem with radically new products is that it is difficult in advance to be

certain about consumer reaction, and very large investments can be made, such as those by RCA is developing its videodisc system,[2] on products which fail to attract buyers. In many cases the conventional techniques of market research are inappropriate, because consumers need knowledge and experience of using the product before they can give sensible answers to research questions.

This book is about a *part* of the innovation process — it focuses on the way in which the suppliers of new IT products incorporate knowledge of consumers into the way they design products. We wanted to catch, as it were, producers in the act of making choices which presuppose knowledge of consumer behaviour, and find out the basis of that knowledge. How far do designers collect systematic information about consumers, or how far do they rely on rules of thumb or impressions of the reasons for the success of earlier products? How far is the image of the consumer based on stereotypes held by producers? — of the early purchaser, for example, or of the nature of family life.

There is now a considerable body of academic writing on the innovation process, and we were also interested in how far this work entered the decision-making process of the designers. In this chapter we present some of the major findings of this work, both to provide a context for the case studies which follow, and to show what kind of information *might* be made use of by producers. In Chapter 2 we have the same two objectives behind an analysis of consumption and consumer markets: what do *we* (observers) know about this, and what do *they* (producers) know and use.

In each of our case studies — home automation, electronic messaging and interactive multimedia — we are dealing with products for which the need or demand is uncertain. We all use (and perhaps need) products now — such as automatic cash dispensers, microwave ovens or CD players — which were quite unknown just a few years ago, but which have since changed the way we live. We can now, if we want to, go out at 3 a.m., get money from the cash dispenser, pick up a pre-cooked meal from the 24-hour convenience store, put it in the microwave, and eat it while listening to a favourite piece of music on the CD-Walkman. This example crystallises just a few of the changes which are continually going on in our everyday life which relate to new IT products. Yet for the most part social research on innovation has concentrated on industrial and office technologies, and there have been relatively few studies of consumer durables or services. This bias is itself part of the conceptual map of producers, yet at the same time there is much useful material which both informed this study, and can be helpful to the designers of new consumer products.

Innovation and diffusion

We shall mainly focus here on technological innovation, though of course social, political and organisational innovations are vitally important to human history. The standard definition of 'innovation' as meaning 'something new,' is quite adequate for this study, where the products we examine are substantively new, not even existing as mass-market products at the time we began research. We shall, however, use a more precise meaning of the term later in order to define more closely the *process* of innovation, whereby 'the new' becomes 'the familiar' when it is accepted into everyday life, or in the case of a product, when it is successfully marketed.

The field of 'innovation studies' has emerged over the last few decades, gaining impetus and influence from the recognition that technological change is a central problem for policy (e.g. achieving economic competitiveness, regulating technological hazards, understanding the evolution of working life). The field represents a return to some of the concerns of early nineteenth century political economics, whose pioneers made incisive analyses of the introduction of new factory and agricultural technologies. Marx, in making the widest (and most controversial) contributions, assimilated many of the results of the work of other commentators — Mill, Ricardo, Smith, and others — into his own opus. His distinctions between base and superstructure, or between the productive forces and the relations of production, remain influential in contemporary analyses.[3]

Modern innovation research mainly dates from the post-World War 2 period, when there was a consolidation of 'policy sciences,' attempting to provide knowledge relevant to the new problems faced by managers and policy-makers. This growth reflected the new forms of state intervention into social and economic affairs, and the acceptance of state responsibility for funding science and some aspects of technology (together with the emergence of large corporations with substantial investment in ongoing technological change). Thus among the problems which informed innovation research were those connected with assessing and managing public and private funds for Research and Development (R&D), the speed and direction of technical change, and the skills and organisational structures required by industries which were becoming increasingly science-based. New disciplines arose, such as technology assessment, technology forecasting, and R&D management.

The diffusion of innovations — the process by which a population comes to adopt new ideas or products — is a topic encompassed within innovation research. The analysis of diffusion was developed extensively around the middle of the century,[4] although there are important earlier contributions to the field. Simple

portrayals of diffusion trends are widespread, and much market research data exists on the uptake of new products. Some new consumer products have achieved such substantial markets that extensive data are available on their purchase by different types of household, over different periods of time — this is notably the case for home computers.[5]

The objective of many studies of diffusion is a desire to determine why what appeared to be an unquestionably good thing was not taken up, or to estimate the length of time it might take for an innovation to become widespread. Early studies considered, for instance, the uptake of new agricultural practices in developing countries; more recently, there have been numerous studies of the diffusion of microelectronics innovations among firms. Researchers would examine the characteristics of 'early adopters' and 'laggards,' and plot diffusion *trends*. These are statistical representations of the spread of the innovation through the potential user population.[6] The diffusion trends of successful innovations typically take the form of S-shaped curves — unsuccessful innovations are more likely to appear as a small hump! S-curves have been plotted for consumer goods and services (such as TV and telephones) as well as the agricultural and industrial innovations.

The S-shaped pattern describes a process in which diffusion is initially slow, accelerates as the incidence of adoption grows; reaches a period of 'take-off' from which adoption continues rapidly, eventually slowing down as the market becomes saturated. The exact size of the potential market may be problematic: sales need not stop when every firm or household has the innovation, given replacement of worn-out (or unfashionable) models, and intensification of use, as in two-car and multi-TV households.[7] The *early adopters* have often been the focus of attention in diffusion studies. They are typically described as being more aware of innovations and to be more capable of taking the risk of acquiring unfamiliar and perhaps untested products; as being younger, more affluent, more exposed to media carrying technical information, and more technically experienced; as having higher status and better linkage into social networks, and perhaps as being psychologically predisposed to innovation. The characteristics ascribed to the *laggards* who are last to be won over to the innovation are typically the inverse of these.

Potential users have to be exposed to information about an innovation in order to consider adopting it, and the more people that have adopted an innovation, the more likely they are to be exposed to information about it.[8] Early adopters tend to be those best-located in the networks of information flows, laggards are those most who are more isolated. Such an account can be represented formally in terms of statistical models, which are employed for describing — and forecasting — technological diffusion.[9] Various equations which generate S-shaped curves

have been applied to different circumstances: the most familiar, the logistic curve, deals with the rate of diffusion. By relating this to the fractions of the population that are adopters, and that remain to be persuaded to take up the innovation, first increases and then decreases in this rate are generated.[10] Economists introduce such concepts as the income and price elasticities of the product (respectively referring to the influences upon uptake of the finance available to the user and the cost of the product) into the modelling of diffusion. 'Substitution curves,' representing the displacement of an older product by a newer product (e.g. colour TVs against black-and-white sets, CDs against LP records) are also a sophisticated area of statistical analysis.

In practice, it is common to find that diffusion trends, especially when examined in detail, do not strictly conform to the ideal S-shape. Some of the 'detail' may be accounted for by perturbations, such as the well-known seasonal fluctuations in consumer expenditure (some purchases tend to increase at Christmas), or longer-term events such as wars and business cycles. Methods of 'smoothing' the data are often used to compensate for such deviations from the trend (e.g. seasonally adjusted sales figures, or five-year moving averages). Other products may not conform to the S-curve, perhaps because of the rapid emergence of successful competitor products, perhaps because of other changes in consumer taste, or perhaps because they are simply not successful innovations in terms of achieving take-off. Some products seem to take an unusually long time before take-off, for instance until the price is brought down to a reasonable level, which is what may now be happening with high definition television (HDTV) in Japan.[11]

The diffusion literature draws attention to two important aspects of the innovation process:

- *there may well be uncertainty as to the population of potential users;* and

- *there are important variations within user populations*.

The first of these points causes problems for statistical analyses of diffusion — just where is the 'ceiling' that might be reached by diffusion of a new product? This clearly means that suppliers of a new product may be uncertain as to how far their market will extend, which has implications for the level of production and pricing they are willing to undertake. Producers are liable to be extremely attentive to early sales figures in order to try to estimate such things, and to identify the imminence of take-off.

The second point extends beyond the stereotypes of early adopters and laggards, though it is common enough to find innovations first diffusing among the more

affluent users, within industry as well as among consumers. But other reasons for variations in the market do not reflect information networks or access to financial resources. The utility of a product may vary across members of a population — for example, improved audio systems are irrelevant to the needs of deaf people. Likewise, early adopters may embody groups with very different motives — for example, VCR users may wish to time-shift their favourite soap operas, or to view pornographic videos. The diffusion of VCRs is an example of conventional wisdom as to leaders and laggards being at least occasionally suspect. In the UK, at least, the VCR penetrated earliest among lower socio-economic groups, and only later into wealthier households. Poorer households, not coincidentally, also spend more of their leisure time watching TV, and in addition are more likely to rent their TV sets. Thus, the perception of benefit, the diffusion of information, and relatively cheap access to the hardware was facilitated for this group.[12]

The prototypical early adopter may vary across innovations of different types. The pioneers for home computers or video game consoles may well not be interested in baby or emergency health alarms, let alone garden tools, environment-friendly household cleaners, and the like. It is plausible that there are different clusters of innovating consumers for different broad classes of product.[13] Consumer electronic products may well form such a cluster — Japan and the USA are claimed to be ‘hot markets’ for such innovations, but this may reflect the technical expertise that these products often demand of early users, rather than any more fundamental common characteristic of such products. Nevertheless, the point remains that early adopters may well be particular types of people, and thus the uses to which they may put new products may not be typical of those which will be common among the wider user population.

Even if diffusion theorists tended to assume that the innovations were unquestionably progressive, ‘Good Things,’ they could not but help be aware that features of the innovation itself might promote or impede the uptake of products. A useful list of such features is provided by Rogers:[14]

Relative advantage An innovation may be expected to diffuse more rapidly if it is perceived as offering substantial benefits (relative to costs) on current ways of doing things. Video recorders diffused rapidly in the mid-1980s, while laser video disc players did not, in large part due to the advantage that videotape offered of being able to record broadcasts, and not be solely dependent on software supplied by retail or rental stores. When we talk of the ‘functionality’ of innovations below, we will be attempting to specify just what advantages they may be seen as conferring.

Compatibility Given that products are often interdependent — i.e. work together

— it can be expected that innovations will diffuse more rapidly if they are compatible with existing equipment or services, or if they are seen as likely to be so with planned future acquisitions. For example, although CD players could not play vinyl LPs, they could be plugged into existing hi-fi systems alongside conventional record decks; thus adopters did not have to discard their existing record collections.

Complexity More complex products may be expected to require more learning on the part of users, and this is expected to constitute a deterrent to diffusion.

Reliability More reliable products may be expected to be available for use more often, to require fewer repair bills, and not to let one down at awkward moments; all of these factors may be expected to promote diffusion, although consumers will recognise that there is frequently a trade-off between price and reliability.

Observability Knowledge of innovations has to be communicated, and this may not always take the form of face-to-face discussion or promotion through advertising. Innovations may simply be observable because people are visibly using them — driving cars, putting TV aerials or satellite dishes on their houses, wearing personal stereos, and so on. Products which are more readily observable may be expected to diffuse faster.[15]

To this list we should add:

Standards Potential buyers of a new product may be dissuaded from purchase where there are competing products offering the same functionality, and thus uncertainty about which product might be the loser in a struggle to establish a dominant format. Using the example of the VCR, whilst a discontinued format (like Philips's V2000 or Sony's Betamax) continued to be usable (e.g. as a time shift machine), supplies of pre-recorded software or blank tapes dried up so that buyers had fewer benefits than those who chose the winning format early on, or who chose to wait until the *de facto* standard had been established.

We shall now discuss all of these features in greater detail when we talk about trends in technology itself.

Technological trends

The 1920s and 1930s saw the emergence of specialists in technological forecasting — a field that was to mushroom in the post-war period. Two particularly important figures in the mid-twentieth century were William Ogburn

and S. Colum Gillfillan, sociologists who pioneered trend analysis and extrapolation as methods of analysing technological change.[16] These authors also contributed to the analysis of social change and technical innovation.[17] Ogburn explained technical change as resulting from a process of the combination of ideas: as new ideas are created out of the combination of old ones, the pool of ideas continually grows, enabling the pace of innovation to speed up — as long as information about these ideas can circulate freely.[18] Thus, trends in the development of technologies were — like diffusion curves — related to the flow and accumulation of information.

S-curves, too, reappear in technological trend analysis: if we plot trends in *technological performance*, a typical pattern involves early rapid growth in capacities until, sooner or later, limits of the technology are achieved — thus automobiles today do not offer markedly greater speeds than those of twenty years ago. However, while individual classes of technologies tend to reach such limits, human capabilities may continue to grow via shifting from one technology (whose limits have been reached) to a technology with superior performance — a substitution process. Thus, if we were looking at speeds that can be attained, we would perhaps move from human locomotion, through horses, trains, racing cars, propeller aircraft, jet aircraft, space rockets... Eventually physical rather than technological limits may be approached (e.g. the speed of light!)

Trends in technological capabilities are commonly extrapolated in order to estimate what sorts of products could be delivered to the market in the future. For example. it can be argued that if the power of microprocessors continues to increase along its historical trajectory, it will be possible to achieve particular levels of processing power or memory storage in ten years time, which can be exploited in future applications and products.[19] Similarly, trends in product characteristics can also be assessed. Innovators may examine what types of innovation are being brought to market (as competitive or complementary products to their own future plans for innovation).[20]

One influential line of analysis in innovation research goes beyond plotting the performance features of technologies, to attempt better to explain the dynamics of change in technologies: this is the ‘product cycle’ analysis (together with its close relative, the ‘industry cycle’). An early formulation by Raymond Vernon[21] was intended to account for the changing international division of labour — in particular, how it was that industries pioneered in countries like the USA were being successfully transplanted to developing countries. Vernon proposed that, typically, major new products are first developed by advanced and innovative firms in the more industrially advanced economies for their sophisticated markets. The innovators of new industrial products and processes are themselves often the

first users, developing these for their own purposes and later expanding production to cater to other would-be users. The production processes associated with the new products are typically very demanding of technical expertise, which is also concentrated in the more advanced countries. There is a great deal of experimentation with product design and with appropriate production processes, another activity where the more advanced countries have a comparative advantage. But over time, new markets become established, methods of production standardised, and skills more widespread (and the requirement for innovative technical inputs is also reduced as the production process is better explored and understood). The industries producing the new products are said to 'mature' and the important factors in competitiveness shift from investment in R&D and possession of technical skills to the availability of cheap labour for large-scale production. At this point, transnational companies are liable to locate production in lagging countries, to take advantage of their lower costs (and, perhaps, their growing markets), while developing country governments may seek to establish their own infant industries in strategic areas of production.

Moving away from the question of the international location of production and markets, the argument is that a product evolves — 'matures' — over its lifetime. The first models of a new product that are released onto the market may be better or worse approximations to what the 'mature' product will be. Examples might include early motors cars (with coach-built bodies) and bicycles (the Penny Farthing). Typically, they will appeal to restricted sets of users; their production will take place in smaller runs and requires more technical expertise than will be the case if they become established products. This may well mean that they are relatively expensive and that their use may also involve considerable skill or effort, and more difficult installation with more maintenance. (And this is not to mention the difficulty of finding spare parts and people to help with servicing!) For instance, the first home computers were supplied in kit form for users to assemble themselves — the implicit market was one composed of tinkerers. This reinforces the point that early adopters may differ in important ways from later users — for example, in their interest, skills and existing knowledge about the innovation. They may be important sources of feedback to suppliers, providing them with criticism and ideas for product improvement, and evidence about ways in which the innovation may be applied. Such feedback may be conveyed not just by conventional market research, but also through letters of complaint or appreciation to the firm itself, to specialist magazines; discussions at exhibitions; and commentary in the mass media.

In the case of an innovation which does reach take-off, experience will have rapidly accumulated as to its more and less desirable features, and producers will have concentrated efforts on rendering the innovation suitable for larger markets. Often this involves increasing product quality, especially ease of use — though

sometimes ‘luxury features’ will be trimmed off in an effort to lower prices. Take-off may also require the stimulation of production of relevant software and services. The achievement of take-off suggests that a basically satisfactory design has been established. The challenge thereafter is to reduce prices so as to reach the largest markets, and innovative effort shifts toward *process* innovation: methods of cheaply manufacturing the product in bulk. According to the product cycle approach both the product and the methods of producing it evolve during the course of the diffusion curve. More specifically, product innovation is liable to be concentrated in the earlier phases, with process innovation dominating the later phases.

The product cycle approach underlines an important qualification to a simplistic reading of the diffusion literature:

during the course of diffusion, the innovation itself is likely to be changing as innovators take account of market feedback and learn more about the product itself.

This insight is further developed by several recent analysts, who point out that we need to take account of the fact that a successful product often becomes so only because of the failure of other products with somewhat overlapping appeal. Very often several innovators will introduce similar sorts of products, or even quite different products offering some of the same functionality, at roughly the same time. This is because competing firms often try to keep up with each other’s new offerings — and because innovations with partly similar characteristics are frequently based on the same core inventions. In the early stage of a product life cycle, it will be common to find several new products ‘striving’ to occupy similar markets, to fulfil similar sets of functions. At this point in the process, there is liable to be some disagreement as to the exact definition of these markets and functions, and the product design characteristics tried out by different suppliers may vary considerably. David Teece[22] describes this stage where there are strongly contested visions of the major design features as a ‘pre-paradigmatic’ one. The belief is shared that there is going to be some successful product delivering a particular core set of functionalities, but its exact form remains a matter of considerable uncertainty. In later chapters we use the term *product space* to signify such widespread views that a certain class of products will be successful. In our case studies, many believe that there is a ‘product space’ for home automation, electronic messaging or interactive multimedia, but at the time of writing no single product has succeeded in capturing the market.

At the point at which product cycle theory sees effort as being concentrated on product innovations, different designs form a major basis for competition. The

competition between different products often involves different firms championing different product configurations, but sometimes a single producer will experiment with alternative designs, attempting to find out which version of a ‘good idea’ actually grabs the market.

The product cycle approach has been extremely useful in analysing the trajectory of innovations, but it tends to beg certain questions concerning the notion of ‘maturity.’ In this book we explore a number of issues concerning product design and definition in relation to ‘mature’ technologies (such as the television). In bringing together our own evidence on these issues in Chapter 6, we stress the nature of innovation in related products as a *continuous* process or stream, where innovations may evolve at any stage of a cycle for a specific product, as innovations in other technology stream are applied to the ‘mature’ product.

The development of products within the product cycle — or, better, the evolution of the product space — thus involves more than the growth of markets, the entrance and exit of competitors, and the shift in the locus of innovation between product and process innovation. It can also require the establishment of a dominant *design paradigm* — what in the case of industrial innovations is often termed an ‘industry standard.’ The supplier or suppliers whose design paradigm is most successful are placed at a considerable advantage.

Once a dominant paradigm has been established, the focus of competition shifts. Instead of struggling to determine the form of the paradigm, efforts to achieve product differentiation around a core design are liable to become the strategic focus. Firms compete to supply minor variants of the same basic product at cheaper prices, perhaps through supplying cheap versions and more expensive versions with ‘feature proliferation.’

Teece described the factors which influence whether imitators or the original innovators are liable to be successful, as *complementary assets.* These can include:

Services such as marketing and after-sales support (is this seen as a fly-by-night firm, or one that will reliably supply refills, repairs, and assistance of various kinds?);

Complementary technologies which are required to form the total technical system (e.g. will there be a supply of software necessary to realise the value of hardware?);

Technical capabilities in design and production (e.g. is the product perceived as

being reliable and reasonably priced? — several home computer firms have faced problems on this front, notably Sinclair).

The ‘image’ of the supplier can thus influence innovative success. Suppliers who wish to enter new markets may carry an image with them, which serves them well or poorly. Are they seen as being large and reliable, or oversized and stolid, as overly oriented to professionals or to consumers? For example, Atari had problems in acquiring business markets for its ST range of computers in part because of its image as a games company; IBM and BT are disliked by some purchasers simply because they are so dominant. In the 1960s Japanese electronic products (and before these, basic consumer goods like ball-point pens) suffered from an image of poor quality which took years of consumer experience to eradicate; now Taiwanese and Korean firms are struggling to shake off the same image.

Confidence in a particular supplier may be important to the diffusion of a new product; especially so when highly diverse alternative designs are presented to potential users compared to the situation where the paradigm is more stable. The familiar supplier may be believed to have its finger on the pulse of change more firmly than unknown firms, or to be likely to take more pains to ensure future-proofing and backward compatibility for its user base. A much-cited instance in professional applications is the personal computer: the industry standard PC, modelled on the IBM design, was neither the first nor the most sophisticated machine on the market, nor was it even the best value for money (or so most observers other than those associated with this dominant system argue). But IBM was a firm with an extensive marketing system, with maintenance facilities and a reputation for solid reliability and ability to stimulate software developments, etc. Both user-supplier links and non-technical product characteristics had a role to play in this case. A similar instance in consumer products involves standards in VCR systems. For a period of some years in the early 1980s it was unclear which of three competing standards — V2000, VHS and Betamax — would come to dominate. In the end the VHS system pioneered by the smallest firm, JVC, won out against Philips’s V2000 and Sony’s Betamax, in part because the smaller firm was prepared to license its technology to competitors, whereas Sony declined to let other makers put their badges on its machines. In addition JVC in alliance with Thorn EMI and Telefunken recognised earlier than did Philips the importance of software in the form of movie rentals, because Philips was pushing what it thought was a technically superior medium for playing movies in the home, the laser videodisc player.[23]

It is not enough to be the first with a new product. If, before the emergence of a dominant paradigm, imitators can add appealing new design characteristics, they may play a key role in shaping the emerging paradigm. They may overtake the

original innovator in the newly created market. Well-established latecomers may be able to gain market dominance without any substantial technological advance, but merely on the basis of their reputation (i.e. their perceived ability to continue to supply maintenance, software support, upgrades, etc). In contrast, producers who have failed to identify key features of the emerging paradigm may find apparently buoyant markets for their products suddenly collapsing as users move over to the new standard — as was the case with many British microcomputer firms. When the paradigm is well-established, the dominant supplier is liable to find further imitators 'cloning' the design — unless it is so tightly protected by patent or other means that this is impossible.[24]

Often, but not always, the first-comer may have the advantage of establishing a market presence (increasing its chances of observability, of having complementary software, etc.), which makes it difficult for later innovations offering similar functionality to gain a foothold. This may not always be a matter of choice for suppliers — for example, in the scramble to introduce direct satellite broadcast TV in the UK at the end of the 1980s, the British Satellite Broadcasting launch was delayed by problems in the supply of appropriate chips for its new MAC transmission system, which gave the Sky consortium, using the existing technology, a critical lead in establishing themselves in the marketplace. Another example is the delayed introduction of the videodisc, which meant that its value was compared to VCR, against which it came a poor second due to its lack of recording capabilities; had the videodisc been launched earlier, its relative advantages might have been weighed up against those of TV and cinema alone.

For the imitator to pose such a challenge to the first-comer, the imitator needs to be able to imitate. If the know-how involved in the innovation can be strictly controlled (e.g. by being patented or kept hidden), innovators are privileged with respect to imitators. They may lack important comp-lementary assets, but their ability to maintain a strong lead in product development gives them a breathing space to (try to) gain market leverage, obtain important complementary assets, and establish their model as the design paradigm. But if the key knowledge is hard to contain, the pioneering innovators may have more problems. In areas of intense research activity — such as is the case at present with many areas of IT — it may be difficult for any one firm to lay claim to the uniqueness of their products. In some areas, such as software and services, the scope of copyright and patenting remains contentious. In such cases, innovators may seek to maintain a position they cannot retain through privileged technical knowledge, by means of strategic alliances, 'locking-in' users, or other means.[25]

If an innovator is successful with a new product, thus demonstrating the viability of a new market, then competitors are liable to move in. Sometimes this will mean

innovative small firms being challenged by large suppliers from adjacent product areas — often small firms who pioneer new products find themselves being bought out by large firms. If they can establish a secure enough footing, however, they may grow into new large firms themselves. In either case, the nature of marketing is liable to change as larger firms, with more access to advertising, to distributors, and to R&D resources, become active in a product area. Not only is there change in the structure of production: there is also change in the distribution environment. Retailers become more confident in promoting the product, and services like maintenance are supplied as markets capable of sustaining them are developed: users can thus obtain the product more readily, gain more information about its characteristics, and have readier access to any servicing that is needed. Eventually, replacement and second-hand markets may also emerge.[26] The lesson is that:

during the diffusion process, it is not only the product and market that are liable to change: the structure of the industries producing and servicing the innovation are also likely to change.

Changing industry structure may affect the diffusion process (as firms with different geographical scope move into the field, as more suppliers of services and complementary products move in, and so on). Yet another point raised in this discussion is that there are often interdependencies between innovations — and that these may not always be apparent when new products are first introduced. The development of convenience foods especially tailored to be used in microwaves is a case in point; as with synergies in biological systems, so each of these products is boosted by the other. Such *complementary innovations* add to each other's functionality. Software innovations are particularly important to many computer-based products — the success of early Apple computers was in large part due to the pioneering *Visicalc* spreadsheet produced for the device by keen programmers. Software is important for many other IT products, as are communications networks. In addition, we should not forget the role of innovations which increase consumer awareness of product choice, design, and functionality (e.g. magazines for computer users).

The successful product is likely to find more R&D effort expended in the direction of improving it further, and it may attract greater development of complementary products. For example, the more successful home computers elicited more software written for them, in part because more young programmers were familiar with these machines, in part because the markets they offered were bigger. Such factors in turn can enhance the attractiveness of the dominant products, setting up a virtuous circle (for them — a vicious circle of decline for the losers). As for the producers of unsuccessful innovations, or of products for which the successful innovations are providing substitutes, their profits, even their

survival, may be in question. They may switch to producing products that more closely resemble the dominant models. They may seek to make their own products more competitive by reducing prices or changing their features. They may quit the particular product area, or, if big enough, seek to take over a successful upstart competitor.

But ‘maturity’ may be elusive, and product innovation does not always slow down, and industry structure stabilise, in the way suggested above. It is often suggested that a feature of mature markets is the emergence of product differentiation rather than the end of product innovation: here many (usually minor) variations on the product design are promoted, and there may be what is known as ‘feature proliferation,’ as more and more extra capabilities are added to the basic product. ‘Dematuration’ is still possible, however, when a dominant product design is challenged by a radically different version of what is still recognisably the same product. For example, in the PC field, perhaps by the introduction of Graphical User Interfaces (e.g. Windows), or by the development of pen-based systems; in the VCR area, the new standards associated with camcorders’ requirements for small cassettes; and, in another application area, perhaps ‘smart phones’ as against traditional dial telephones. In such cases, a break in market trends and industrial pecking-orders is possible. Such upsets can be prompted by new entrants spotting unexplored niches, new combinations of existing products, or new directions for product development.

Paradigms regained?

Teece’s ‘design paradigms,’ discussed above, refer to the accepted ideas of what a new product will look like. This provides a framework of common assumptions, within which innovators search for design improvements (rather as the original use of ‘paradigm’ to describe a scientific world view refers to the basis of shared assumptions as to the sorts of theory to develop, evidence to use, and questions to ask). A related notion of ‘technological paradigm’ is used by many recent theorists.[27]

The idea here is that, as expertise grows in the characteristics of and opportunities offered by a new technology — and of the nature of the market for these opportunities — a framework of understandings and expectations will be developed by innovators. This framework leads to a concentration of efforts along lines determined by perceptions about what is technologically feasible to achieve, and what users will pay for. The result of this concentration of effort is that technologies tend to develop in predictable ways — there is a *technological trajectory*. Some authors stress the trajectories pursued by particular firms,

capitalising on their own specific knowledge of the technologies involved. Others apply the term to broad trends in technological performance such as were discussed earlier, where the trends result from numerous firms and research establishments competing with each other to provide successful improvements. Thus the trends are not inherent dynamics of technology itself, but the outcome of search behaviour and technological efforts of firms acting within technological paradigms.

These are powerful and persuasive accounts of the innovation process. Yet they harbour ambiguities. In looking at concrete instances, we may have some uncertainty as to which of several possible levels of analysis we should be applying the concept of 'design paradigm.' Take the video recorder — is the appropriate comparison between VCRs, reel-to-reel recorders, and videodiscs? Or is it between VHS, V2000 and Betamax standards? The account is plausible at either level. Similarly, when is a design feature a frill, when is it part of a paradigm? How does one tell when a paradigm is stable? What, indeed, are the criteria for answering such questions? The ambiguities are not necessarily fatal weaknesses, but they do open the door to all sorts of arm-waving and post hoc descriptions masquerading as explanations.

There is another variant of the concept of 'technological paradigms' which is particularly useful in our analysis of radical new consumer products. The products we are looking are based on new IT (Information Technology), and IT itself is often described in two related ways — as being a 'technological revolution,' and as being the basis for a new 'techno-economic paradigm.' The innovation theorist who has been most influential with respect to these approaches is Chris Freeman.

While talk of the 'IT revolution' is so common and casual that we may be inclined to dismiss it as mere hyperbole, in Freeman's analysis technological revolutions are more than just semantic phenomena. He relates them to the development and use of certain fundamental basic inventions — to put it in other ways, on the development of far-reaching technological knowledge — allowing for the introduction of new *'heartland technologies.'* These are products that can be used to carry out operations common to a wide spectrum of economic activities. For example, the application of motor power is required by many activities in manufacturing, transport, agriculture and construction, and substantial changes in these areas of economic activity have been achieved by applying such technologies as water and wind power, steam power, electric power, and petroleum engines (involving distinct heartland technologies). Steam power, in particular, by freeing motor power from dependence on the weather and by reducing its dependence on geography to a considerable extent, allowed for the substitution of machinery for human and animal effort in many factory and transport applications: it was a key component of the great industrial revolution of

the early nineteenth century.

Freeman, discussing industrial innovations, distinguishes technological revolutions from incremental and radical innovations. *Incremental innovations* occur more or less continuously, involving small modifications in products or processes, with minor if any changes in training and work organisation. These often derive from improvements and suggestions supplied by engineers and production workers on the job, or from users themselves. *Radical innovations*, by contrast, involve more substantial change. In the twentieth century, these have often originated from formal R&D activities, which are usually carried out in the suppliers' laboratories. They may involve substantial changes in production processes and organisational arrangements, and/or new products which establish new markets or displace familiar products from established markets. A technological revolution, though including many examples of incremental and radical innovation, is something bigger. Typically it will be based on scientific discoveries, possibly carried out by pure scientists in non-industrial settings ('basic research' in universities and specialised laboratories, for example), which yield new basic knowledge about fundamental chemical, physical, biological or other processes. This new knowledge, and the techniques associated with it, allows for changes to be made in extremely wide ranges of products and processes — not just improvements in a particular class of product (more likely to be an incremental or radical innovation), or even in a whole industrial sector (more likely to be a radical innovation).

A technological revolution, then, involves the application of the new heartland technology across broad swathes of the economy, and the associated changes in products and processes, in working practices and inter-firm relationships, and in the centres of economic power that develop as new opportunities are recognised and seized. The steam engine is frequently depicted as an exemplary new heartland technology. It became the focus of a great deal of innovative effort as smaller and lighter, more efficient and more robust engines were developed. It was seen as presenting opportunities to create new products: the railway engine, the traction engine, and a great many industrial devices that could use the unprecedentedly powerful and reliable source of motor energy. It was applied in a vast number of industrial and commercial processes. Innovation in processes allowed, in turn, for innovation in products: a whole wave of new industrial products emerged as the engineering industries developed. These developments unfolded over a long period of diffusion and experiment, during which period many social, institutional and organisational changes were also tried out.

A new heartland technology may form the basis for many new products and processes, and for radical change in existing products and processes. The new products generated from the new knowledge and techniques are themselves liable

to be subject to incremental innovation over long periods of time; design paradigms will be forged and restructured, and winners and losers emerge among firms. In a technological revolution many innovations are liable to be developed, with many unsuccessful products as well as many successful ones. For a breakthrough to become a heartland technology — which may be a protracted process — there must be recognition that substantial opportunities can be created and seized in many areas of production, and in many new products. The 'swarming of innovations' is also a 'swarming of innovators,' and a concentration of (often mutually reinforcing) innovative practices. This swarming reflects the efforts that are made to capitalise on the perceived opportunities offered by the new heartland technology, or by innovations that already embody some of its potential. Innovators are perceiving new opportunities for products that will reap profits in new or old markets. Users are perceiving opportunities to achieve their objectives — for example, higher productivity in the case of industrial users, more convenient or more pleasant leisure pursuits on the part of consumers. Such new opportunities are presented in market selection environments — through discourse about the new products in trade shows and journals, in mass media and in conferences, in laboratories and retail outlets, and in the course of actual use of the products.

Technological revolutions are said to involve change in 'techno-economic paradigms,' the frameworks of ideas associated with the use of heartland technologies. Essentially, the 'common-sense' notions that we have about the feasibility and value of particular types of activity are seen as being derived from our understandings of the opportunities presented by these technologies. The ways we behave, and the things that we attempt to do, are constrained by these notions. A classical case is the organisation of factories around power sources: for some time after the introduction of electric motors, which allowed for each machine tool to possess its own power source, and thus to be located wherever there was an electrical outlet, the organisation of factories continued to reflect the earlier paradigm of steam power with machine tools grouped together around a central power source. Heartland technologies allow for substantially new common sense to be developed about where production and consumption can be located in space and time, how costly energy will be, and so on.

The argument is that these shifts in common sense have profound implications for the organisation of work and social activities. The skills required, the communication and co-ordination links between different agents, the costs and benefits routinely expected to be associated with different activities — these may all be rethought, but it can take an extremely long time to accomplish. The notion of 'cultural lags' has effectively been resurrected in some of the innovation research literature to describe — or account for — this process. Thus the problems in adapting social norms to the potentials of new technologies is held to be

responsible for the apparent paradox that, despite high levels of investment in new IT over the past decade, our economies have relatively little to show for this in terms of an increased rate of productivity growth.[28]

Freeman, along with many others, has argued convincingly that new IT is at the heart of a currently unfolding technological revolution. The new heartland technology addresses a process which is implicit in all human activities, and thus in all economic production and distribution processes — information processing. Microelectronics has meant that it is possible to apply technology to producing, storing, retrieving, communicating, mani-pulating and displaying information in ways that are considerably cheaper and more powerful and convenient than was previously possible. It would seem to fulfil the requirements for a heartland technology — and the rapid emergence of IT applications across our economies and societies seems strong evidence that a new revolutionary technology has indeed emerged, and that we are entering, or are already well into, a technological revolution.

The implications of this discussion for our studies are numerous, but a few key points may be listed here:

- *there are liable to be a great many new products emerging onto the market, with various design configurations, aimed at applying new IT to industrial and consumer activities;*
- *many products are liable to offer overlapping functionality, and it is by no mean clear which of the 'solutions in search of a problem' will come to dominate;*
- *the process of change is liable to be a long-drawn-out one, with considerable uncertainty as to how the constellation of successful new products will be used; and*
- *this uncertainty is accentuated by the rate of change that is continuing in the heartland technology itself, so that ever more powerful and compact devices are appearing, and can be expected to continue to emerge.*

The social shaping of technology

The discussions to date have made it clear that technological change is a social process, even if some of the theorists discussed use misleading terms like 'natural trajectories' of technological evolution, or even defend 'technological determinism.' Technologies are *shaped* by social actors, to use a term popular with several social scientists. Both innovation theorists and researchers who have

moved into the study of technological change from the analysis of the sociology of science, see several elements to this shaping process.

First, there is the process of choice within the industrial firms responsible for the innovation. We have already discussed some aspects of the formation of design and technology paradigms, but have so far treated industrial innovators in rather monolithic terms. In practice, however, firms are typically composed of numerous individuals and sub-organisations, who do not share all of their perceptions and interests in common.

In order for products to get onto the market at all, there must have been an allocation of effort into developing the innovative ideas — in the step from invention to innovation. Choices must be made, for example, as to the orientation of R&D expenditures. If we take a large corporation with an R&D department as an example, it will usually have numerous alternative directions for new product development. Managers have to appraise market prospects for different products, and balance these against development costs, the challenges that might be posed for the firm by moving into new technological areas or new markets, access to complementary assets, and so on. Decisions are faced as to which products to develop, and what design choices are required to ready them for market. When the innovation is not a single product, but rather a ‘product family’ (e.g. a range of bicycles, loudspeakers, microwave ovens, etc.), there may be choices about what features and functions to combine together. Such decisions bear on the choice of areas of R&D to fund (based on assumptions as to the likelihood of their yielding profitable innovations), as well as on sales and marketing strategies. Senior managers in firms take these decisions alongside numerous other calls for allocation of resources among products, branches of the company geographical areas, and so on. They determine the overall funding given to R&D, the main directions of research to be pursued, and related issues such as the location of research, the time scale within which returns are required, etc. Although these decisions closely resemble the policy decisions on the allocation of scarce resources made by governments, there has been surprisingly little effort by theorists to apply the idea of the ‘politics of the firm’ to the innovation process.

Furthermore, within R&D laboratories and departments, there are also decisions being made. Technology managers and other innovators have to prioritise particular ideas within broad lines of work. Research itself involves generating and testing out new ideas against existing technical knowledge and against those properties of the natural world on which the technologies are acting. Technological paradigms play a role here, in governing the sorts of problem that are formulated and the sorts of solution that are accepted.

The opportunities that are perceived, and the trajectories that are identified, are

thus *social constructs*. To the extent that they are well-founded in technical knowledge, many of these beliefs are liable to be self-fulfilling prophecies, since competitive firms will often act upon the assumption that their rivals are striving to achieve progress along a trajectory. Thus, chip manufacturers create the trajectory of increasing chip performance, because they believe that they have to compete with other firms who will secure and exploit these product improvements if they themselves do not. Some social scientists consider that talk of 'trajectories' and, especially, 'technological revolutions,' is solely a matter of hyperbole — the term 'technological revolution' is just a way of dramatising something that could equally well be described as a 'bonanza,' a 'honey pot,' etc. Hyperbole may well play a role in mobilising actors into participating in radical technological change, to be sure, and it may well be applied in extremely misleading ways. But the fact that numerous trajectories are stressed by commentators eager to make their own distinctive marks, or that every minor development of a new piece of hardware or software is hailed as revolutionary, does not mean that all such change should be regarded solely as 'hype.' Technological trends can often be plotted, and it is a relatively simple matter to demonstrate that IT is, indeed, being introduced with extreme rapidity into a huge range of products and processes as would be expected from a revolutionary technology. It is important both that innovators act upon their assumptions as to trajectories and implications of change, and that they have to test these assumptions, first in the laboratory, and then within the firm and in the marketplace.

It is not enough for research staff to be convinced that they have a breakthrough. Numerous studies have indicated that one of the key factors determining the likelihood of success of such innovations is the existence of a 'product champion' at senior levels — someone to promote and support the innovation process, and to ensure that sufficient time and resources are devoted to it. The other factor that is repeatedly stressed in the literature is the need for innovations to be related to markets: failures are frequently encountered when a brilliant technology is simply brilliant from an engineer's perspective, rather than from that of users.

This leads us on to the second part of the shaping process: the role played by markets. Without advocating any simplistic notion of consumer sovereignty, it is clear that success or failure in the market shapes the technologies that are available, especially for products purchased by final consumers rather than by governments. We have already discussed how design paradigms emerge, and how the consolidation of a particular type of product is liable to lead to R&D being attracted to that area. The point should be made that markets are not neutral 'selection environments,' however (to use the jargon of 'evolutionary' economists). Markets disproportionately reflect the influence of those with more resources to wield in the market, and this may drag other consumers into the use of products they would otherwise have resisted. A good current case is the decline

of vinyl LP production as CDs have proved to be particularly successful and profitable: the result is that followers of new music releases are effectively forced to make use of the more expensive new medium. Perhaps a more dramatic and socially significant case is the decline of public transport in the face of the motor car. And, as has been demonstrated earlier, success in the market need not go to the product which industry insiders consider to be the 'best': the dominant offering may well come from the firm with greater advertising clout or even a better image.

A third aspect of the selection process reflects the fact that purchase is not the end of the story. We have already seen that users may play important roles in the innovation process, with information flows between producers and users being particularly significant at early stages of the product cycle. Industrial innovation studies frequently depict users as making substantial inputs into product redesign — and they may also contribute to the creation of complementary technologies (e.g. software) or new applications of the product. Similar phenomena are visible with respect to consumer products, especially where there is a hobbyist market. In the home computer field in the 1980s, it was also apparent that software often emerged from the user community, and there were many stories of teenage millionaires who had written successful games. But there is a deeper dimension to this. Some commentators refer to the *re-invention* of products by their users, in circumstances where the products are modified, or else are used for purposes other than those originally intended. The home computer is again a good case, with users defining the devices as games machines, despite early promotion by manufacturers of computers as educational or labour-saving products. The later evolution of the product is affected by the types of use to which it is applied.

The focus on the social shaping of technologies does not just draw attention to the roles of individual social actors — engineers, managers, users — in the innovation process. It stresses that social shaping of technologies is a matter of flows of information among social actors, and these flows of information take place through *social networks.* Such networks involve, not just the innovators and users, but also a range of agents including: advertisers; mass and specialist media (the latter includes trade press, consumer magazines, hobbyist magazines, etc.); distributors (retailers and wholesalers) together with, if separate, installation engineers and repair and maintenance services; and producers of complementary products (e.g. software, peripherals and consumables). The social networks to link these agents may already exist when an innovation is introduced into an existing class of products, but it is likely that at least components of them will need to be constructed afresh where substantially new products are concerned.

In the research literature, there are various formulations stressing the role of networks in innovation. One prominent approach is called 'actor-network theory,'

while another writer has talked of the ‘socio-technical constituencies’ required for successful innovation. Whatever the formulation, it is clear that in studying new products, we need to look beyond their original inventors, or the champions they find in manufacturing industries. We find particularly complex webs of social interaction where new IT products are concerned, with a large number of different industrial, government, and consumer communities involved, as amply illustrated in the case study chapters which follow.

New information technology and consumer products

What is new about new consumer IT products? If we are correct that they embody a revolutionary technology, the key step on from earlier means for reproducing and disseminating information is the application of microelectronics and related inventions. Consumer IT applies these new capabilities to consumer goods and services.

Innovators, aware of the opportunities offered by IT, apply it to consumer products and thus create new technological trajectories in these products. Change in the capacity of core technologies implies new opportunities for applications, ranging from minor improvements in familiar products (e.g. somewhat smaller devices, or radios with digital clocks); through major transformations of products (e.g. new combinations of devices, substantially new functions associated with devices); to radically new products (with little in common with established products). These distinctions are not sharp ones, and what a user sees as a radical innovation may not be the same as the supplier’s view — a completely different core technology may be brought into play, for example, but patterns of use may mimic those developed for earlier products. (For example, it is possible to use a word processor just as if it were a typewriter).

While innovators can talk comfortably about changes in the technological performance of the core technologies (deploying measures of information-processing capacity such as processor speed (MIPS), feature density, channel capacity, megabytes of storage, etc.), there is far less consensus as to what parameters are of interest in the consumer technologies. Still, we find some IT-related terms being widely used to describe certain trajectories of consumer product innovation. Thus, as trends in the heartland technology provide new opportunities for developments of applications, so technological trends in IT applications are created and named.[29]

IT can be classified in various ways, although there have been few attempts to do so on a systematic basis for consumer IT.[30] Here we concentrate on three

aspects: the technical trajectory within IT; application areas in everyday life; and the extent of interdependence within systems of products. We will now examine each aspect in turn.

Technological trajectory of IT

Terms applied to consumer IT, but also influential in other applications, include:

Digitisation Microelectronics tends to mean digital information-processing, and computers, communications, and consumer electronics systems are said to be 'converging' as they all handle data in digital form. This means that information generated in one medium can be more readily transferred to different media or processed by different devices — which is the basis of a growth of 'networking' whereby devices inter-relate to one another, and the emergence of 'multimedia' products, which allow the simultaneous manipulation of information composed in audio, video, text and graphic forms. To describe products as 'digital' seems to be used as a selling point, but this should not obscure the fact that there are numerous ways in which this feature can be utilised — to add teletext capabilities to ordinary domestic TV sets, to record crackle-free sound, or simply to add a digital clock or timer to devices.

High volume data storage New products which allow for higher volumes of software storage are being introduced. Some of these exploit digital recording techniques, the most successful product to date being Compact Discs (CDs); but for consumer use this is so far a play-only (ROM) medium, and various recordable digital media are being introduced for hi-fi audio reproduction, including digital audio tape (DAT), Philips/Matsushita's digital compact cassette (DCC), and Sony's MiniDisc. These media enable better quality reproduction, more rapid access to material, and storage of larger volumes of information than previous audio technologies, and are capable of high levels of programmability (e.g. tracks can be selected in a specific order). Although electronic still cameras have been introduced, without great success to date, manufacturers have agreed to standardise digital VCR technology for models expected to appear in the mid-1990s. But even analogue video systems are displaying increased storage capabilities: new video recorders squeeze twice as much on to tapes as earlier models. When new products involve data storage, increases in storage capacity are also typical: consider the progress in home computers, from no data input, to tape, to floppy disc, and now to CD-ROM.

'Smart' products With large and continuous decreases in the costs of storing, transmitting, and manipulating data, IT-based controls, memories, etc. are added to many products, and existing electronic functions are often enhanced. Products

are then often described as ‘smart’ products, implying that they have been supplied with intelligence — however primitive in practice this often is — and sometimes products are referred to as *intelligent*.[31] The capacity to store data (memory) is being added to many products. The telephone answering machine, and ‘smart phones’ which can store and recall frequently required numbers illustrate two ways in which this may be achieved — by use of storage media such as audio tape (most commonly to store speech), or by use of RAM on microelectronic chips (most often to store details of the operation of devices, though digitised speech may also be recorded). With the addition of memories, devices can report on their previous states — most notoriously, perhaps, weighing machines that report on the user’s progress (or regress!)

Miniaturisation Decrease in the size of equipment, since microprocessors are much smaller than conventional valves and transistors. The term is used not only to describe the decreasing scale of the core technology of microelectronics (where increasing power is compressed onto chips — their ‘feature density’ is said to increase), but also the physical shrinking of many applications. Thus we have ‘mini-’ and ‘micro-’ products.[32] The move from cumbersome, typically large facilities, requiring expert skills to use, to products that can be much more widely diffused, is indicated by the prefix ‘personal’ (sometimes used synonymously with ‘portable’ as in ‘personal stereo’ and ‘Personal Communication Networks’ or PCNs). Another way of expressing the shift in focus of activity associated with downsizing of equipment in the office environment is to refer to ‘desktop’ systems, while for consumer applications the equivalent prefix is more often ‘home.’ Smaller devices are potentially more portable, and portable TVs, video games machines, and video recorders are now becoming commonplace. We shall see below that portability and mobile communications complement each other in important ways.

Programmability Microprocessors can be programmed to carry out a set of instructions (a ‘program’). Potentially, then, these devices are very flexible — they can be programmed and reprogrammed to behave in different ways — effectively to become different pieces of equipment. Software becomes essential to drive the hardware, with programs a key element of the total system (and an important part of its costs). Software also becomes highly important, as products allowing access to information resources are developed. Another relevant term here is *control*. IT can be used to process information of any kind that is encoded, or can be ‘captured’ and encoded, in electronic form. This means that the new consumer products are not only involved with delivering, recording, or transmitting information: they may also be controlling devices on the basis of programs and data inputs. Thus new consumer IT also encompasses household appliance control (and also the use of IT to control external services, as in emergency alarms).

Human-machine interaction The increased speed, capacity, and reliability of data-processing devices may be used to increase the ‘user-friendliness’ of systems, so that they require less training and are more suitable for non-expert users. Additionally, improved interfaces in the form of new controls and displays are added to devices, as IT permits more detailed monitoring and reporting on performance. The new controls may be designed so as to aid users faced with complex decisions (e.g. camera focusing systems, sensors in microwave ovens). But the user may also be deluged with data in the move toward more programmable ‘brown goods’ and ‘white goods.’ Warning systems may be introduced to inform users if equipment is malfunctioning or being badly used. Maintenance data can be presented, as in motor cars whose ‘autodiagnostic’ systems help garages to establish the source of problems. Energy conservation features may be added: greater energy efficiency may be attained by regulating motors’ performance microelectronically; energy-intensive household devices may be made to operate at times of low electricity tariffs.

Interactivity New media and other products can interact with users in a ‘conversational’ manner, rather than presenting a standard package of information in a linear flow. With many new products the package of information delivered, or the operations performed by the product, is responsive to inputs from the user. For example, queries to an on-line database yield a specific selection of material, as opposed to a traditional encyclopaedia or TV broadcast which is always the same. There are different levels of interactivity, ranging from minor enhancements to devices (e.g. more programmable audio systems) through products which demand active participation from users (the choices presented on TV screens to the players of computer games, where the user’s responses determine the course of events).[33] This term is often called into play as a prefix: ‘interactive video,’ ‘interactive TV,’ ‘interactive compact discs,’ etc.[34]

Multimedia New IT products are being used to combine material hitherto mainly restricted to distinct classes of media (such as text, hi-fi sound, video images). A familiar example is teletext, which presents text information via the TV screen. New information-processing capabilities make it possible for new experiences to be created ‘on the fly’ (e.g. to ‘sample’ sounds, or capture images from TV broadcasts, to view them as stills or print them out), as well as for information from various sources to be packaged in new ways. Information of all kinds is increasingly being generated in digital form, which opens up additional possibilities for processing it.

Computer-communications Data can be processed in computers and transferred from device to device via telecommunications links. In industrial applications

there is much talk of IT networks. New consumer applications of IT telecommunications include cordless and keypad telephones and answering machines, which are the most visible devices at the time of writing. Multi-user communications are mediated by some of the new products (e.g. chatline and messaging services, multi-user on-line games), so they are not simply means of delivering information from commercial or public service providers to 'passive' consumers. In principle, messages can be conveyed from one consumer product to another in a remote location, as is the case in some alarm systems, and in some integrated hi-fi systems.

Intercommunicating devices become more feasible as microelectronic controls are added to products: this means that devices can report on their status to remote interrogators, and be controlled remotely — for example, telephone answering machines can replay the messages they have recorded over the telephone system. Thus the ubiquitous remote controls (mainly hand-held infra-red devices), used for control of audio-visual equipment, are being complemented by more long-distance *telecontrols.* It is becoming possible to transmit greater volumes of data, in part through data compression techniques, in part though new methods of delivery of data, including new cable TV (CATV) networks, and the early stages of the evolution from existing telephone systems towards the Integrated Services Digital Network (ISDN). More scope for broadcasting data is being introduced through CATV and Direct Broadcast Satellite (DBS) systems.

Mobile communications (cellular and portable telephones) have been very successful with industrial and professional users, and efforts are underway to introduce consumer cellular telephony.

Asynchronicity is another term with a pedigree in the computer field. While broadcasting media to a large extent freed information from space constraints, and telephony did the same for interpersonal communications, these media were still highly time-bound. The user had to be around at the right time to receive the broadcast or telephone message. The video recorder and telephone answering machine are examples of innovations which loosen this constraint, and new media such as electronic messaging are premised on the functionality of asynchronous communications, allowing users to interact at a pace that is mutually acceptable. The opportunity to time-shift TV broadcasts by video recorder is a further contribution to the demassification of this medium. Many consumer electronics products already were asynchronous — record and CD players, for example — but the facility is now added to a wider range of media: and as they become asynchronous they also tend to become more interactive.

Application areas

As the discussion above suggests, IT applications can be very diverse — from satellite communications to industrial robots, from ‘smart’ telephones to High Definition TV, from computer games to videotex systems. They can be very diverse, precisely because IT can be used to enhance the informational components of just about any product. Consumer applications of IT span practically all areas of consumer activity:

Entertainment (where audio-visual equipment (‘brown goods’) such as hi-fis and TVs are being transformed by new controls and displays, and where games machines of various types have been introduced);

Domestic work (where ‘white goods’ such as washing machines and cookers are also subject to change, for example with new controls and displays);

Transport (the motor car is a major user of microprocessors, for in-car entertainment and for more efficient operation);

Communications (telephone answering machines and portable phones are evident applications);

and areas such as *health* (e.g. digital thermometers, baby alarms), *sports* (computerised sports equipment), *personal security* (intruder alarms, etc.), and many others.

Efforts to apply IT in such products may take one or more of a number of forms — all of which will be seen to relate strongly to the specific characteristics of IT identified above.

Innovators may seek to improve the perceived effectiveness, quality or power of established consumer technologies by applying IT.[35] Among the key trajectories here are the development of features such as we have already noted: miniaturisation and portability; communications capabilities; program-mability; high-volume data storage; memories; improved interfaces; and so on.

As well as enhancing familiar products by incorporating microelectronics within them, some consumer IT innovations are *new products*, which accomplish activities in new ways, sometimes facilitating such change in behaviour that we may begin to speak of new activities. Some products already mentioned are often identified as new products: home computers, microwave cookers, CD players, and so on. Whether these really *are* new products may be challenged: do they really substitute for traditional products and/or allow for new activities, or are they simply new peripherals and add-ons to familiar products? Thus CD players could

be seen as new products substituting for conventional record players, or as new peripherals to the hi-fi systems; telephone answering machines may be seen as new products, or as add-ons to the household telephone; even VCRs can be seen as extensions of the TV. Whether consumers see innovations as radically new products will probably depend on the extent of learning required to use them, or the extent of behaviour change associated with this use. Thus video games consoles and home computers used for games-playing both provide alternatives for traditional board games and add interactivity to TV viewing.

Interdependence of systems of products

In addition to new products, we can also conceive of *new systems of products*. Miniaturisation makes it feasible to put more devices into the same chassis (as in small 'rack' stereo systems and ghetto blasters), but new IT also allows for more integration of functions, and for networking of products distributed around (and even outside of) the house. This goes beyond, say, simply sending audio signals from an amplifier to other rooms in the house; it allows control of the amplifier, the radio, and other types of equipment, from distant locations. 'PeriTelevision,' for example, involves using domestic TVs to display messages (from doorbells, alarms, etc.). More ambitious home automation systems allow for the control of devices from a central location, or from any point where a communication terminal can be used. It thus becomes possible to think of consumer technologies, not just as single products, but as systems or networks which involve interdependence between products. Specific items of equipment can no longer be viewed in relative isolation: their use will be affected by the structure of the network in which they are located. Telecontrol is extended to increasing numbers of devices, and — or so it is forecast — this will lead to new forms of integrated home systems. New communications systems are emerging within the home, from simple infra-red controllers and devices that communicate via mains signalling using the household electric circuitry (e.g. baby alarms, local telephones), to more advanced systems (e.g. integrated home security systems, and systems that relate audio and video entertainment from room to room) which may use radio, infra-red, or cable media.

We have seen that products can be applied to many household activities, and that they can range from minor modifications to familiar household equipment to whole new systems of consumer products. But a further set of distinctions is important for the innovation and diffusion process, in large part related to the types of complementary innovation required by a new product.

Some innovations are *stand-alone devices* sold as a complete package by themselves. Many traditional consumer products, like bicycles, motor cars, vacuum cleaners and refrigerators require little further input, except perhaps

power supplies and occasional maintenance. A solar-powered calculator is an IT example. The operation of stand-alone devices may require 'consumables' — in traditional domestic equipment these might include the detergent and fabric softeners used in washing machines — and, of course, the materials which they are processing (convenience food in microwaves, clothes in washing machines, etc.) It may be helpful to identify IT products as stand-alone if their use is not dependent upon informational inputs from other products. Of course, microelectronics depends on programming of some sort, but this can be 'hard-wired' — embedded in the circuitry. User instructions can be input by typically pressing a few buttons, twisting a few dials, etc; and users can produce their own software as in home-made video films and musical compositions. Given the nature of IT, many products can be in principle linked to other products, so the definition of stand-alone may in large part reflect usage patterns and the images of products as diffused through example and through the media. Thus while the audio recorder could be an instrument for recording family conversations (and there are people who send each other audio tape 'letters'), it is typically used for playing (or copying) pre-recorded software, and not primarily as a stand-alone product. The same is true for the video recorder, but not the camcorder. Products that can be networked, but which function adequately by themselves are appropriately treated at present as stand-alone products — although this may change if home automation systems take off in the future. The microelectronics-controlled washing machine is currently a standalone innovation, since the consumables purchased for it are not primarily information inputs. We can also put in this category other domestic appliances such as microwave ovens and many new cookers, dishwashers, and products which are mainly used by consumers to create their own recordings or informational outputs, such as camcorders, music synthesisers, and the electronic still camera. While some of these products may be used with purchased software, they are typically used for user-produced information, with their consumables being blank tapes, discs or cartridges rather than pre-recorded information products.

By contrast, *software-dependent devices* are critically dependent upon externally supplied information, in the form of broadcasts, telecommunications, or data supplied on information storage media like discs and tapes. Let us first consider information products supplied on tapes, discs, and similar media, where the consumer typically buys or rents the physical carrier of the information along with the information itself. Software is the more traditional informational consumable: piano rolls for player pianos, audio recordings for LP players and cassette recorders, and more recently videotapes for VCRs. Software programs are now also supplied in order to control the functioning of products in ways beyond simply reproducing recordings. Computer software for home computers and video games consoles is the most obvious example; software may be applied to enhance some stand-alone products, e.g. 'sound bank' cartridges for music synthesisers,

electronic aids for sewing and knitting machines.

Both types of information markets grow alongside hardware markets — and in scale, often they surpass it (e.g. many CD owners rapidly acquire music collections considerably exceeding the value of their player, many home computer owners purchase — or pirate — large volumes of software). *Standards* have proved very important in the delivery of both kinds of information product: the agreement of CD-Audio standards doubtless facilitated the diffusion of the hardware and software alike; while some home computers have reportedly been regarded as less useful on account of limited availability of suitable software.

Broadcast-dependent devices receive informational inputs — mainly software[36] — delivered by radio frequency transmissions or CATV links. These services are 'point-to-multipoint,' with communication from one source to many recipients, typically based on rather expensive broadcasting facilities (though these need not be so costly as to prevent pirate radio and TV stations!) Inexpensive broadcasting equipment, such as Citizen's Band (CB) radio, is used by consumers in a manner more closely resembling many-to-many and one-to-one networks as discussed below. One common early view of radio was that it would be used predominantly in this way, but this has not been the case.

Large audiences mean that the delivery of programmes per individual user can be relatively inexpensive. Consumers access radio and TV programmes, traditionally paid for by licence fee or advertising (unlike software supplied on CDs and LPs). Subscription services and pay-per-view services are still relatively uncommon, at least in the UK, so while users recognise that services are needed to make their devices useful, these services are neither paid for individually, nor are they delivered via a physically tangible medium. Satellite and cable TV operators are seeking to change consumer expectations, by offering consumption related to payment on a per programme or per channel basis. These operators have to offer programming advantages in competition with existing channels, and with videotape rental outlets. (Thus the effort to acquire exclusive rights to major sporting events, and the extensive use of 'news' stories in the tabloid press owned by satellite broadcasters to promote their services).

Conventional broadcasting has recently been joined by digital transmissions: teletext and Radio Data Services (RDS). Teletext information broadcasts are usually in the form of 'pages' of news and other information, more or less like a conventional programme, although there is some use of teletext to transmit computer software and for data broadcasting by industry. RDS can be used for equipment control: the signals can be used for tuning purposes (e.g., radios can search out news broadcasts) or even to instruct the radio to turn on or change

channels for an emergency broadcast. Radio transmissions have occasionally been used for other types of equipment control — for instance, some domestic storage heaters have been instructed remotely in this way to turn on when electricity tariffs are at lower levels, and clocks are currently being marketed which set themselves on the basis of ultraprecise radio timing transmissions.

Network-dependent products here refers to those relying on telecommunications networks. The telephone network has long provided a service to consumers, who are used to paying for the ability to communicate on a one-to-one basis (rather than for the access to software on the network). Consumers use handsets (the 'peripheral' to the network) to access other people for business or social purposes, and themselves generate some part of the information that is conveyed. The service supplied, then, is not typically information provision (though various information services — time, weather, etc. — have long been available), but rather *interactive communication*. This is a kind of interactive and do-it-yourself software, recently augmented by the proliferation of commercial information and communication services such as 'adult conversations,' dating services, chatlines, financial advice, and recorded messages. These are innovations involving the network supplier, or new service companies who have hooked into the network.

New IT has facilitated the development of new telecommunications peripherals and facilities. Conventional telephone answering machines, by contrast, are widely diffused peripherals. Asynchronous messaging — the storage of text or voice communication, so that the recipient or some human surrogate does not need to be physically present for a message to be left — becomes possible via facsimile (fax), electronic mail, videotex and voice messaging systems. While these have not to date made a substantial impact on consumer markets in the UK, they have become established in some business settings.

The newer telecommunications network services also enable some applications that are in some respects like the one-to-many features of broadcasting. For example, videotex, fax and electronic mail services often offer 'electronic newspapers,' 'letters to the editor,' and other types of database that users can access rather as they might access TV programmes or teletext signals. However, the services we are here considering are not broadcast continually (like teletext) or only at fixed times (like conventional TV). They are transmitted to the user on demand, and may be adapted to user requests (as in the case of databases which deliver only material chosen by certain keywords). In some cases the services are many-to-many: in chatlines (which may be voice or data), the user can add messages to an accumulating correspondence, or can immediately interact in real time with other users who are currently on-line (much as several people can join in a CB conversation).

Unlike the three earlier classes of consumer IT product, how many other users there are is of direct consequence to the consumer of network-dependent products: since each successive adopter means more other users with whom one can potentially communicate. This may affect diffusion processes, since the perceived value of the product may be a function of its degree of adoption: there is generally believed to be a 'critical mass' of users required to make the innovation attractive. (The differences in diffusion dynamics are often only a matter of degree, since other types of innovation feature some indirect equivalents: e.g. the availability of advice, support and back-up increases as more people adopt the innovation; the chances that stable standards will develop increases with the size of the market; as does the range of available software; and it is often the case that the innovation's price falls and performance improves over the diffusion curve).

All types of software-dependent product require that informational inputs are made available, in the form of storage media, broadcasts, or network services. Hardware manufacturers are thus dependent upon the availability of these complementary service products in order to secure consumer markets. One of their big challenges must be convincing the potential users that worthwhile services are available (and will continue to be available for a reasonable time) at reasonable prices.

Our case studies

The range of IT-based consumer product innovations is so great that it would be impossible to follow all of them in any detail. Thus we chose three particularly interesting examples of radical consumer product innovation for particular attention, although we have been continuing to assess the whole field of consumer IT in less depth.

Our cases were selected to exemplify some of the most important types and trajectories of development, as well as for more pragmatic reasons. We sought examples where there is significant product development underway in the UK, which considerably restricted the range of potential cases. We have cases of software- and network-dependent innovations, but not stand-alone or broadcast-dependent products. The bulk of our research activity has been conducted within the UK and, to a lesser extent, Europe: we have been able to interview some US and Japanese informants, but we were aware that our study was bound to be limited geographically, so this influenced our choice of studies. Since IT development is very much a global phenomenon, we cannot claim to have comprehensive evidence on the technologies we chose to study; nevertheless, we believe that we have amassed extensive material on all of them, even if we have much more depth of knowledge on UK and European developments.

We have selected three case studies:

1 *Home automation products.* Here we are interested in efforts to create integrated systems of consumer IT products: what are known variously as ‘smart house’ or ‘intelligent home’ systems, ‘interactive home systems,’ ‘home networks,’ ‘domotique,’ ‘batimation,’ and so on. The challenge for suppliers here is to produce and market not individual products, but to succeed in creating and marketing a viable mode of integrating products and providing control systems for such products.

2 *New text-based messaging services.* These are examples of network-based goods and services. While versions of services like electronic mail and videotex have been aimed at consumer markets for a decade now, there has so far been little success in achieving this; and while facsimile has taken off in business applications, it has yet to become familiar as a consumer good.

3 *Interactive CD-based multimedia products.* These derive from an instance of a software-dependent innovation. The new products here use optical disc technology, already familiar as a medium for audio recordings (CD-Audio), to deliver additional types of information (text, graphics, video) in new, more interactive ways. New products here include interactive CD (CD-I), the self-explanatory CDTV, Digital Video Interactive (DVI), and more recently the Video Information System (VIS).

These products and technologies are a very small sample from a very large range of new consumer IT, and we do not claim that they are typical of consumer IT in general. They do, however, provide important illustrations of many of the features of new consumer IT that we have identified in this chapter, and Figure 1.1 shows which of the three sets of factors identified above are applicable in each case study. Our research methods have been conventional: interviews and study of trade and other literatures. Our interviews have concentrated on various types of innovators (R&D managers, key industrial figures, owners of small innovative firms) and those around them (marketing managers, consultants, journalists, other researchers). We have attended trade shows and industry workshops, and perused the trade press. We have been drawn into closer relations with certain sectors of the industry, providing consultancy inputs in product design processes; this has provided us with valuable insights into the product development process, being privileged to be exposed to presentations of new product ideas and associated

ideas about markets and marketing; and one of us is now editing an industry newsletter in one of the areas we have chosen for study.

But in addition to drawing on the innovation research literature discussed above, we have drawn on a second body of work, to which we now turn — social studies of consumption.

Notes

1 New products can be physical artefacts (such as a compact disc layer) or services (such as telephone call diversion). Throughout this book we use the term 'products' to apply to both, unless the context makes it clear that a distinction is necessary.

2 See M.B.W. Graham, *RCA and the Videodisc: The Business of Research*, Cambridge: Cambridge University Press, 1986.

3 Marx's position (or rather, positions, since his view evolved over his massive written output) is often presented as a form of technological determinism, in which change in technology in production (the base) is responsible for changes in social affairs (the superstructure). Over the years, elaborations and rebuttals of such readings have reached sophisticated levels.

4 It is interesting to note that the author of the classic synopses of this tradition, Everett Rogers, has recently written within the IT field on both the social psychology of innovators, and on diffusion processes. See E.M. Rogers, *Diffusion of Innovations*, New York: Free Press, 1980.

5 L.G. Haddon, *The Roots and Early History of the British Home Computer Market: Origins of the Masculine Micro*, Unpublished PhD thesis, Imperial College, University of London, 1988.

6 See Rod Coombs, Paolo Saviotti and Vivien Walsh, *Economics and Technological Change*, London: Macmillan Education, 1987, for a good introduction to these issues from an economics perspective, and Rogers, *op.cit.* for a more social-psychological perspective.

7 This latter point means that one needs to be careful in distinguishing between diffusion data that cite the percentage of individuals or households acquiring a product over time, and data which chart product sales over time (which will

include cases of replacement, multiple ownership - and of purchase but subsequent disposal - of products).

8 Information can also be conveyed through mass media, in journalism and advertising, and by mailshot and retail store-based marketing campaigns. Consumers may be wary of such information sources, of course, but they can bring new products to their attention, and lead them to actively search out more information about them.

9 However, there is a persistent line of criticism as to the generation of self-fulfilling prophecies in the use of such models in planning - for example in the extrapolation of car ownership trends to determine road-building requirements. See, for example, Jonathon Gershuny 'Transport forecasting: fixing the future,' and Roy Turner and Samm Cole, 'The Brighton Marina: a case study in arbitrariness, uncertainty and social welfare in planning models' in Tom Whiston, ed., *The Uses and Abuses of Forecasting*, London: Macmillan, 1979.

10 For the mathematically inclined, the formula is $dx(t)/dt = b.x(t).(1-x(t))$. The integration of the equation yields two constants, one representing the take-off point and one the speed of the whole process; applying it to real data assumes that we know the parameters of the potential user population. Coombs et al., *op.cit.*, note that a case has been made that different types of diffusion curve can be expected for goods that are simple, inexpensive and mass produced as opposed to these which are complex, expensive, and built in a small-batch or one-off manner, with the former (which corresponds most closely to consumer goods) taking rather less of the pure logistic curve.

11 Nearly two years after market launch, the price of an HDTV set in Japan was ¥1 million or £6,000 and only 15,000 had been sold. Most observers think that the maximum price for consumers to begin buying is around ¥400,000 or £2,400. From interviews with, inter alia, officials at the Hi-Vision Promotion Center, Kawasaki, Japan, April 1993.

12 Jill Hartley et al, *Public Acceptance of New Technologies: Innovation and the Consumer*, Manchester: University of Manchester, PREST, 1985. Chapter 5 notes some evidence that the same may be true for interactive compact disc (CD-i) players.

13 Rogers, *op.cit.*, notes US data claiming that IT pioneers are not first to try other innovations, citing health clubs, wood burning stoves, and new types of bank account as examples.

14 Rogers, *op.cit.*, p. 117.

15 Although the reverse may be the case for some groups where innovations become identified with lower status groups, as may be the case with satellite dishes in Britain.

16 Interesting studies include William F Ogburn's *The Social Effects of Aviation*, Boston: Houghton Mifflin, 1946; William F Ogburn and M F Nimkoff, *Technology and the Changing Family*, Boston: Houghton Mifflin, 1955; and the retrospective essay by S Colum Gifillan, 'A sociologist looks at technical prediction' in James R Bright, ed., *Technological Forecasting for Industry and Government*, Englewood Cliffs N.J.: Prentice-Hall, 1968.

17 Ogburn saw the social implications of technological change in terms of a 'cultural lag' of society behind technology - an echo of Marx's influential base and superstructure formulation. Much of the current literature on the implications of IT is little more sophisticated, moving from an extrapolation of trends in the performance of microelectronics and optical fibres etc. to a set of judgements about the patterns of application and 'impact' of these technologies.

18 An obvious implication is that would-be innovators should be scanning their own and adjacent industries with an eye to ideas that might be combined with their own products and processes. For the view that one of the factors behind Japanese success in innovation in high technology comes from just such scanning, see F. Kodama, *Analysing Japanese High Technologies: The Techno-Paradigm Shift*, London: Pinter, 1991.

19 Even though there are believed to be physical limits to the amount one can cram onto a silicon chip, there are new types of chips to be explored, such as optical chips, three-dimensional chips, and the like.

20 And, as we shall see, such trends may be used as evidence is on what consumers want (i.e. the development of many products with a specific feature is taken as indicative of consumer demand for that feature).

21 The account of the product cycle was formulated in Raymond Vernon, 'International investment and international trade in the product cycle,' *Quarterly Journal of Economics*, 80 (May 1966): pp. 190-207.

22 D.J. Teece, 'Firm boundaries, technological innovation and strategic management,' in L.G. Thomas, ed., *The Economics of Strategic Planning*, Lexington, Mass.: Lexington Books, 1986.

23 For an account of the VCR format battle, see A. Cawson et al, *Hostile Brothers: Competition and Closure in the European Electronics Industry*, Oxford: Clarendon Press, 1990; and A. Cawson, 'Running a High-Tech Industry: Consumer Electronics' in *Running the Country*, Unit 13 for Course D212, Milton Keynes: Open University Press, 1992.

24 An example of struggles to protect a paradigm is the legal battle pursued over Graphical User Interfaces. Apple successfully commercialised these and, despite having borrowed the idea in the first place from Xerox, subsequently sought to stop Microsoft emulating it in its 'Windows' environment for PCs.

25 See G Thomas and I Miles, *Telematics in Transition*, Harlow: Longmans, 1989.

26 See James M Utterback and William J Abernathy, 'A dynamic model of process and product innovation,' *Omega*, 3, 6: (1975); reprinted in Christopher Freeman, ed., *The Economics of Innovation*, Aldershot: Edward Elgar, 1990; and James M Utterback, 'Innovation and industrial evolution in manufacturing industries,' in Bruce R Guile and Harvey Brooks, eds., *Technology and Global Industry*, Washington: National Academy Press, 1987.

27 For example, Giovanni Dosi, 'The nature of the innovative process,' in Giovanni Dosi, Christopher Freeman, Richard Nelson, Gerald Silverberg and Luc Soete, eds., *Technical Change and Economic Theory*, London: Pinter, 1988; and Gerlad Silverberg, Giovanni Dosi and Luigi Orsenigo, 'Innovation, diversity and diffusion: a self-organisation model' in Christopher Freeman, ed., *The Economics of Innovation*, Aldershot: Edward Elgar, 1990.

28 This is a highly contentious topic. Some commentators argue that conventional estimates of productivity are not appropriate to a new paradigm. See, for example, OECD, *Technology and Productivity: The Challenge for Economic Policy*, Paris: OECD, 1991.

29 The following draws on Everett M Rogers, *Communication Technology: The New Media in Society*, New York: Free Press and London: Collier-Macmillan, 1986. Rogers discusses interactivity, asynchronicity and demassification, and his Table 2.2 is an interesting attempt to classify various new media on these three dimensions. Demassification refers to the declining dominance of traditional mass media, where it could be assumed that users would be receiving effectively the same service - and indeed, that large proportions of the population would be viewing the same programme at the same time. In many respects demassification results from greater interactivity, but it also reflects the greater choice in media

use made possible by, for example, video rental libraries and proliferating TV channels. In addition, some new products apparently restore some of the scope for do-it-yourself home entertainment (do-it-yourself video recording, music synthesisers, etc.).

30 For one such which draws on the approach developed here, see A. Cawson, 'Innovation and consumer electronics,' in M. Dodgson and R. Rothwell, eds., *The Handbook of Industrial Innovation*, Cheltenham: Edward Elgar, forthcoming.

31 Unfortunately the industry antonym to 'smart' is not 'dull' or 'uninformed,' but the offensive 'dumb.' This is a term with lineage in the computer environment, e.g. 'dumb terminals.'

32 Again the terms 'mini' and 'micro' have clear antecedents in the computer industry, though uses of 'mini' to describe skirts and cars were established in the 1960s. The term 'pico-' has been employed as a prefix for even smaller products, but has so far failed to catch on widely.

33 For further discussion of the multifaceted nature of interactivity, see G. Thomas and I. Miles, *op.cit*., and the case study in Chapter 5 of this book.

34 Its origins seem to lie in the transition from time-sharing and batch-job computing, where users had to wait their turn for their programs to be processed, to interactive computing, where the programs were handled in real time.

35 Not all of the new features we discuss are absolutely contingent upon new IT: some were already apparent before microelectronics, and others might be obtained in other ways. But the cost-reduction and other features of new IT have given them a powerful boost.

36 There has been some transmission of computer software via broadcasting; and radio is used in some regions of the UK as a medium to inform energy-intensive appliances to turn on or off in accordance with tariff changes.

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TECHNOLOGICAL TRAJECTORY	Home automation products ①	Text-based messaging services ②	Interactive CD-based multimedia ③
- digitisation	+	+	+
- high volume data storage		+	+
- 'intelligence'	+		+
- miniaturisation	+		+
- programmability	+		+
- human-machine interaction	+	+	+
- interactivity	+	+	+
- multimedia			+
- computer-communications	+	+	
- asynchronicity		+	

APPLICATION AREAS	①	②	③
- entertainment			+
- domestic work	+		
- transport			
- communications		+	
- health	+		+
- sports			
- personal security	+		

INTERDEPENDENCE	①	②	③
- stand-alone			
- software-dependent			+
- broadcast dependent			
- network dependent	+	+	

Chapter 2

Consumer products and markets

Introduction: consumer markets and consumer studies

The previous chapter introduced several key themes of this study by way of a review of relevant points emerging from the innovation research literature. Although we were able to illustrate the discussion with reference to consumer products, most of this literature dealt with industrial innovation. Many commentators — as we shall see — suggest that this limits its value for thinking about consumer product innovation. The demand for industrial products arises from demand for final products, which include consumer goods and services (and also government expenditure, military activity, and the like). To use economics jargon, it is largely ‘derived’ as opposed to ‘inherent.’ Industrial goods and services are intermediate products, consumed in the process of creating final goods and services. The purchasing decisions are made by firms (or, rather, their managers) and not by members of households.

But how far do these features make consumer products and markets different in other respects? A first point to make is that social science has diverged in its analysis of the two types of market — and to some extent in its analyses of consumer and industrial products too. Several distinctive lines of social research are concerned with consumption, and often these are conducted in considerable isolation from related (whether parallel or divergent in reality!) lines of study of industrial behaviour. Thus the sociology of consumption, and related areas of cultural studies, have developed their own terminology and conceptual tools. At first glance these have little resemblance to those examined in the preceding chapter, although there is more in common than may meet the eye. This work does, however, add to the contribution made by innovation theory in stressing the active role of the user in the process of innovation, and by drawing attention to the symbolic nature and meaning of products.

We shall review some of the contributions which these studies can make to our task in this chapter, This work does not constitute the systematic theorisation of innovation, as attempted by the writers whose work was reviewed in Chapter 1, and we make no attempt to be exhaustive. Rather, we wish to draw attention to several approaches, or ways of thinking about products, which we have found useful in our study.

Our review is structured in terms of the various ways in which consumer products and markets may differ from their industrial equivalents.[1] Major contrasts can certainly be identified between consumer and industrial markets. But before going into these, we wish to make one point about the markets themselves, and one about the divergent lines of research.

As to markets, it is important to stress that each type of market is actually composed of a vast number of sub-markets. In other words, each type of market is internally highly heterogeneous, and any sharp distinctions drawn between them are liable to blur, in practice, in the case of at least some of the sub-markets.

Both industrial and consumer markets include diverse sub-markets such as those for livestock, energy supplies, and electronics goods. To be sure, the marketing and treatment of pets differs from that of farm animals, the volumes of power consumed by firms and households differ by many orders of magnitude, and the electronics they use may be of quite different orders of complexity. But in many cases the two major types of market do overlap in practice. For instance, though some industrial markets concern raw materials, near-finished products and specialised industrial equipment, others deal with products that are physically identical to consumer products (such as hammers, nails, telephones, video recorders and basic telephone services). Consumer products are often mass market versions of what were first industrial products — from the sewing machine to the home computer. In some cases a product is deliberately designed to cater to both consumers and industrial customers (for example, many

lower-priced PCs are aimed at small businesses, and at students and home-based workers).

So differences between industrial and consumer markets may often be matters of degree rather than of absolute contrasts; some consumer markets may be more like the typical producer market than like other consumer markets, and *vice versa*. But there may nonetheless be considerable point in considering what the 'typical' differences between the 'typical markets' are. Even if often flouted in practice, a number of features do appear to distinguish many consumer and producer markets from one another. We shall shortly consider some of these features.

But first a word about the approaches taken by social researchers to consumption as contrasted to industrial behaviour. There are numerous strands of social analysis applied to consumption, though much of this work only tangentially addresses technological change. As we shall see, much of the analysis is influenced by studies of fashion, and of consumption as expressive of status and social values. The stress is paced on symbolic aspects of consumption, and some of the most interesting studies demonstrate the role of 'consumers' (the term is treated with increasing caution) in creating the meanings and practices associated with products, and as themselves playing constructive role in determining fashion change and the like. Some arguments of this sort can be dismissed as the attempt by advertisers and market researchers to legitimate their activities by portraying themselves as responsive to consumer demands, but there is also a large body of work — spanning studies of specific youth cultures through to diagnoses of postmodernism which see consumption as something that is produced by consumers themselves, using the artefacts that industrial society supplies them with.

However, consumption also attracts its share of moralistic writers, and the case is frequently made, too, that many consumer products are diffused among the population as a result of 'false needs' generated by the advertising industry in collusion with media and manufacturers. A rather different, but related, critique of consumption which has been specifically addressed to new consumer technologies suggests that these technologies are 'expressive' of innovators' values. This may be a matter of a 'toys for the boys' mentality of male innovators, which means that instead of tackling the oppressive labour of housework — cleaning, bed making, and almost everyone's nemesis, ironing — innovation focuses on gimmicky gadgets and entertainment devices. Or it may reflect rather more subtle (and not necessarily conscious) desires to rationalise everyday life — in this view new consumer products are related to the domestic science movement of earlier years, which attempted to impose scientific management upon domestic work.

This line of argument is reminiscent of one developed in the discussion of industrial innovation and there labelled the 'labour process debate.' This was triggered off by

the pioneering and impressive arguments of Harry Braverman to the effect that new industrial technology was primarily motivated by the aim of deskilling and controlling the workforce.[2] While this compelling account initially attracted a great deal of support, empirical studies suggested that a deskilling trend was hard to detect — in fact, a raising of skills often followed innovation. Even where these particular managerial values clearly informed the deployment of a new technology (as opposed, say, to the aim of increasing customer satisfaction or introducing new product lines), often the incomplete knowledge of all parties concerned (both about the technologies and about the organisation of the labour process itself) affects outcomes decisively. The interests and capabilities of various levels of employees and technical experts has to be negotiated, and users of new technologies often proved able to shape the ways in which they were used, to greater or lesser extents, and to more constructive or (as in the case of industrial sabotage) destructive effect. Contemporary labour process analyses rarely portray technologies as simply expressive of managerial values — and, in keeping with innovation research, often portray managerial technical choice as bounded by the existing technical knowledge of the managers.

But there are still analysts of consumer product innovation who are prone to see consumers as being putty in the hands of producers — and who cite the absence of certain desirable innovations as indicative of blinkered attitudes or unsupportive values, such as men being happy to see women chained to housework and thus not researching ways of automating laborious and time-consuming tasks such as vacuum cleaning and bed-making. There may be *some* truth in this, since innovators are driven by social rewards; most of them are men, and they may well find certain lines of research more prestigious than others (but some men do research vacuum cleaners, tampons, ‘disposable’ nappies etc.) But it smacks of elitism to portray consumers as pawns of producers, who will willingly absorb whatever innovations are thrown at them. Moreover, the innovation literature would suggest that innovators pursue opportunities perceived on the basis of knowledge of existing technologies and expectations as to their trajectories — that innovations are developed on the back of past innovations. The absence of the sorts of labour-saving innovation cited above may well derive from the lack of perceived opportunities for applying technologies to these functions (at viable costs), rather than from an absolute lack of concern for them.

We shall return later in this chapter to considering how the dynamics of IT research may be shaping consumer product evolution, and what implications this has for our study. Let us now turn, as promised, to a more detailed scrutiny of similarities and differences between industrial and consumer markets, beginning with the important issue of the symbolic role of products in consumption.

Pleasure, symbolism and risk

In the innovation research perspectives discussed in Chapter 1, the course of technological evolution is seen as being shaped by the success or failure of new product ideas in 'selection environments' in the innovating firm and in the various markets in which products enter and 'compete.' It is evident that in many ways consumer and producer markets will form distinct environments. But how different are they in practice, and what importance might this have? It is often assumed that different rationales and rationality are displayed by industrial and consumer purchasers. The most prominent issue in the discussion of consumer and industrial markets is the supposed contrast between consumer markets as being, at least in large part, fashion- and symbol-driven pursuits of objects of desire. Industrial markets, by contrast, are seen as involving the 'rational' pursuit of efficient production.

Consumer purchases can reflect a wide variety of motives: these can range from 'domestic economy' considerations which sound quite like industrial goals (e.g. saving costs or time, increasing household efficiency) to those that are much more socially or personally oriented (e.g. making an impression upon neighbours, enhancing leisure time, giving oneself a treat). Households have a range of requirements to satisfy within their budgets, with pleasure and the maintenance of family relationships accompanying the more mundane goals of nutrition and shelter. A given product can satisfy different motives, sometimes simultaneously: for example, the food processor may be acquired to speed meal preparation, to make the experience of gourmet cooking more pleasurable, or to render its results more impressive. Several symbolic features of products are often identified as important ones: they may connote :

- observance of fashion or striving for individuality,
- novelty and modernity or tradition and custom,
- wealth or prudence,
- sense of taste (or anti-tastefulness)
- group identity (subcultures, ethnic groups, etc.)

These features may be important because of the private frisson they yield the purchaser, or because they are communicative acts in which other people will 'read' the message that one is trying to convey by association with the product.

An influential approach to the symbolic nature of consumer purchases, focusing on fashion, actually resembles the diffusion curve literature in certain respects. A 'trickle-down' theory was articulated by Georg Simmel in an essay on fashion;[3] simply put, this perspective sees innovations as being adopted first by an elite, in large part to demonstrate its superiority to the rest of the population. Other groups subsequently adopt the innovation in order to demonstrate their own superior status, with successive

groups modelling themselves on their immediate superiors. While it is often the case that the pioneering elite will consist of the rich and famous, it is also possible for the relevant innovations to emerge from counter-cultures. This is particularly the case in fields such as popular music, clothes and hair styles, for example, where important innovations have often emerged from deprived groups, often in part as expressions of their identity. These innovations may be adopted by others out of sympathy with these groups, and/or be commercialised by mainstream vendors.

Many studies by historians and cultural researchers have examined such processes in the creation of fashion, and their work documents an important element in the diffusion of many consumer products. It might be suggested, however, that the analysis is relevant to greater or lesser degrees to different classes of product. Fashion may be the major issue in the selection of some products (e.g. clothes — although here other factors, such as durability, may also be significant) and a relatively minor (though not insignificant) factor in the selection of others (e.g. central heating boilers). Note that fashion may also influence the choice of product within a product class (e.g. which boiler to buy), or the selection of an entire product class (whether to buy a boiler at all).

We could speculate about characteristics of products and markets that may be critical here, such as frequency of purchase, degree of social observability of purchase, and so on, but for now we shall just remark that one could examine many of the studies in this area without discovering any discussion of factors other than the symbolic. This is even true when one looks at studies covering broad historical periods, when substantial changes in living standards have been associated with the diffusion of household appliance and consumer durable innovations. Of course, ‘standard of living’ or, more narrowly, the specific functionalities of new products, are culturally relative concepts. (We hope that this study contributes to the understanding of the ways in which functionalities are identified and perceived). But there are important changes in social life which have been enabled by the fact that innovations are not all alike — that a different pattern on one’s pullover has fewer implications for one’s choice of lifestyle than having a telephone line installed, for example. So, in addition to the characteristics of products mentioned above, we should also note that there are important differences between the development of products that put a new symbolic gloss on a standard activity, and offer few fresh opportunities for use; and the sorts of product innovation that allow users to do new things in new ways.[4]

Still, fashion and status, along with other symbolic meanings that may be attached to new products — e.g. their being ‘futuristic’ — are features that are liable to play a role in consumer markets. In terms of ‘trickle-down,’ since the sorts of IT-based innovation we are considering are usually first released in relatively expensive forms, we would expect trickle-down to be from affluent elites rather than marginal groups,

though even here there may be exceptions.[5]

In contrast, firms are often treated as rational actors, weighing up the consequences of their buying decisions carefully, without following fashion or indulging in impulse buying. Industrial buyers, typically, have highly specific objectives for their purchasing decisions, compared to private households; crudely put, how far the purchase will contribute to the buying firm's profits. While this goal may well require attention to such factors as work-force morale, good consumer relationships, environmental and other regulations, business decisions are nonetheless structured around a set of largely economic objectives.[6]

These claims must be treated with some caution, despite their common sense nature. Firms do not act: individuals act as their agents, and are necessarily acting on the basis of their own perceptions — and calculations as to their self-interest. Assumptions as to the rationality of purchasing behaviour in industry are rarely tested empirically, though there are grounds for thinking that some purchasing decisions are far removed from questions of immediate profitability. For example, company cars and mobile phones may well be 'perks' for senior managers; those who make the purchasing decisions may be treating themselves to pleasure much as an ordinary domestic consumer does. And purchases can have symbolic force, affecting one's prestige in the firm. Corporate status and prestige is certainly an issue in some purchases — the acquisition of fax machines in the late 1980s was accompanied by a sense that this was a bandwagon which everyone else was joining, so that one's company (and by extension, oneself) was being shown up when one did not have a number to exchange. Advertisements aimed at business show such perceptions to be played upon by suppliers. Impulse buys may happen — as observation suggests is the case at trade fairs. Even more extensive expenditures, going more to the core of one's business, may be undertaken without the sort of painstaking costing out of options which the assumption of rationality would imply.[7] Thus there have been lengthy debates in the management and accountancy literature as to how to justify expenditures on corporate IT systems. They seemed to be the 'modern' way to go, the natural trajectory for the firm to take — and the IT Department would certainly have been pressing their case — but it may be difficult to establish what was the financial case for them, and whether they met the expected objectives if these were never formally specified.

The demarcation between consumer and industrial purchases that puts pleasure and symbolism on one side, and rationality and efficiency on the other, then, is not a very sharp one. Nevertheless, consumers are typically purchasing for themselves or their families, while industrial buyers are acting as agents for organisations — and may well be constrained by formal and written-down rules governing their decisions. Thus, despite the imprecations of the domestic scientists and Calvinists, a higher proportion of the expenditure of consumers in affluent societies is liable to be related to the

pursuit of pleasure and other personal goals. And when it comes to new products, many of the same symbolic issues may be faced by firms and private individuals alike, including the images associated with the innovations themselves. For instance, the personal stereo (Walkman) appears in its early days to have been perceived as a product for youth, so that other users may have felt inhibited about its use; this appears to have faded away as the product has become more widely socially acceptable. Some types of consumer may wish to appear go-ahead and experimental, while others seek to reaffirm traditional values and identities, and the choice of products and lifestyles is liable to reflect this, within limits. In the business world it is probable that certain innovations are at first thought of as 'flashy' or extravagant, and only gradually become more generally used. Certainly some products — faxes, mobile phones — are deployed by some firms to convey an image of modernity. But other firms may wish to cultivate a sense of their solidity and dependable traditional service, and may thus deliberately avoid making (or overtly displaying) certain innovations.

The discussion in Chapter 1 noted that symbolism may attach to the manufacturer or supplier as well as to the product itself, and suggested that the image of the firm may serve (in innovation research terminology) as a 'complementary asset,' influencing purchase decisions. Images may be less easy to control than firms would hope: thus users of home computers have been liable to see IBM as providing conservative and costly products, even if these have been setting the future industry standards for workhorse computers, while Apple has been seen as providing fun and innovative, but rather maverick and also costly, innovations. Industrial purchasers may well be influenced by such corporate images — 'nobody ever got sacked for buying IBM' is a familiar slogan (more recently twisted by a competitor who added 'nor did they get promoted'). So symbolism may be associated with the entire class of consumer product (e.g. a stereo system), the particular design configuration (e.g. a rack system rather than a single portable unit or a set of separate components) and/or with the brand (e.g. Sony, Bang & Olufsen). Innovators as we shall see, are not unaware of the need to take these dimensions into account.

Symbolism may itself be studied in innovation and diffusion terms: innovation and diffusion is involved in the creation and circulation of concepts about new products. For example, such products as interactive video, electronic messaging, and 'smart buildings' (which bear on the case studies of this book) are currently far more familiar in industrial than in residential applications; and we might expect jargon, product concepts, accounts of technological trajectories, and theories of human-computer interaction to be imported from these application areas. If the diffusion of products to new markets and applications is a 'technology transfer' process, we can also say that considerable 'terminology transfer' accompanies the transfer of products from industrial to consumer markets. Awareness of application potentials, and expectations as to user activities, are constructed in part from experience of technological change and user reactions in industrial and professional applications — just as the use of

technology in supposedly more advanced countries is often taken to be a model for the future of the whole world.

To the extent that industrial purchasers have a more utilitarian orientation to the products they purchase, one might expect them to display greater concern with reliability of the technology[8] than do final consumers. Failures can have major cost implications for users, at the worst disrupting production entirely: in 1993 the TAURUS system, installed by the British Stock Exchange in order to move to paperless share settlements, was abandoned at a cost of £400 million (and unknown cost to the reputations of the parties involved). Often industrial versions of products cost more than consumer versions, one factor being that their buyers are more prepared to pay a premium for reliability. They are also more likely to be willing to shoulder the costs of additional services such as back-up facilities (e.g. disaster recovery services for computer systems), on-site maintenance, and insurance.

Consumer preferences in terms of the trade-off between price and reliability are likely to vary considerably between richer and poorer, and vanguard and laggard consumers — though we should not underestimate differences among industrial buyers. The product cycle model would tend to suggest that reliability problems will decrease as suppliers gain more familiarity with the product and improve its design. But making products cheaper and simpler for consumer markets (a topic to which we shall return) may involve some compromise with reliability.[9] However, suppliers may well underestimate consumer sensitivity to quality and reliability, and the extent to which they are prepared to pay for these features. The manufacturing and pricing strategies of British television producers in the 1970s, when faced with the Japanese emphasis on product reliability, showed just how much they had misread consumer preferences.[10] Consumers shifted from British televisions on a large scale, just as they shifted away from British cars, partly on account of perceived problems of reliability and quality. Likewise, the reliability of UK home appliances was a source of such concern in the 1980s that NEDO produced statistics showing the declining incidence of problems with washing machines and refrigerators (and thus less reason to acquire imports). Some manufacturers of consumer electronics products — e.g. Bang & Olufsen — actually base their strategy to a large extent on the design and reliability features of their products, knowing that they can find market niches which favour these attributes, even if the firm cannot hope to compete with overseas suppliers on cost or technological innovation as such, and even if much of the componentry is standard and shared with cheaper brands.

The sensitivity of consumers to product reliability is likely to vary by type of product and type of consumer. For some products, clearly, reliability is more critical an issue than for others — car breakdowns are potentially life-threatening or seriously inconvenient, while intermittent problems with a CD player are more liable to be a

source of irritation. Hobbyists may be more prepared to accept unreliability as part of the adventure of pioneering new products. Early adopters of home computers, for example, seemed to have a surprising tolerance for unreliability of delivery and product — but this does not seem to have extended to mass purchasers further up the diffusion curve, and the unreliability of Sinclair machines in particular became quite a talking point in the trade and consumer press. Consumers may be uncertain as to the reliability of a product in their own domestic circumstances, and in such cases acceptance may be faster when the product can be tested out without purchase, e.g. through rental as with TVs and VCRs in the UK.

Other perceived risks may affect the diffusion of consumer IT products. Physical danger is sometimes an issue: are VDU screens safe? On the whole, however, such fears are probably assuaged by the testing which consumer products are expected to have been through, although there are still frequently-voiced doubts about microwaves and, notably, both health and psychological aspects of computer games. Industrial products, too, are expected to be safe, but here there is more onus on the user to ensure safe working practices.

Economic risks may also be important considerations. Consumers may delay adoption in the expectation of price reductions as the mass market develops and the product matures. There are some signs that consumers have developed the strong expectation that electronics-based products cheapen over time. Besides that, they have long been accustomed to heavy discounts during sales, and during times of recession when retailers are desperate to clear their stocks. At the beginning of 1992, in the middle of a major economic recession, several UK advertisers tried to persuade people that now was the time to buy — overtly saying that people who had made purchases in the run-up to Christmas 1991 would be kicking themselves. Industrial purchasers may not always have a choice as to when to acquire equipment — but often they do, and there is no reason to think that they will not delay purchase and shop around as much as consumers do. Similarly, both consumers and industrial purchasers may likewise anticipate a rapid rate of technological change, and fear that their purchases will quickly become obsolete as the performance/price ratio improves. Advertising may again be targeted towards allaying consumers' fears — '*this* is the product of the future.'

Other risks concern product compatibility and lock-in. Incremental innovations which ensure 'backward compatibility' with existing equipment, and promise 'forward compatibility' with subsequent innovations, can have a significant impact on purchasing decisions. The risk of one's treasured recording becoming unplayable, for instance, should be reduced, maintaining the relative advantages of the innovation. However, the purchaser may also beware of being locked into a particular supplier's products, or to a particular standard whose future is uncertain. The perception of compatibility, and the fear of lock-in, may guide purchasing decisions in industry, and

also in consumer markets: VHS camcorders, for instance, are marketed on the promise of compatibility with the installed base of VHS video recorders (even if most actual use involves play-back through the television set or copying and editing from tape to tape where such compatibility is irrelevant).

On a somewhat different point, some writers suggest that industrial buyers should be at least initially more receptive to radical innovations than consumers. The argument is that industrial buyers can apply more precise criteria to the preliminary evaluation (including formal tools for assessing purchases) than can consumers. On the other hand, marketing studies would suggest that affluent societies (particularly Japan) typically contain many vanguard consumers, who are willing and able to experiment with radically new products. While differences may well exist between industrial and consumer markets on these dimensions, then, they may well be equalled or even overshadowed by differences within the two markets. From the available evidence, there is little reason to expect that the general principles derived from the innovation research literature will fail to extend to consumer markets.

Market volatility

We have touched on fashion as one aspect of symbolism in consumption. Fashion, of course, is notoriously prone to swings: things come in and out of fashion. If products are acquired for this symbolic freight more than because of other features, their markets are liable to be subject to rapid change, of a more or less unpredictable nature.

Thus, certain consumer products are believed to be prone to rapid boom-and-bust market developments. Being purchased more for their symbolic nature than for any more direct functionality, the market can collapse when the symbolic freight is changed — which is more easy to effect, perhaps, than changing its functionality. Some IT products may have been purchased because of their symbolic associations; in particular, the home computer is often described as a product bought for its own sake rather than for any clear final application and was purchased in order to stay abreast of a ‘wave of the future.’ When there was a classic market shake-out in the mid-1980s, in which many UK microcomputer companies lost market share and collapsed, it was widely felt that the bubble had burst for good. The perception of the consumer market as faddish influences industrial and financial activity in turn: the decline of financial support for parts of the IT sector at this time reflected distrust of this volatile and unpredictable sector, as far as we can judge from commentary in the press. Fashionable opinion in the City is a force to be reckoned with.

Consumer markets may change in ways different to industrial markets, for reasons

other than those to do with fashion. For example, consumers respond in particular ways to seasonal variations (e.g. celebrating holidays, buying cold drinks in hot weather). They react rapidly to changes in family circumstances (such as increase or decreases in major classes of income or expense), which may particularly affect impulse buying and the consumption of luxuries. Many businesses, on the other hand, may try to maintain relatively stable levels of activity, since it is difficult to lay off and acquire staff rapidly, equipment should not stand idle, and so on; and impulse buying is rendered more difficult by the financial procedures of at least the larger firms.

How real are these stereotypes, and how substantial are their implications? Consumer markets certainly do fluctuate in various ways. Price and wage levels can have substantial impacts on consumer expenditures, as can actual levels and expectations of unemployment and interest rates. Government macroeconomic policy has often centred on manipulating levels of consumer demand by changes in tax and consumer credit, for example. There are also predictable seasonal cycles such as the pre-Christmas demand for electrical goods, the increase in out-of-home activities in good weather, and so on. Impulse buying is also a significant phenomenon for the cheaper consumer goods and services, although whether this fluctuates in any regular way is unclear — perhaps millions of impulse buying decisions tend to constitute a continuous ‘background noise,’ only growing or declining in volume as disposable income fluctuates.

In contrast, relatively more of the demand in industrial markets is liable to be inelastic. Staff are hired for long periods, orders are placed months in advance, equipment is installed with the expectation of maintaining certain levels of production. There is thus a built-in momentum in the production process, and this tends to smooth out short-term fluctuations in demand. Some industries are highly seasonal, however, and have adapted their working practices accordingly, such as by recourse to much casual labour — parts of construction, agriculture and tourism, for example. While such marked seasonal swings are the exception rather than the rule, longer-term business cycles of four or five years are common in many industrial sectors. Fluctuations in consumer demand have impacts on industrial production and thus on industrial demand — suppliers may find it more profitable to reduce output or switch activities when consumer expenditure drops, rather than to stockpile products in the hope of an upturn. When products are sold globally, and when business cycles are not strictly synchronised in different countries, these impacts may be muffled as suppliers shift sales to different countries.

There are grounds for thinking that this contrast between industrial and consumer markets may be becoming less marked. In particular, it is widely argued that new styles of production involve increasing the closeness of production and consumption, with more use of ‘just-in-time’ and related production techniques. The 'flexible firm,’

as identified in the management literature, is able to adjust both levels of production and the details of the product to the demands of users (be they consumers or other firms). The archetypal ‘flexible firm,’ Benetton, is of course operating in a field where fashion is very important, and its fame is in part based upon the information systems and organisation of production which its managers have set up in order to respond rapidly to changes in consumer demand. Its demands upon its own suppliers and sub-contractors, then, closely follow the demand experienced in its retail outlets, so that there is much more synchronicity between the consumer market and its own industrial market — though of course this is a transnational company, which is able to put together market signals from many different countries in which it is active. Similarly responsive strategies are being put in place by many other retail chains, in sectors such as food and DIY as well as in clothing.

If the analysis of ‘flexible specialisation’ has any validity, we would anticipate some blurring of the differences in volatility between the two types of market. Nevertheless, it is likely that many consumer markets — especially those most associated with luxury and fashion expenditure — will remain volatile as compared to many industrial markets. Thus, although consumer markets are of such a scale as to promise large rewards to successful suppliers, they pose particular risks. This was apparent in the UK home computer market in the mid-1980s, when, as we have noted, rising sales were suddenly interrupted — leading to the collapse of several leading firms in the field, and the failure of a number of new product launches. Many commentators were inclined to think that this demonstrated that the market had simply been a fad, a bubble that had finally burst. In retrospect, it is apparent that the home computer market has simply stabilised, and that expectations as to continuing year-on-year growth were considerably overstated. More recently, the economic woes of the early 1990s have made it a difficult time to launch expensive new products, as suppliers of new audio-visual and multimedia products have been discovering: though there are many affluent consumers still around, many of these are cautious with their money due to fears of unemployment, mortgage rate increases, and other problems of this sort.

Complex products and unskilled users

The product cycle model, as outlined in Chapter 1, suggests that early versions of products are typically harder to use than are later versions. As experience with the product’s characteristics and users’ difficulties evolves, designs should be modified to make products less technically complex (this aids producers as well as consumers), less demanding of maintenance and user-modification, and generally easier to use so that lower levels of skill and training are required from users. This is a standard component of product cycle accounts. Given the related notion that consumer products are frequently developed out of industrial products, the implication is that

industrial products will typically be more complex and skill-demanding than similar consumer products.[11] To reach mass markets products have to be not only cheapened, but also made more user-friendly.[12]

Terms like ‘complexity’ and ‘user-friendliness’ are relative ones: judgements of what is complex or friendly depend upon the skills and expectations one brings to the product. Particularly interesting here are the supposedly more ‘user-friendly’ graphical user interfaces of Apple Macintosh PCs and Windows systems running on IBM PCs. These interfaces use a ‘desktop metaphor,’ which implies users being familiar with office arrangements such as filing cabinets, wastepaper baskets, and desks.[13] The new interfaces have proved extremely successful in introducing PC applications into professional life. But many experienced computer users react to these interfaces with annoyance, on the grounds that these make it harder and slower for them to work in the way that they are used to with traditional command line interfaces — perhaps the new systems are felt to be overbearingly friendly, or too simple for experienced users, thus interfering with the direct use of the computer.

The expertise of users influences their responses to new products, determining how much effort requires to be put into mastering their use. Industrial goods suppliers can generally assume that buyers of complex technical products have, or will be prepared to invest in acquiring, expertise. But they will also be aware that industrial products give maximum returns when their features are exploited effectively; it does not pay the industrial buyer to purchase redundant functions. The economies of scale in producing goods for the mass market, however, may allow the supplier to build in extra functionality at minimum cost, even where most of the buyers will never make use of the extra functions.

For mass consumer products, suppliers need to assume a fair degree of technological indifference or ignorance. It will be important, then, to maintain ease of use of basic functions, even if there are many other features that can be used with some learning effort (and thus appeal to hobbyists). Thus few VCR or camera users may make full use of all the programming possibilities in current machines; this does not matter as long as it remains relatively simple for users to achieve satisfactory basic results.[14] The design problem may become more acute as manufacturers seek to differentiate their products through enhanced features.

Training and education of users will mean different things within the two settings. Industry employs specialised trainers, recognises specific qualifications, and so on. Suppliers may provide after-sales service, training, and technical assistance — sales personnel interact particularly intensively with users in the early stages of adoption, not just as a marketing ploy but also in order to tailor products to specific customer needs (such contact is a major source of feedback from users in early stages of

innovation). In contrast, the training inputs for very few consumer products will go beyond the manual that comes with the product, and often not even that will be consulted. The automobile is the outstanding example of a consumer product requiring substantial training, with paid instructors and driving tests; other means of personal transport such as horses, bicycles, sailboats, and gliders also require substantial skills acquisition, which probably reduces the difficulties that this might otherwise pose for the motor car.

As we have so often noted, the differences between industrial and consumer markets can be overstated. Consumer markets may contain hobbyists and people experienced with the product from use at the workplace or at school; consumers are liable to vary considerably in their levels of understanding of mechanics, electricity, electronics, and the like. There is also considerable variation in such specialist knowledge amongst industrial purchasers. Many small firms are frequently technically knowledgeable only about the particular fields that bear directly on their products and markets, and may be as bemused as consumers when it comes to evaluating products that are unfamiliar or uncommon purchases.

In many ways, IT products are more technically complex than many familiar goods and services — since they are based upon technical principles to which few older people have been exposed during their formal education. This poses challenges to managers and consumers alike; and in industrial markets, the actual purchasers may be experts in particular technologies while the eventual end-users may be less experienced. Many similar problems may thus confront professional users and consumers; and while professional users may be supported by trade press and consultancies, as well as in-house sources of expertise, it is likely that many smaller firms are less well-informed than many consumer hobbyists when it comes to purchasing, for example, personal computers.[15] Likewise, the boundary between intermediate and final goods blurs, as we have already noted, when we are considering items like PCs: some products are retailed as both home and office machines, and high street outlets serve both industrial and household customers.

To the extent that there are differences in skill levels between industrial and consumer markets, we would anticipate effects upon the innovation process. Technical skills and knowledge may affect both purchase decisions and the use of products. Through market and other modes of feedback, these may influence product design.

Purchasers may be more or less well-informed about what products are on the market, and how their performance, price, and other features may compare; and this too may have a feedback effect on the innovation process.

First, the more knowledgeable industrial user, or potential industrial user, may be

better-informed about the availability or otherwise of technical solutions to her or his problems. Especially with specialised innovations bearing on the main processes undertaken by the firm or organisation, it is likely that the user will understand much of the main technologies that are in use, and have some notion of the trajectories of change in these technologies' cost, performance and the like. However, radical innovations can destabilise this received knowledge, requiring users to learn about new core technologies that can be applied to their sectors. The trade press, the business sections of newspapers and other media, trade fairs, industrial conferences, consultancies, and government awareness schemes are busy providing intelligence on such issues. In terms of innovation theory, these information channels are raising the *visibility* of the new product to the users, which should speed the pace of diffusion of the innovation.

Visibility is not just a matter of being aware that new products exist; for potential users it is also a matter of having a sense of how and by whom they may be used, and of forming judgements as to whether they are products they might sensibly use — even whether they can afford *not* to use them. The existence of government awareness schemes suggests that many industries are perceived to face problems in the visibility of leading edge technologies. Such schemes may go beyond simply advertising the existence of new technologies, and provide consultancy and other support to firms which can help them determine whether these technologies are appropriate for their aims. An example was the Vanguard programme, run by the Department of Trade and Industry in the late 1980s, as an attempt to inform business about the merits of Value Added Network Services (Electronic Data Interchange in particular).

In mass consumer markets, product awareness is liable to be particularly problematic. Innovations have to reach unskilled and uninformed consumers who initially have no perception of needing or demanding the product. Advertising campaigns, product displays in shops and public places, and a host of other strategies have been developed to raise awareness of products. Sometimes intentional or unintentional 'product placement' in other media can be important — thus new consumer products are often displayed in films and on television. Colour TV was displayed on UK cinema screens before British consumers had a chance to see it in their high street stores, for example. TVs were also widely experienced through their early use in pubs; at the time of writing, efforts are being made in Japan to popularise HDTV through locating sets in public places such as railway stations. Prestel, which we discuss further later, was made available through libraries.

The very novelty of radical innovations may mean that there is an absence of role models to draw upon. This may be particularly relevant to new IT. In the case of the consumer products that took off during the post-war boom — cars, washing machines, hi-fis, etc. — there were often many examples of vanguard users among elite groups, encountered in everyday life or, more often, in media representations. The challenge

for marketers was to diffuse use to much wider markets from the foothold among these elites. But new consumer IT products have simply not been around for a long time in any kind of domestic setting. If anything, it is professional use — e.g. of computers, fax machines and cellular telephones — which provides the products with visibility. In contrast to earlier innovations, then, the imagery of the new products is more liable to be gained from science fiction books and films than from glimpses into lifestyles of the rich and famous — which can give rise to problems in that the products may be perceived as too technological, too futuristic.

Displays in shops may play an important role. This may extend beyond the shops directly retailing the product — the appearance of CDs in record shops, and the emergence of video rental stores are examples of 'observability' based on the software associated with new devices. Another example of indirect observability is the display of hobbyist magazines in newsagents (many visitors to the UK in the early 1980s were astounded by the proliferation of specialist magazines for home computer users). Consumers themselves may play an important role in promoting products to potential purchasers. Product visibility is likely to be achieved spontaneously if a product is a portable one: thus few consumers could have been unaware of the Walkman as personal stereos began to be worn in the streets in the 1980s, and portable computers and telephones are also frequently encountered on trains and elsewhere. Some products are effectively displayed on one's house — consider TV aerials, and, more recently, satellite dishes.[16]

Consumers may be eager to display their purchases when possession of the product is felt to be an indicator of wealth or taste. Friends and neighbours may be invited to one's home, under various pretexts. Firms may adopt similar strategies with clients whom they are hoping to impress — for instance, the appearance of fax numbers on company letterheads acted in such a way in the early stages of market development. Thus firms seek to convey messages about the company being 'go-ahead.'

Market concentration and atomised consumers

Industrial markets are typically more concentrated than consumer markets, involving fewer, and bigger, buyers. There are many more private households than there are firms; and while households may vary remarkably in size and wealth, firms vary even more, from the one-person enterprise to the multinational corporation. Many industrial markets are dominated by a few large purchasers, who, furthermore, tend to buy in large quantities, with frequent repeat orders. Numerous other industrial markets are fairly small ones, with only a small volume of production going to a small number of purchasers.

A few large quantity orders at premium prices can often ensure the success of a new industrial product, unlike most consumer innovations. The reason is that the industrial innovations can be retailed at very high prices — if the expected benefits to the user are also very high. (There are some luxury items sold to extremely affluent consumer markets where such conditions also apply. Film stars and top managers, for example, may invest in extravagant clothes, housing, cars, yachts and even aircraft.) The opportunity to realise satisfactory profits from a small market base, however, does not necessarily mean a high level of innovation. For example, industrial suppliers may become relatively complacent, and fail to recognise or pursue opportunities to enter wider markets (including reaching out to consumer markets). Thus Ampex, having invented videotape recording for professional applications in the 1950s, remained in this niche while Japanese firms perfected the technology for the mass consumer markets.[17] Such problems are not solely a matter of complacency, since innovators may lack the resources to extend their production, to maintain the dynamic of their innovations, or to find out about and enter broader industrial or mass consumer markets.

But small markets often mean at least that suppliers can be in fairly close contact with their major purchasers. They can send staff to visit them — not only to take sales orders, but also to elicit feedback on attitudes to the products (and the competition), and on likely directions of change in demand in the future. This is a rarity in the consumer field, except perhaps in the case of door-to-door sales and milk rounds! Furthermore, trade and professional associations often link together prospective industrial purchasers. Thus there are often well-established channels for innovators to get to know their clients. By contrast, suppliers of consumer products have had to develop formal market research techniques (e.g. surveys and focus groups) to determine information about consumer markets.

Both buyers and suppliers in industrial markets may have relatively extensive knowledge about each other, gleaned from past transactions, from the trade press, from specialised enquiries using consultants and credit-checking agencies, and the like. Buyers and suppliers interact relatively intensively and directly; indeed they may form active social networks. Industrial buyers often have considerable specialist knowledge, continuously reinforced through trade and professional journals. This allows for user involvement at fairly early stages of the innovation process.

The role of users in innovation has received considerable attention from some innovation theorists — but the focus is industrial users. Eric von Hippel has been particularly influential with his analyses of the role of such users in innovation.[18] In some areas of technology, users are the dominant source of innovations — according to von Hippel, this includes such areas as scientific instruments, semiconductor and printed circuit board processes. Users are an important source of innovative ideas,

even where they are not themselves the originators of innovation — and it should be recalled that many industrial innovations first emerge from companies who have developed them for their own internal processes. Compared to consumer markets, industrial buyers more frequently have the choice as to whether to buy or produce in-house, so that purchasing decisions are not necessarily restricted to comparisons between different suppliers — in-house production (and thus in-house design and innovation) can be considered. Firms which do decide to produce in-house may themselves enter the market as suppliers (which they may have considered as a factor in their decision as to whether to 'make or buy').

Many large firms cultivate groups of users who are important sources of feedback on the desired characteristics of products, the good and bad features of innovations, and even the direction which they would like to see innovations take. Some sectors feature strong links between suppliers' R&D laboratories and customer firms; users may specify their needs in considerable detail, so that innovations are tailored to meet them. For example, the automobile manufacturing industry exercises considerable influence over its suppliers of components and raw materials, while some large retail chains are highly influential on the suppliers of the consumer products — such as foodstuffs and clothing — that they sell. Furthermore, industrial customers, with their substantial spending power and recurrent demands, face the choice of buying on 'spot' markets, or entering into more permanent kinds of obligatory contracting arrangements, which is a much more intense form of social network, but one where suppliers can more easily be drawn into the innovation process. Individual consumers are rarely in such a position (though retailers may be).

The involvement of sophisticated (potential) users of new products should help to reduce the risk of innovation. Industrial innovators may be well-informed about the intended market for their products, and may even be largely directed by users in that market. Users may even form user groups to press their claims and share experience, and are likely to meet each other in industry and professional associations of various kinds. In the IT area, for example, there are groups representing users of various classes of hardware and software, and professional associations representing various influential occupations in the field (even within specific sectors, such as local government, where in the UK there is SOCITM, representing IT managers).

By contrast, consumers may appear more like a large mass of individuals, only rubbing shoulders in the anonymous act of purchase. There are many more households than there are industrial firms. Consumers will typically make use of their purchases of goods and services in an atomised way as individuals, or members of individual families, only coming together into larger groups at occasional mass spectator activities. However, there are some organisations which are established to represent consumers' views.

First, there are *consumers' associations*. These only enlist the active support of a small number of consumers, and are not in the main very powerful, though they have been known to effectively raise media alarms about issues such as unhealthy foodstuffs and, in the IT area, 'phantom withdrawals' from bank cash points (apparent misattributions of withdrawals to users of cash cards, as reported by many users but claimed by banks to be impossible). Only in the case of a few hobbies and spectator sports are there active *clubs* for hobbyists and supporters. Then there are *specialist magazines* which are able to inform enthusiastic hobbyists, and may be used in this way by innovators. 'Ideal Home'-type exhibitions are sponsored by the trade both to promote new ideas and fashions and to take the pulse of the market (though these are as much aimed at retailers and distributors as at potential consumers). However, discourse about new consumer products is less a two-way conversation between consumers and suppliers than a stream of advertising information directed at consumers by suppliers. Consumers may talk among themselves, of course — but it is not clear whether anyone else is listening.

While individual consumers may be 'atomised,' this is not so true for the industries which intermediate between final consumers and industrial suppliers.[19] The retail sector has become much more concentrated in recent decades, as powerful retail chains have emerged, many of which are sufficiently powerful purchasers to be able to influence manufacturers' strategies. While this is especially true in the food and clothing sectors (where product design and quality standards are often set by large retail firms), it also applies to consumer electronics. It is evident that decisions as to whether or not to promote a new product by a major chain can have dramatic influence on its market success, and marketers begin discussions with major retail chains at an early stage.

However, once again it is important not to overstate differences between industrial and consumer markets. Industrial users are not in practice always well-understood by their suppliers. Many consultants would urge that there is considerable scope for reducing failure in industrial product innovation by use of precisely the sorts of market intelligence that these consultants purvey. Industry newsletters and market intelligence reports are designed precisely to plug these information gaps. The use of market research agencies and similar bodies represents an effort by firms to assess what consumers require — or can be made to require.

'Marketing' is not just a recent buzz-word: indeed, in the 1950s, there was much talk about a 'marketing revolution.' The literature of the day stressed that producers should not simply sell what they are accustomed to supplying, but should be constantly asking what consumer wants and needs are — or might be, since consumers may have many unrecognised latent demands. Producers should focus less on their specific goods, and identify what 'benefits' and 'solutions' (the current jargon would often be 'functionality') they are providing to consumers. They should reassess the boundaries

of their markets, and broaden their horizons (e.g. railway companies should not think of themselves as merely suppliers of train services but as actors in the transport industry) — an argument which clearly relates to the industrial trends of the day (e.g. the formation of large, agglomerated, multi-divisional corporations). Such prescriptions can be interpreted as saying that the emphasis of innovation should be on demand-led innovation, rather than on technology-push; that the key issue should be one of finding what latent demands could be evoked by technological changes; or even that the product itself should be less important than consumers' sensing that they are achieving a certain level of service or satisfaction from it. How far such prescriptions have actually been put into practice is unclear — sceptics claim that much of the 'revolution' has been a facade; most firms try to sell what they can most easily develop and produce, notwithstanding the growth of marketing staff and departments. Despite the advice cited above, limited attention was paid to technological innovation in writings on the marketing revolution.

Notwithstanding the massive growth of the market research industry, with its many journals, magazines and conferences, and the increase of marketing and market research personnel in companies, lack of knowledge of the market is still cited as a perennial problem. Textbooks as well as empirical studies of firms' experiences continue to cite this lack of knowledge of consumers as the biggest reason for market failure. Beside this, it is interesting to note that there has been some criticism of the utility of US marketing literature for European practitioners — it is argued that the US consumer goods market is unlike European consumer or industrial markets.[20]

While there may be a surplus of 'hype' about marketing, there is much evidence that suppliers have been seeking to become better informed about their consumer users, often using new IT to improve their intelligence about purchasers and markets. Especially in financial services, but increasingly in retail and other sectors, extensive databases about clients are being developed. Banks and credit card companies construct sophisticated profiles of individual consumers for personalised mailshots and marketing. The data include 'lifestyle' information, such as the stage in the family life-cycle and interest in certain broad classes of product as expressed in previous purchases.

This may well mean that the divergence in the information which suppliers can deploy about their consumer and industrial markets may be reducing. In any case, the point must be made once again that both markets feature considerable internal heterogeneity, and in both cases suppliers can be more or less well-attuned to user requirements.

In the conventional view, consumers are not only atomised: they are also largely passive with respect to the innovation process. After all, they do no R&D; their role is

to give innovations their approval or disapproval in the market, or at best to supply information about their requirements to market researchers. Industrial users are very varied. Some firms have well-endowed R&D laboratories and others provide meagre inputs into formal research activities. Some industrial sectors (such as chemicals and electronics) are very active in influencing the course of innovation, while others (such as construction and many services) are more passively led by external innovators.[21]

We have so far been considering feedback about the product from users to producers. However, the innovation research literature points out that users do not merely learn how to *use* new products; they may also play an important role in the further *development* of products. This is often mentioned, for example, in the 'technology transfer' literature, where it is pointed out that the importation of a Western technology into a Third World context often only proves successful if the users make numerous changes to make it more appropriate to local environmental conditions — e.g. protection from heat and dust, adaptation to local skills levels, unreliable electricity supplies, etc. But product modification is not confined to developing countries: it is common to find firms in industrialised countries making adaptations to the products they have bought in. Products may also be modified by their users in consumer markets: consider, for example, the interest among hobbyists in 'customising' their motor cars and bicycles, fitting new wheels and motors to them, tuning the engines in ways that would surprise the manufacturers, and so on.

Products are not only modified: they are sometimes **'reinvented.'** This term has been used, by sociologists and others interested in consumer appropriation of innovations, and corresponds to innovation research analyses of users' innovative activities in applying industrial technologies. It describes the situation where users establish substantially new roles for products, other than those originally foreseen by manufacturers. Since products in industrial markets are often highly complex, substantial skill may be required for any reinvention to occur in them — and the same may be true for complex consumer products.

In industry, especially with respect to new process technologies, significant reinvention is reported in many studies. Buyers are liable to make significant modifications to the technology as it is being installed and used, in order to adapt its operations to local conditions, changing production needs, etc.. Because of their more intimate involvement with users, suppliers of industrial products can more easily incorporate the experience of reinvention amongst users into their own product development. (This may help to account for the finding that while there is little difference in overall 'success' and 'failure' rates between consumer and industrial products, complete success or complete failure is more common for consumer products).

It might be thought that as new IT products are rather complex, they are unlikely to be modified or reinvented by consumers. But in practice both modification and reinvention are commonly experienced with complex consumer products, with hobbyists and other ‘expert consumers’ playing a prominent role. To take one recent example, hi-tech automobile hobbyists in the USA have been not only ‘customising’ their cars with new paintwork and tyres, they have also been substituting new EPROMs (reprogrammable microelectronic chips) for those supplied by the manufacturer, so as to change the performance characteristics of the microprocessor-regulated motor. In this case, as in others, these user innovations are now being commercialised in their own right, by garages that will ‘retune’ your car in this way.[22] So it is not only a vanguard of consumers who may participate in this ‘subversive’ reappropriation of consumer products: the innovations made here can also diffuse, by commercial means, by copycat activity, and so on.

There are cases where the reinvention or modification of a product is extremely widespread. The home computer, for example, was promoted as a useful household tool and educational instrument — yet rapidly became a best-seller as an excellent system for games-playing. The young people who so happily used the product had little doubt that this was its prime functionality, even if their parents were gulled into purchasing computers on educational grounds.

So we should not write off the consumer market as making purely passive contributions to the innovation process, as influencing technological change merely by sending market signals as to the product’s acceptability. More active contributions often are made by consumers to the innovation process.

Nevertheless, it is widely recognised that — especially with the rise of science-based industries in the twentieth century — the emergence of new consumer products is much more likely to be the result of initiatives undertaken by industrial actors than the product of consumer demand itself. The difference between industrial and consumer markets here is a real one, even if. as noted above, some industrial sectors are more like consumer markets, with technological change being driven more by supplier industries than by in-house efforts, with some consumers, especially hobbyists, more like industrial purchasers.

It is, however, rare for consumers to originate completely new product concepts. Consumer inputs into new product development are most likely at later stages of the innovation process. This is particularly true when we are dealing with radical product innovations; consumer feedback on design details is much more likely when a product is already established, and reinvention demands that the product is available to be reinvented.

Active producers versus passive consumers

Innovation studies demonstrate that often technological innovation in industry is liable to involve organisational change — in particular, the introduction of radical innovations may lead to staff being retrained, new service departments being set up, factory layout redesigned, and so on. Such changes are likely to be required to make effective use of an innovation, once it is recognised that new inefficiencies and bottlenecks are evident. It is common for the understanding of such changes to be developed rather slowly — this is part of the 'learning by doing' process.

Large industrial users can devote substantial resources to effecting organisational change: they may employ consultants to manage the change process, they may have training divisions to which staff can be sent. Organisational change may be sought for reasons that have nothing to do with the use of technology, and sometimes the introduction of new technology provides a good legitimation for attempting to restructure working practices. Staff as well as management may play this game: for example, some secretaries have been able to exploit the uncertainty associated with the shift from electronic typewriters to word processors to achieve improved seating, lighting, and other working arrangements.

The situation for consumers is clearly very different. Yet domestic culture too may involve traditions and habits which are resistant to change. We see this on a small scale with the reluctance many people still have in using telephone answering machines — they may have yet to learn the skill of leaving a succinct message, or simply resent paying to speak to a machine. In general, we would expect that the more extensive the adaptation required, the more time will be required for new consumer habits and lifestyles to emerge around the innovation — but clearly many other factors may influence this process. Greater degrees of change may form a barrier to adoption of innovation — but this is to assume that change will necessarily be resisted, and sometimes it may actually be strongly desired. But we might note that change in household relationships may disturb balances of power, by giving family members access to new resources and opportunities. Thus some members may resist change which others welcome. There are clearly important differences between household and industrial relations, but the scope for technological change to exacerbate lines of stress between different parties is common to both.

While bearing in mind the point that some major changes may well be welcomed, it is possible to speculate about changes which are liable to be resisted. For instance, it can be hypothesised that products which require the use of existing (scarce) household resources may be linked to particular stresses. Thus, the use of products which use the television set (e.g. home computers, games consoles, videotex, VCRs, interactive CD systems) may require considerable adjustment to household behaviour patterns based

on the viewing of broadcast TV; for major changes in activity the purchase of a second television set, an additional telephone line, or the reallocation of rooms may be required. Another way in which the introduction of new products may be challenging is if they substantially change the form of meaning of an activity: making a solitary activity shared or vice versa. Another instance is the scope for computer game-playing and other interactive entertainment activities challenging existing practices of shared 'passive' leisure.

Rather than try to predict how easy it will be for new products to find consumer markets, at this stage we wish to introduce another set of issues about consumer passivity or activity. From several lines of social research the point has been underscored that consumption is not the only activity of people's 'spare time,' and that consumer goods are not only for consumption. The notion of industry actively applying its purchases to productive ends, and consumers passively consuming the end-products which result from this, is fundamentally flawed.

Feminist critics have pointed out the fact that much 'consumption' is, especially for women, often onerous domestic work — preparing meals, cleaning the house, and so on. In other words, new consumer products may be oriented towards work, rather than leisure activities — just like industrial products, although of course the organisation and social relations of work at home are considerably different from those of paid employment. New products play an ambiguous role in domestic work activities, providing some tools which make some household tasks easier, but also providing more things that need management. A fierce debate about whether such routine housework was increasing or declining seems to have been largely resolved in favour of the view that over time there has been some reduction in the housework burden (although not as much as might have been expected from the 'labour-saving' claims of innovators — presumably household standards and demands have gone up?) There is some evidence of an upward trend toward reduced inequality in such housework, at least as measured by the time put in by men and women (but this is more due to the decrease in women's time inputs than to a small observable increase in men's inputs). The division of labour in less routine activities (such as DIY) is more complex, as Pahl demonstrates in his study of how families get a number of basic functions accomplished in the 'informal economy' of the household — men tend to engage most highly in many of these activities.

Another line of analysis starts out from the view of the household as an 'informal economy,' within which work is carried out and goods and services produced; the argument is then developed that 'consumers' have a choice as to whether to acquire (some) goods and services by self-production or by purchasing them from the formal market economy. In other words, they can work at home directly for their requirements, or they can work for employers for the money to buy products that satisfy their requirements. While we clearly cannot make everything that we could

choose to buy from the formal economy, we do have a range of choice. There are often a variety of options available to us when it comes to such decisions as how we are to clean our clothes, get to work, entertain ourselves, and so on. For example, we often have the choice between using our own goods (e.g. washing machines, cars, TV sets), using public facilities (launderettes, cinemas, public transport), or even paying someone to provide us with a personal service (domestic 'help,' taxis, hired entertainers)?

The acquisition of new products from the formal economy is often part of a process of choosing, and shaping, what activities will be carried out in the informal household economy, and how. These decisions may not be consciously formulated, and consumers may well be pushed into specific choices by virtue of political and market forces that are affecting their living environment — not just advertising, but also the availability, quality and pricing of goods and services. Nevertheless, the acquisition of consumer goods and services is a matter of some moment in long-term socio-economic development. Thus Gershuny argues that social change (e.g. higher wages) and new consumer equipment have led to a shift towards the more privatised 'self-service' choices — from traditional services (e.g. laundries) to consumer goods (e.g. washing machines). Some of these trends represent 'self-services,' in which unpaid household labour uses new consumer devices, displacing traditional services like laundries and public transport — and domestic service.[23] Other innovations do not really involve much 'self-service' work — indeed, there may be less effort involved in selecting an LP or turning on the TV than there would have been in going out to a show or concert. Feminists tend to point out that the person doing the unpaid 'servicing' was often not the only person receiving the 'service.'

Both the feminist and the 'self-service' accounts make the very term 'consumer,' with its passive connotations, suspect. The term already had a rather negative tone to it — a 'mere consumer.' Toffler sought to replace the term with the not very happy neologism 'prosumer.' One of the problems with this term is that it simply puts together 'producer' and 'consumer,' whereas we may really need to think in quite novel categories — active appreciation of an art product, playing a video game, planning a family trip, may not fall comfortably into either category. But the point that we cannot classify all consumption as passive is well-taken. Even the activities defined in time budget studies and elsewhere as 'passive leisure' — e.g. watching TV — can be anything but passive. Much of the time spent in front of the TV set, according to some studies, is spent in talking, reading and other activities; and even the most mindless TV programme is something which is actively interpreted and cognitively processed by viewers, even if most of the time we do not share this interpretation with other family members beyond the odd laugh or expostulation.

Technologies present opportunities to potential users — or rather, they are seen as presenting specific opportunities, with the range of possibilities being conditioned by

the people's experience and awareness. Technologies are liable to be adopted by potential users if they are seen as offering useful opportunities at reasonable costs.[24] Decisions are being made between products which are seen to offer different sets of characteristics: to enable more or less costly, convenient, and comprehensive satisfaction of some selection of (more or less clearly articulated) objectives and goals.[25]

As we have seen, some choices are made between products that differ in detail, while others concern such substantially different modes of 'consumption' as eating a meal in a restaurant, buying a take-away, heating up a convenience meal, and preparing a meal from scratch. There are also choices made about which members of a family group will undertake which of the various tasks of informal production and consumption. Technological opportunities, then, imply choices as to the mode of use of the product: how, when and where will it be used, by what family members, how frequently, and so on. New products have to be fitted into ways of life — or ways of life may have to be modified to take advantage of the opportunities presented by new products. Often this will be a dialectical process, with the way a product is used evolving as the user comes to understand better its strengths and weaknesses, and sees examples of other users' experiences. This learning process has parallels in the industrial innovation literature — indeed, a similar process is part of the foundation of the notion of techno-economic paradigms, as discussed in Chapter 1, and the concept of 'lifestyle innovations' extends it to the consumer sphere.[26]

Innovation, consumption, and IT: the research problem

There are many features of the dynamics of industrial and consumer markets that could bear closer examination. Many of the assertions of difference between the two markets have some plausibility. But, on the whole, our discussion suggests that the differences are more qualitative than quantitative ones, and that some consumer markets resemble some industrial markets more closely than either resembles the bulk of their 'parent' markets.

The implication is that we can expect to find the innovation research literature a valuable source of concepts and insights when it comes to looking at consumer product innovation — even though, as we have pointed out, the bulk of this literature deals with industrial innovation. Specifically, this means that in looking at new consumer IT, we can utilise the insights gained as to technological trajectories and revolutions, design paradigms and product life cycles, and as to the behaviour of innovators involved in creating and reacting to such phenomena.

IT, as noted at the end of Chapter 1, is seen as providing many opportunities for new

consumer products — and these include both more or less incremental improvements to familiar products, and radically new products in their own right. Whatever the case, the costs of R&D, product development and marketing, will only be recouped if the product is a market success. So how do innovators go about assessing what the prospects of success are? How do they envisage the potential markets for their products, and how does this relate to their notions about consumers and their behaviour?

When established products, or incremental product innovations, are concerned, the task may not be so difficult. Consumer markets have already been established, and can be examined via conventional market research techniques. Consumers' behaviour and attitudes can be elicited by surveys and interviews, or estimated from studying purchasing trends. Images of the product can be determined from focus groups or by examining media commentaries. (Nevertheless, the rapid turnover of minor variations upon established products suggests that mistakes are common enough).

When the products are radically new — as with some of the new IT-based products discussed above — the task is more difficult. Such products pose innovators with the problem of imaginatively constructing a market which does not yet exist. There are liable to be many open questions as to what sort of people are going to use these products, in what circumstances, and in what ways. For a long time the product itself is only an imaginative construct, one that is realised only as diagrams and visualisations on paper, or as rough mock-ups made of balsa wood. Often even early versions of new products on the market are rough-and-ready ones, launches to 'test the water.' As we have seen, such products typically undergo considerable modification when they are still fresh to the market.

Thus, innovators face uncertainty both about how people might use the potential product, and also about the nature and design of the product itself. The familiar forms of market research are thus of problematic utility for dealing with radical innovation. How is knowledge of consumption gained, to set alongside the technical knowledge that is being employed in product innovation? How are these forms of knowledge combined, and the results utilised in the innovation process? These questions have guided this study.

Notes

1 In this study, we shall make only limited use of the media studies literature, which has paid only limited attention to new consumer IT. Perhaps more importantly, new consumer IT cannot be treated as simply a linear extension of existing household goods. There have certainly been numerous studies examining the diffusion and use of TV and, in some cases, the newer products of cable and satellite TV; some have also

treated home computers and video games. Media studies are prone to view the new consumer products as being no more than new types of TV and other audio-visual product, promising improved sound and vision quality. These aspects of the new products are certainly important, though they are also sometimes contested - as in the long-running argument as to whether CD-Audio sound is really superior to vinyl recordings. But, in addition to these features, the new products offer new characteristics, as shown in the previous chapter, which restrict the utility of the approaches developed in media studies to the analysis of new consumer ITs. Furthermore, media research has tended to take the technology as given, with most studies looking at patterns of use of established consumer products, and paying little attention to the origin of products.

2 H Braverman, *Labor And Monopoly Capital* New York, Monthly Review Press, 1974.

3 Georg Simmel, 'Fashion,' *International Quarterly*, Vol. 10 (1904), pp. 130-155. (Also of interest as an early analysis of consumption - in this case, especially 'pecuniary emulation' and 'conspicuous consumption,' see Thorstein Veblen, *The Theory of the Leisure Class*, London: Unwin Books, 1970 (originally published in 1912). For an interesting critical exposition, and presentation of important historical studies on the growth of modern consumer society, see Grant McCracken, *Culture and Consumption*, Bloomington: Indiana University Press, 1990. One of the interesting points made in this work is that the modern era witnessed a shift from consumer items being valued for their patina (e.g. being handed down through the generations) to their novelty. Novelty is, of course, par excellence a feature of the products discussed in this study.

4 The two may of course coincide; indeed it is likely that there is a fashion component to the adoption of even radically different products. Even in the clothing sphere, it is arguable that, for example, nylon stockings and later tights had elements both of fashion and (non-fashion) functionality behind their diffusion.

5 Marginal but affluent groups may play important roles as carriers of innovation - for example, it is alleged that drugs dealers have been major users of mobile phones.

6 At least in the case of large enterprises: there is some evidence that family firms, constrained less by shareholder short-termism, are more able to pursue social and environmental objectives.

7 Note that organisations will apply different rules according to the value of purchases, requiring higher levels of approval the larger the purchase. Suppliers of 'personal' office equipment such as PCs, photocopiers and fax machines recognise that

these may be purchases which managers can approve for themselves (and so can be impulse buys). In this respect the 'personal' professional market and the consumer market overlap considerably.

8 And also, we should note, reliability of the supplier, in terms such as promptness of delivery, adequacy of after-sales service, accuracy in claims about the product. All of these factors may have considerable bearing on the successful implementation of technological innovations.

9 This should not be assumed to be invariably the case. Micro-electronics components are typically more reliable than electronic and electromechanical ones - once dud chips have been sorted out - and thus the consumer versions of technologies which have become available because of the cheapening associated with microelectronics are potentially more reliable than the old industrial systems.

10 A. Cawson et al, *Hostile Brothers: Competition and Closure in the European Electronics Industry*, Oxford: Clarendon Press, 1990, Chapter 10.

11 Of course, not all industrial products are translated into consumer markets - though the growth of do-it-yourself and related activities does mean that homes are now often equipped with tools and machinery that would only have been found in factories and workshops a generation ago. Furthermore, the leading role of industrial markets may not always apply. TVs were mainly developed for consumer applications, and had limited industrial use until fairly recently. The high costs of producing certain new technologies (notably High Definition Television systems) are such that, it is argued, mass production for consumer markets will actually be necessary for industrial experience to grow with these products. The idea is that only mass production can enable economies of scale sufficient to reduce prices to levels which would enable wide use in industry. The use of video recorders in shops for point-of-sale demonstrations is unlikely to have become widespread had VCRs remained as equipment used by professional broadcasters.

12 The greater complexity of industrial products also reportedly leads to fewer product launches and longer life cycles than for consumer goods.

13 This is recognised by suppliers who are now trying to extend computer use beyond professional in offices by introducing new types of interface - such as so-called 'notebook user interfaces' - for new portable computers. On model that is receiving much attention is the personal organiser, for instance.

14 Although suppliers may introduce simplified models with accompanying messages indicating thrift and concern for environmental resources as well as ease of use. In the

consumer recession of the early 1990s one of the most popular camcorders in Japan was one introduced by Panasonic with very few features (no play-back facility, no motorised zoom, and a simplified viewfinder) and a strikingly different design. Advertisements showed grandmothers able to use the camera, and commentary in the press suggested that its success was part of a reaction to the over-indulgence (and feature proliferation) of the 1980s. Likewise, car manufacturers in Japan are beginning to offer models with stripped down features.

15 There seem to be few analyses of industrial market segmentation as compared to the literature on consumer markets.

16 Wiith home security systems, the visibility of the product is effectively part of the product itself, since it performs an important deterrent function, with the box on the outside of the house announcing to would-be intruders that the house is secure. There is also a market for imitation alarm boxes, just as there is for imitation car phones.

17 Richard Rosenbloom and Michael Cusumano, 'Technological pioneering and competitive advantage: the birth of the VCR industry,' *California Management Review*, 29, 4 (Summer 1987), pp. 51-76

18 E. von Hippel, *The Sources of Innovation*, New York: Oxford University Press, 1988.

19 It may also be less true in the case of services such as telephony and broadcasting than it is for consumer goods.

20 E Gummesson, 'The New Marketing - developing long-term interactive relationships,' *Long Range Planning*, 20, 4 (1987): pp. 10-20

21 See, for example, K. Pavitt, 'The size and structure of British technology activities: what we do and do not know,' *Scientometrics*, 14, 3-4 (1988): pp. 329-46

22 A similar instance emerged in 1993, when a British firm won a case against a video games company that had been trying to stop their retailing of a device which would enable users to play games at more speeds than originally intended - effectively extending the lifetime of games, it was alleged.

23 Jay Gershuny, *Social Innovation and the Division of Labour*, Oxford: Oxford University Press, 1983. It is interesting to recollect that the first vacuum cleaner advertisements in the UK, which portrayed the cleaner as chasing the servant out of the home, were withdrawn - because those who could afford vacuum cleaners at that time did not want to give up their servants! The offending advertisement was replaced

by one depicting harmony between servant and vacuum cleaner. Later, of course, the costs of domestic service meant that the technology could increasingly be seen as a substitute for, rather than a complement to, paid labour.

24 These costs are not merely financial ones: Sinclair's C5 electric vehicle failed in part because it was seen as costly in terms of users' lives, since the vehicle looked suspiciously low and fragile compared to cars and lorries; other costs may include time taken up in using the product, or in learning to use it.

25 This rather tortuous formulation is presented in an effort to avoid our account being immediately read in terms of an economistic framework of assumptions about the rationality of consumer choice. Our account is compatible with a wide range of assumptions as to the form - and the limits - of consumer rationality; and of producer rationality for that matter.

26 Interestingly, there have been few attempts to broaden the analysis of paradigms beyond the sphere of industrial production. See I. Miles, 'The New Post-Industrial State' *Futures*, 1985. However, it is worth noting that the so-called regulation school of analysts of long-term socio-economic change do draw attention to shifts in the patterns of income distribution and spending power associated with changes in industrial regime - for example, mass production requires mass consumption and associated mass spending power.

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Chapter 3

Home Automation

Roots

Images of homes of the future have a long history, especially in science fiction. Writers have often speculated about future homes, in part as a source of entertainment but also to explore social issues concerning utopian and dystopian lifestyles. Hence, the press, fictional novels, film and latterly television have all drawn upon such images and continue to do so, while exhibitions have often been designed to create a sense of wonder, of marvel, even of fantasy. Indeed, one showpiece building in the 1930s was named the 'House of Magic.'[1]

This history of images has both provided a source of inspiration for product designers and meant that potential consumers may be familiar with some product themes. Yet, there is further significance in the fact that these visions of homes of the future have been well worked terrain, full of symbolic meaning. Consumers and producers may well evaluate the costs and benefits of the particular functions offered by novel domestic products and designs. But, consumer research and the interviews conducted for this book suggest that sometimes producers' and consumers' evaluations of future homes, whether embracing them or reacting with great scepticism, are influenced by this background of accumulated connotations.[2]

In fact, portrayals of future domestic life have consisted of several different elements. On the one hand, we have radical architectural and interior design, which may or may not include moving furniture and interior walls. Then there is the vision which involves the presence of robots. More recently we have the home as information centre, where inhabitants can, 'at the press of a button' seek information from the outside world or conduct remote transactions via telecommunications.

The field of home automation (otherwise known as Smart Houses, Intelligent Homes or Domotique) specifically involves only certain dimensions of these scenarios: home control functions. Here we are firstly talking about the ability to pre-program appliance. Devices can then operate 'automatically,' switching on and off at certain times, or under certain conditions as indicated by sensors or information from other appliances. The other dimension is remote control, encompassing both control of appliances from another point inside the house and from a distance outside the house.

In practice, firms have been able to achieve remote control and programmability capabilities for many years. But to do so required a substantial amount of electronics and computer power plus a wealth of cables running throughout the home. Both the demonstration rooms and houses built by various firms over the last decade and the current spate of 'Homes of the Future' in different countries often resort to such expensive and cumbersome cabling in order to present a vision of what lifestyles in

advance of affordable commercial products.[3]

We have also been provided with the forerunners of home control from two other sources. A number of wealthy individuals, sometimes computer experts, have managed to wire up their homes to enable these forms of control.[4] And from the mid-1960s there have been subsidised remote control products for the severely disabled where the costs and inconvenience of wiring could be justified.[5] But until the late 1970s, the technology was still too expensive (and unwieldy) to justify mainstream commercial products, even if suggestions about home control had been voiced for some time within different firms.[6] Nonetheless, some elementary forms of control have been creeping into the home prior to this time. The infra-red remote controls to operate the television and later other equipment provides one early, and now ubiquitous, example. Timers have allowed us to pre-program cookers, VCRs and heating systems. Sensors for security and lighting products have appeared, for example, in the lights which come on when we approach the house. Thermostats are routinely used for temperature control. Meanwhile, the electricity boards provided the first form of control from outside the home through schemes such as ‘Economy 7’ in the UK (where an outside radio signal triggers the heating system).

Concurrent with these developments in controllability was the notion of interconnecting equipment into systems. In the field of commercial building, ‘building automation’ was initially stimulated by the desire for cost savings through more efficient energy management. In the 1960s, some firms dealing with temperature control had used mainframes to monitor and control the heat flows in large buildings. Eventually, the necessary sensors and controls were connected on a network which ran around the building to reduce the wiring which had previously connected each discrete device to the control board. These centralised control system covered not only heating and ventilation but later security as well. A broader definition of ‘intelligent buildings’ can also encompass networks handling office automation (e.g. Local Area Networks and e-mail within buildings) and enhanced telecommunications with the outside world.

One particular product area has perhaps done most to pave the way for the home control now being discussed. Audio-visual control systems have been under development for over a decade and are only just reaching fruition. When products first appeared which plugged into the TV (e.g. first the VCR, then video games and home computers), various manufacturers started to identify benefits which might emerge from connecting these devices on a network. Such an arrangement would eliminate the need to replug in the different units every time that they were required (e.g. setting up the home micro every time someone wanted to use it). Networks could also reduce wiring and facilitate remote control.

A group of consumer electronics companies working on the standardisation of the

Peritelevision (‘Scart’) plug foresaw this possibility shortly after 1976. Subsequently, Philips took the main initiative, developing what evolved into the D2B (Digital Data Bus) specifications for an audio-visual product network. D2B became a standard supported by a range of Japanese and European producers. In such a system, the TV could also make use of the hi-fi’s speakers, or one VCR could feed signals to televisions located in different rooms.

The normal electronic controls already present in audio-visual ‘brown goods’ devices meant that it was relatively easy to remotely control them via a network. In contrast, many other domestic appliances, such as kitchen ‘white goods’ still rely mainly upon mechanical switching (i.e. a physical motion was required to turn a machine on, or change a setting). Manufacturers anticipated that this might eventually change. One important vision connected with the ‘chip revolution’ was that semiconductor technology would gradually enter into more and more household products.

According to this scenario, electronic chips, and even microprocessors, might initially be incorporated into products because of their potential reliability or reduced cost. However, once in place, their presence could also allow new functions — for example, new forms of programmability. In particular, such ‘smart’ appliances could also be more easily installed on a system once they contained electronic switching. And the new chips in appliances could allow them actually to transmit messages about their status onto the system. If this were possible, then it increased the scope for monitoring appliances from a distance (as well as for controlling them) and for the interworking of appliances, where a change in the status of one product could initiate action in another.

In sum, by the late 1970s a number of developments were creating a product space for home automation. Some products were already appearing offering new control functions. Firms and individuals had started to construct exemplar houses to show what might be possible. There was the prospect of an increase in the number of individual smart products, and various technologists within the building and audio-visual industries were starting to explore the possibility of linking these into systems. It was at this point that the falling costs of microprocessors, combined with incremental improvements in various transmission media (e.g. signalling via the mains) tipped the economic scales. For the first time it became feasible to consider a cheap enough, mass marketable ‘interactive system’ of products which could offer consumers extensive and sophisticated controls.

Routes

This chapter focuses on the development of home systems, and specifically those emanating from appliance manufacturers. But to put this into context, it is important to appreciate that this whole field of home control has developed via a number of different

routes. Only some of these use the ‘network’ approach outlined above. This preliminary outline charts some of these routes. The full implications of this product space — the question of how products from different sources compete or support each other — will be discussed later.

Apart from timers, the first pioneering domestic appliance control system to take advantage of cheaper electronics was the American X-10 system (originally invented in Scotland). This system does not rely on the presence of smart products. It circumvents the problem of mechanical switching by inserting a module (i.e. a small electronic box) between the electric plug of an appliance and the wall socket. To turn on the appliance, this slave unit allows the current to pass, and later switches the appliance off by interrupting the power supply. The slave units can be remotely programmed and operated from a control unit via messages sent over the electric mains. Infra-red technology is used to connect hand-held controllers to master units.

The X-10 system appeared in 1979. Within a few years, a range of North American, and some European, companies were offering X-10-based products, often badged under a different name. The product was only much later sold under licence in Britain — appearing in 1991. Other such ‘black box’ controllers using related principles have also been developed. For example, several products that have appeared and been withdrawn in the UK. These came from small to medium sized firms with previous interests in home computers, lighting and security controls.

A second route to home control emerged when the home computer appeared. A number of hobbyists and firms looking for new applications for the microcomputer appreciated that the machine could be used for control purpose.[7] Designs and prototypes using home micros appeared in Japan as early as 1978, and by 1983, a number of companies, especially in the US, were offering products to link X-10 systems with various home microcomputers such as the Commodore VIC 20 and 64, the Apple, and the IBM PC. Either the micro could act as an input device plus display for a home control unit which then functioned autonomously (e.g. Red Box in the UK), or the micro could be in permanent control of various appliances (e.g. the MDR system in the UK). These systems were sold mainly to electronics and computer hobbyists, receiving coverage in the hobbyist press, although one large Japanese company, NEC, also proposed the computer as the home automation interface.

A separate, parallel, development was that of ‘environmental controls’ for the disabled market. While some of units offered an element of pre-programmability, the main type of function offered was remote control within the home or in hospitals. Some firms which were already geared to providing other equipment for this clientele diversified into environmental controls, while a number of smaller companies started up during the 1980s, designing controls and interfaces which were appropriate for the disabled. The

controls which emerged could operated a flashing emergency light outside the door, raise or lower beds, open doors, control lights, TV etc.

Meanwhile, a standard range of input interfaces were developed such as switches operated by foot, mouth, touch of head, grip of hand of whatever else the disabled person can manage. What these systems have in common is that the inputs and display systems were geared to the user who was only able to press one or two switches repeatedly — as opposed to the multiple choices offered by a keyboard or hand-held remote control. Some of these devices were designed with government support and certain purchases were also funded by social services in cases of severe disability.

Next, there are agencies who to date have introduced a few products with home control functions, but who could move further into this field. One key set of actors here must be the electricity, gas and, in a much more minor way, water utilities. These have, in a number of countries, spent more than a decade running trials on smart systems which have telecommunications facilities connecting them to the outside world (e.g. via radio, mains and the telephone communications).

One common interest they share is remote meter reading, billing and payment. Remote meter reading would not only save the utilities some labour costs but enable them more easily to check for tampering. Billing and payment offers an enhanced service to users, as does the facility for users to more clearly see displays of what they use and how much it is costing them.

A specific interest of the electricity utilities is to shift demand from peak times — a process called load management. These electrical utilities have to maintain the capacity, plus some energy in reserve, to cope with peak demand. So smoothing out the demand curve would mean the peaks would be lower, the capacity to supply electricity would be less and so the utility would require fewer power stations. In some countries, such as the US, overall demand is actually increasing faster than expected, and faster than the utility can expand supply. Here, the option of load management becomes particularly attractive.[8] The issue, which is discussed later, is the various ways in which home automation systems can some assist in this goal of load management.

Unlike the electricity utilities, gas suppliers can more easily store their energy source and so do not have the same pressing problem of load management. However, they have other interests in this field which will be documented in more detail later. In general, they would like to monitor the gas supply and gas appliances in people’s homes. Hence, one area of interest common to both gas suppliers and white goods manufacturers is telediagnostics. This is the ability to detect remotely when appliances start to malfunction or work less efficiently and determine the cause of this in advance of sending a service engineer. Gas utilities in France, the US and Japan have been actively looking at control

technology for some time, while in the UK British Gas has now started to explore some of the possibilities.

Another source of domestic home systems has been the commercial intelligent building sector which was noted previously. Control networks, in some respects akin to residential ones, were developed for commercial intelligent offices in response to the increasing complexity of buildings' functions. It made more sense to have systems sitting on a single network than separate wiring to deal with heating, lighting, ventilation etc. Changes in building materials had also meant that it became increasingly difficult to install cables. Cable and electronics suppliers from this sector have already diversified into residential apartment buildings in France — often but not solely in local government subsidised housing — and others have considered other possibilities in the domestic market (e.g. large houses and houses with businesses attached).

New home builders have sometimes taken the initiative, as in the US 'Smart House' programme to be discussed later. But they were not the first. One of the earliest products in Japan arose from this sector. And in the UK, a number of house builders have recently been experimenting with prototypes.

Apart from participating in collaborative programmes initiated by the consumer appliance sector, telecoms companies have also contemplated their own home systems products. From the point of view of the telecoms operator, intelligent home functions can be achieved as an extension of the public network into the home. In other words, telecoms software can operate the home network rather than that provided by appliance manufacturers, which means that more value accrues to the telecoms service. As yet, this potential has only been discussed, not implemented. On a more modest scale, both telcos and their hardware suppliers have developed products which offer some control or monitoring function: British Telecom's security monitoring system being and example.

Finally, there have been the initiatives from component manufacturers. An early example in Britain is that of Mullard, which later became Philips Components. Home automation represented a future possible source of demand for the chips which Mullard produced, and so the company was active from the earliest discussions and in the later European collaborative work. However, the most significant development in the 1990s has come from the US company Echelon. This start-up venture did not wait for regional standards to be fully developed, but instead launched its own chips and network specification for controlling intelligent homes.

The point to underline at this stage is that all these different manifestations of home systems can play a part in how this 'product space' might be structured and how a market might materialise. In practice, the main focus of this chapter is the efforts to develop home automation systems which originated from European consumer electronics and

appliance companies, albeit it in collaboration with other interested parties such as telecoms operators. These efforts, and the attempts to develop collective standards, have been under way over far longer time span than the Echelon initiative and played a greater part in shaping ideas about home systems applications and end users — upon which the Echelon standard may build.

Home systems

Described in technical terms, these home systems consist of a network, or 'bus,' within the home akin to the office LAN (Local Area Network) which links computers and peripheral equipment. 'Smart,' chip-bearing household appliances and sub-systems (security, heating), are attached to, and can intercommunicate via, this network. The transmission media used in the network includes mainsborne signalling (using the electricity wiring), infra red, low power radio, twisted pair wires (copper cable used in telephone wiring) and coaxial cable (for carrying audio-visual signals).

Many new consumer technologies have aimed to provide either labour-saving or time-saving functions. While there may be instances where home systems reduce time or labour, by and large this is not the main point of these innovations. Instead, these systems provide enhanced control, offering the consumer 'benefits' in terms of headings such as 'flexibility,' 'convenience,' various senses of 'security' and the possibility of some cost-savings (e.g. in the case of electricity usage at different tariff levels).

Apart from offering the 'integration' of appliances, home automation systems often include some new products. Security sub-systems sometimes use cameras at the door, as video intercoms, or for monitoring the children's room. These systems also employ a range of sensors which have to be fitted — to detect heat, movement, gas, smoke etc. In the case of audio-visual sub-systems, distributed audio (or video) facilities mean that a compact disc playing in one room could be piped music through to the speakers in several other rooms.

But the most important qualities of home automation are based on forms of remote control and programmability. Remote control and monitoring from within the home might include using a panel on the wall or a hand-held device to set up or adjust the heating or security devices, check energy consumption, alter lighting and control or monitor any audio-visual or kitchen device. Sometimes the aim is to simplify control, given the potential proliferation of separate hand-held controllers, especially for brown goods. So, one set of buttons might control the TV, VCR, Hi-fi and compact disc, where one or two button presses might order the VCR to play material on TV or to record what is showing on the screen currently.

Remote control from outside the home allows all these functions, usually via the telephone system. Control is achieved by pressing a sequence of numbers on the telephone dial at appropriate moments (when requested by a synthesised voice) — i.e. in much the same way as some answerphones can be remotely accessed. The usual benefits cited are: (a) that the appliances of the home can be monitored (e.g. to check if anything has been left on — in which case it can be switched off); and (b) if there are changes of plan, such as coming home early, then appliances such as the heating or cooker can be switched on in preparation. This is supposed to provide more flexibility than timers which rely on users sticking to their schedule.

The enhanced programmability offered by systems means that several devices can operate in conjunction. An example would be where a system remembers previous patterns of appliance usage and can turn lights on, draw curtains and even turn TVs and radios on at appropriate times to convey the impression that somebody is home. Lights could be programmed to come on if intruders or smoke are detected by sensors. Or washing machines can be programmed to detect the signal on the mains showing that electricity tariffs are low (against a backdrop where numerous tariffs may apply at different times in the day).

Technological configurations

The types of control and application described above can be achieved by various technological configurations. Some of the key variations are now outlined to provide some sense of how home systems may differ.

First, if products are to communicate with each other and with some form of control unit operated by the user then they need some rules concerning what signals mean — i.e. protocols. Such rules would include how to handle the situation where several devices on the network try to send messages simultaneously. In other words, there have to be arrangements for prioritising messages as a means of resolving such conflicts. Of course, such a network also needs rules detailing how messages travel around this system (the routing) and how they find the appliance at which they are directed (i.e. find its ‘address’). These rules are encoded in the network’s software and, where appropriate, in chips or even microprocessors located within appliances.

Next we have the actual transmission media which carry the signals. One example of such a medium is a wire akin to that used for carrying telephone signals: called ‘twisted pair.’ Many of the environmental control units and some of the computer control systems have utilised these extensively and certainly commercial builders are accustomed to this very reliable medium.

While suitable for carrying limited information about commands and the status of appliances, twisted pair cannot cope with the vastly greater data of audio-visual signals.[9] So for brown goods sub-systems, where you might want to convey pictures and sound from TV to video, a medium capable of carrying more data is needed. Co-axial cable is usually used for this purpose. With applications such as the security camera transmitting to a TV there are trade-offs: a high quality image would require co-axial, but if a poorer image is sufficient, twisted pair may be used. Fibre optics present another possibility for the future. But, at the moment this new medium is still to costly for most manufacturers to use.

The problem with wires of any kind is that they are either unsightly if left on show, or require effort to hide them behind skirting boards. This is less of a problem for newly built houses where the wiring can be fitted during construction: hence its appeal for programmes like the Smart House one. But there are more ‘invisible’ alternative transmission media. One is mains-signalling: where messages are sent to and from appliances via the mains alongside the actual electrical power.

This technique has existed since the start of this century, and was often used outside of the home, for example, as a means by which the electrical utility could turn on its street lights. Baby alarms were the first consumer product to utilise mains-signalling in the home, followed by the X-10 control systems. In recent years, this transmission medium has been much used by small firms in the UK, and the Credanet prototype system uses this medium. While it has its supporters, mains-signalling also has its problems. Manufacturers have had to devise ways to ensure that signals do not influence the products of neighbours and to take into account the fact that signals can be disrupted by the electrical ‘noise’ on the home’s power lines.

The remaining invisible media are infra-red, currently used in the remote controls for TVs, VCR’s etc. and radio-signals. Infra-red is limited both in that it can usually only send messages in one direction and only within its line of sight — i.e. one room. Yet, the medium can still be useful. For example, it can be used to send messages from a hand-held remote control to a main control box on the wall, say, which can in turn use other media to contact products in other rooms. Radio has some limitations in that it is a regulated medium — in terms of what frequencies can be used. In sum, different producers can and do use different transmission media, or combinations of media. All the standards programmes aim to specify how all these media can be used together and intercommunicate.

Another set of decisions relates to how users will be able to monitor and control products: i.e. the human interface. Environmental controls for the disabled use a variety of innovative interfaces because these particular users are more limited in the physical actions they can manage. But the range of interfaces for home systems generally is more

restricted. One option is to use a computer (or computer-like) keyboard and monitor, which has been favoured by systems from computer firms and even one Japanese company: NEC. A variation on this interface applicable mainly to France is using a Minitel terminal for controlling appliances.

On the whole, manufacturers have avoided the computer interface. Key-boards can be difficult to use for those not familiar with computers or type-writers and it is a costly interface if it is not already present in the home. However, the most important consideration for appliance companies is that using the keyboard as interface gives an impression they are trying to avoid: that home automation is only for those interested in and capable of handling computers.

One key candidate for a human interface has been some sort of box on the wall, with either an LCD display and an array of buttons to press, or a touch-screen, where pressing the appropriate point on the screen will send the appropriate signal. Alternatively, or in conjunction with the wall control, there are various hand-held remote controls (from coffee table book size to a chunky TV remote control size), some with their own LCD displays, some making using of the TV screen as an information display device.

We have already seen how the phone provides for controlling and monitoring the home from outside. In addition, some producers of telecoms equipment can also envisage using forms of cordless phones as the interfaces inside the home. And in the longer term we may see voice recognition and synthesis in use, avoiding the need for visual displays and button controls altogether. There have been products using voice control (e.g. ‘Butler-in-a-Box’ in the US and available in the UK since 1990,[10] and some have particular expertise in this area. However, to date voice control has been widely seen as being still too unreliable, while some feel that voice synthesis would meet consumer resistance and suggest misleading futuristic connotations.

A rather different question concerning end users concerns how much control they are given. In Europe, for example, white and brown goods manufacturers have favoured providing end users with a good deal of control, so that they can set up systems or configure them in a variety of ways. This also fitted in with a philosophy that systems needed to be open enough to accommodate future forms of utilisation which could not yet be anticipated.[11] In contrast, some electrical installers in particular have preferred to limit consumer choice to fewer options as well as embed these control options in components only accessible to professional installers. For example, in a subsystem offered by Electricité de France, customers can only choose to be one of a type of user, and the installer then sets up the program.

Lastly, we have differences in the overall arrangement of the system: the systems architecture. One key dimension here concerns whether the net-work is centralised or

relatively decentralised. Centralisation meant that there is a single central controller which receives data from and gives commands to slave products on the system. The X-10 command unit or the computer-controlled house would be examples. Decentralisation refers to a dispersion of processing power. This might mean locating microprocessors in various sub-system controllers — for example, one unit to control the security, one to control heating, one to control white goods, and so on, as with the European system. Alternatively, more of the 'intelligence' to init-iate actions might be located in chips within appliances in an even more decentralised system.

In the European model, the different sub-systems can intercommunicate, and so sensors for intruder detection can pass information on to, say, the consumer electronics controller for relaying a message to the TV screen. One advantage of more decentralised sub-systems is that part of the network breaks down, the rest can continue to operate. Perhaps more significantly, decentralised systems can be bought piecemeal, a sub-system at a time. This fitted in with how European manufacturers saw the market emerging, in evolutionary fashion. Hence, the European standard initiative has opted for a relatively decentralised version compared to, say, the Japanese.

This outline cannot hope to cover all the design choices of diverse manu-acturers. For example, there are issues in systems architecture concerning how expandable the network can be — i.e. the capacity to accept the addition of extra appliances to the network. Or there are questions regarding how new appliances are added to a system and how exactly messages are routed on the network. But this overview gives at least some indication of the various shapes in which intelligent homes may appear.

Historical overview

Japanese initiatives

The current major initiatives in Japan, the US and Europe to develop more comprehensive systems originated in the 1980s. The term 'home auto-mation' was first coined among the Japanese companies who showed the earliest interest in the concept of a complete home control system. The earliest home control systems were proposed by Hitachi and Matsushita in 1978.

From the early 1980s, many Japanese firms published their own home automation blueprints, developed demonstration houses and launched proprietary systems. These include major electrical appliance manufacturers such as Matsushita, Toshiba, Mitsubishi, Sanyo, Sony, and Sharp. Also involved were prefabricated house builders Misawa Home, Matsui and Sekisui Chemical. Nippon Interphone, Aihon and Nihon are examples of interphone companies who first added security functions to their system and

then expanded their product to cover a more comprehensive list of functions. Secom, a security services firm, expanded upon its original security system to develop a central control station for remote control of home security. Among the other parties who have designed and constructed experimental houses are the Osaka Gas Supply Corporation and the Ministry of Posts and Telecommunications (MPT).

The first moves to achieve some form of standardisation date back to 1981, with greater effort being shown from 1984. This whole process took longer than many had expected, but the 'Home Bus System' industry standard was issued in September 1988. There have been at least seven committees in various organisations which have been debating, sometimes only certain aspects of, home automation standards. In effect, these committees relate to two poles based on the two ministries who have contested jurisdiction of this field: MPT for telecoms and MITI for the electrical appliance manufacturers. Only a few products have been launched based on this standard.

In addition to these initiatives, KEC has also proposed a 'Superhomebus' which compatible with the standard Homebus and is aimed at connecting apartments in blocks. Work on this concept has been far less developed than the main Homebus, but some apartments have now been cabled with the system.

Meanwhile, the TRON project, which started in 1984, encompasses more than the other home automation packages currently under development, being especially concerned with architecture and the experience of space inside the house. Microelectronics facilitate this experience. For example, the 'border' between the house and outside world can be made to alter by pre-programming all the windows to open and allow in breezes. On the whole there are far more sensors than anticipated by other smart home systems (e.g. for humidity, air currents), and there are 1000 microprocessors in the pilot house which has been constructed in Tokyo.

US initiatives

The earliest US product dates back to 1979, with the simple X-10 system noted earlier. By the mid-1980s, about 20 companies in the US were selling some sort of system with or without home computer interfaces. Prices varied, in part reflecting the different elements in the package being sold — i.e. whether it included sensors, thermostats, burglar detectors etc., or was the basic unit controlling all-purpose, plug-in slave units.

Of the larger companies, Honeywell Control Systems was one of the first to investigate the possibilities of home automation as a 'natural' extension of their domestic control products (heating, ventilation air-conditioning) and of their products for commercial intelligent buildings. Honeywell started work on their first demonstration house in 1978. In the 1980s a proprietary bus developed for the demonstration house was applied in their

top-of-the-range domestic security systems and finally in 1992 Honeywell launched its Total Home system in the US.[12]

General Electric (GE) first reported their multi-media home bus signalling protocol 'Homenet' in technical journals in 1983. In 1984, GE launched a different system 'Homeminder,' but the company seems to have had less interest in the field since pulling out of consumer electronics. Mitsubishi (US) have launched products, but in general systems in the US, as in Japan, have had very limited success. Two rival programmes started in the early 1980s and which aimed to support home automation product development: CEBus and Smart House.

The Consumer Electronics Group of the EIA (Electronic Industries Association) started to examine the field of home automation in 1982. This initiative did not originate as a specific attempt to promote home systems so much as an effort to avoid some of the problems emerging with the proliferation of remote controls (e.g. VCR remotes unintentionally turning off the TV).[13] Following a review of current developmental work on communications between products, in April 1984 the EIA expanded its remit beyond infra-red controls and set out to develop non-proprietary standards. Its 'CEBus' (Consumer Electronic Bus), design was initially based upon GE's Homenet protocol, although this element has now been dropped.

The initial 12 participants soon expanded, and by the early 1990s reached 250 companies, including Japanese and European subsidiaries. In this sense, it is the most 'open' standard setting forum in the world, which has led to accusations that it was 'design by committee.' Even though the EIA group had started off by examining consumer electronics products, the potentially wide scope of home automation soon led to interest from other bodies such as cable TV, telecoms companies and utilities. The process has received no state funding and hence has far fewer resources than comparable programmes: about $2m compared to the $40m in Smart house. CEBus work has also involved a few active companies volunteering their time while many of the other 'participants' monitored developments. Standardisation has taken longer than expected, because of this lack of resources and the committee structure. The committee has had to go over the same ground frequently for new members. By 1992, a complete interim standard had been agreed and released.

In the meantime, the National Association of Home Builders (NAHB) Research Foundation launched the Smart House project in 1984 and shortly afterwards set up the Smart House Limited Partnership. Smart House is a proprietary system which is licensed to the participants who have paid to join the project. The initial focus was the development of a simplified and safer wiring system, so that no electrical power could be delivered to an outlet until an appliance or light called for it. This 'Programmed Power' — which has now been dropped from the project — was meant to avoid the dangers of a

shock from outlets and of short circuits. Later, the initiative took on board the idea of home systems and, in particular, their use in relation to energy management and conservation.

A prototype of the Smart House was completed in Washington DC in 1987. By 1990 there were 65 manufacturers involved in various capacities (a number of whom are also in the CEBus programme) and 45 gas, telephone and electrical utilities — although only 21 were actual partners. Following several delays and funding crises, a 'Smart Redi' system was launched in April 1991 in a systematic roll-out programme across the US.[14] House builders had feared that house buyers might start to delay their purchase while awaiting for the new technology and so had pressed for the launch of what was in effect the underlying cabling system. In other words, there were no actual products on the system at this stage — consumers would be buying in anticipation of such products. The full Smart House (products and system), originally due in late 1991, was in fact delayed for a few years.

British and European initiatives

The German company Busch Jager, a subsidiary of ABB who are involved in commercial building automation, have sold X-10 units on the Continent for some time. Limited home control packages have also been launched in the UK at various times by firms such as General Information Systems (whose Red Box is somewhat similar to X-10), MDR (using the Amiga computer for control), Home Automation Limited (a specialist in dimmer lighting and person detectors), and MK Electric (who deal with wiring and circuit protection). These all failed to attract much interest in the mid to late 1980s. By 1991, the UK had seen the licensing of the American Butler-in-a-Box system by Master Command UK and the X-10 by Centel,[15] as well as the launch of Switchlink by Emlux.[16] These firms respectively represent a start-up company, a company specialising in audio-visual remote control and another specialising in emergency lighting.

The larger European firms first examined the idea of home automation at the same time as their counterparts in Japan and the US. In 1978, Philips' Eindhoven R&D staff developed a prototype of a 'Dobus' system, which, although concerned mainly with audio-visual products, was extendable to cover control of security. When Thorn took over the EMI labs in 1979, the company started to explore home systems as a way of matching EMI's computing expertise with its own interest in domestic appliances. Thorn's Central Research Labs subsequently built a demonstration house and by 1985 were organising a business plan for developing marketable systems products. At that point company losses and the subsequent reorganisation of Thorn led to selling off large parts of the company. Home systems were less attractive once the company had disposed of its consumer electronics and white goods sections and so those plans were put on a back-burner. Thorn

EMI’s labs nevertheless continued their involvement with standardisation efforts.

In 1980, Zanussi’s Zeltron Institute started work on an ‘Integrated Kitchen System,’ although this has yet to be marketed. In 1984, Philips Components (formerly Mullard) set up their own demonstration apartment in the UK, although this was mainly designed to encourage potential clients to think about applications rather than suggesting a product that the company itself would market. In 1989, Creda, the white goods firm partly owned by GEC, started to develop its ‘Credanet’ system. The firm developed demonstration houses and ran consumer trials, initially planning to launch the system in 1991. However, all plans were put on hold when Creda became wary of launching during the recession.

While the above examples illustrate that there has been low-key interest this field for some time, Europe has been a later starter in home automation than Japan and the US in terms both of product launches and regional collaboration. It is only within the last few years that larger companies have launched sub-systems such as the security orientated networks of Thomson in France (Securiscan — now a separate company) and of Electrolux in Sweden (the EASE system). On the whole, France has experienced the most activity in Europe, with government-inspired experiments, and systems emerging from the utilities and small phone and security firms.

In the UK, the National Economic Development Office (NEDO) first discussed home automation in a 1980 Report and in 1984 it set up a Task Force on ‘Interactive Home Systems.’ It was in this forum that many issues were clarified which later influenced the path of European initiatives. Later, in 1989, NEDO launched a new Steering Committee to promote home systems but that disappeared with the overall demise of NEDO in 1992. A very separate initiative began life as a multi-client study carried out by a firm of consultants, Taylor Nelson, in 1987 and later became the Home of the Future Group. This body covers a variety of possible developments in the home, which can include intelligent home aspects.

Back at the European level, 1986 saw the launch of a two-year ‘Integrated Home Systems’ project organised within the broader Eureka programme. This drew chiefly upon some of the discussions conducted within the NEDO Task Force. With some limitations, it achieved its main goal of producing rough specifications for a provisional standard. At this point, efforts switched to the Esprit 2 project on ‘Home Systems.’ Initially another 2-year programme, its aim was chiefly to finalise and submit proposals for official standards. The NEDO, Eureka and Esprit collective initiatives will be discussed in more depth in later sections.

Development of product ideas

Origins: technological and market consideration

Let us be clear: the development of the home automation concept did not originate from an analysis or statement of wants or needs which had been articulated by potential consumers. In general, technological products originate in part based on the expertise which companies have developed in the past. The other part of the equation is their assessment of the relative costs involved in different technical trajectories. It is at this point that firms take into account their impressions of potential market size as well as what they can profitably produce given that they will be up against competitors.

There was certainly a strong element of technology 'push' in the case of home automation. But, important market considerations also made home systems attractive to many firms and even motivated some state support for this innovation. This enthusiasm was caused by the fact that home automation implied than a new set of black boxes which could be sold to the consumer. In the longer term, home automation meant that producers could to add value to a wide range of existing domestic technologies by incorporating new electronics into traditional appliances. Hence, the eventual leader of the Esprit consortium referred to interactive systems as 'the sleeping giant', while another interviewee described home automation as potentially 'changing British culture in the home.'

Furthermore, once the network was established in homes there was scope for other new products, as yet unknown, to be developed which could take advantage of this new network infrastructure. If accepted by consumers, home automation could ultimately prove to be very profitable for a whole range of producers who could offer services relating to the system, such as brown and white goods manufacturers, builders, security firms, heating an lighting system suppliers, telecoms firms and utilities.

The search for applications

The general inspiration provided by the long history of the 'home of the future' imagery, and by exemplar demonstration houses has already been noted. What we now have to examine is the question of how ideas for spec-ific applications emerged.

Some features of automated homes were first and foremost in the interests of particular producers, rather than consumers.[17] We have already seen how the electricity utilities wanted to develop load management. In the US Smart House programme, they also had an interest in home systems which would bring back power gradually in the case of a blackout by prioritising which devices received power first. In the same programme, installers wanted a technology to help prevent disconnects, mis-wiring or breaks in wiring. And we have already seen how companies servicing white goods felt that telediagnostics would facilitate their work, cutting down the time spent in customer

premises.

Other product ideas were transferred from professional and industrial user markets to the domestic setting. For example, commercial ‘intelligent buildings’ stimulated thoughts about new means of controlling heating and lighting in the home. In fact, two of the smaller companies in this field, MDR in the UK and Cyberlynx in the US, both started by engineers who had worked on dairy automation and were now applying the technology to the home.

However, the main process of developing product ideas related to these home systems was one of spotting a technological potential (e.g. a home network containing a microprocessor and display system), translating this into function which at least made sense in the home (e.g. displaying a note on the TV that someone was ringing the doorbell) and then trying to conceive of conditions when this might be perceived as a benefit (e.g. for those people with hearing impairments). The genesis of this particular example was described as follows:

> We had a lot of ribbing over this initially. But amazingly, it’s started to sell itself. Someone rings the front doorbell and the act of ringing the bell brings a legend onto the TV that says ‘front doorbell ringing.’ Now initially some people said that’s silly. Except that, as other people quickly pointed out, an awful lot of people are hard of hearing or they are absorbed in the television. But then the message gives you the chance if you wish to press a button on your remote control handset and suddenly you can see that there’s Auntie Mary come for a cup of tea, or it’s the insurance man, or it is someone that you don’t want to see. And if you’re infirm or aged, that’s useful. So right away, something that started off along the lines ‘Yes, we can do this. What use is it?’ has developed into something that has an application for the two million hard-of-hearing or the so many million invalided.[18]

In the case of European home systems, the systematic search for evidence of potential consumer interest tended to occur at a relatively late stage after the list of possible functions has already been generated. Within firms, a good number of such applications arose from the judgements of R&D staff, often reflecting what they would like in their own homes and what intuitively seemed to be marketable products. Staff from different companies also combined their efforts in a certain amount of collective brainstorming and scenario writing. This occurred both informally and formally, for example in collaborative enterprises such a Esprit. Such sharing of ideas meant that some product features and some of the images of home systems (e.g. in promotional films), occur repeatedly. Instances of these are phoning to check the status of appliances, turning on the heating on the way home, and turning the lights off at night from a central point

(often the bedroom).

Despite these areas of consensus, these remained a good deal of disagreement about which functions provided ‘real’ benefits, which were really a gimmick, and which would give a good impression of home systems. For example, some designers thought it would be useful to have a system where the TV or stereo sound automatically decreases when the phone or doorbell rings. Another idea was to program lights and music to come on in the morning to wake you up. For others involved in product development such suggestions were anathema.

In deriving these application ideas, personal experiences and simple vignettes about consumers’ daily life seem to have played a major part. For example, one product manager described the scenario justifying the idea of displaying warnings about the status of the oven or smoke at the bottom of the TV screen:

> You’ve left something cooking in the kitchen. You’ve gone in to sit down and watch the TV and you’ve got absorbed. And half an hour later something’s gone wrong in the kitchen. The kitchen’s full of smoke. It’s a very real domestic situation.[19]

Other messages about appliances could also be displayed:

> Again, this was taken a bit frivolously when we started, but we saw situations where certain folks really are quite busy — for example, single girls living on their own, or single fellows if you like. They want to watch TV or catch the news. They don’t want the machine to run on beyond a certain point. It can tell where it is. For example: ‘just started the last rinse’ or something like that.[20]

Producers also conceptualise consumers through generalisable models of human behaviour. One key rationale behind an electricity board’s develop-ment of a smart meter was the argument that ‘spot pricing’ of electricity would be successful — i.e. that electricity should be priced to reflect its cost of production during the day, rather than being priced at some average figure. This claim in turn rested upon a view of behaviour derived from neo-classical economics: that given the necessary information, consumers would change behaviour to optimise their electricity usage. In fact, this assumption does not match the mainstream ‘understanding’ of consumer behaviour held by consumer watchdogs.[21]

Apart from identifying a range of applications from home systems, the firms were also concerned to pinpoint ‘trigger’ product features. In other words, they searched for the benefits which would somehow cross a threshold of usefulness so that consumers would

be willing to start buying home systems for that particular aspect. In practice, the main contenders have been seen as security functions, entertainment related sub-systems and energy management controls.

The VALS approach to product genesis

An exception to the general process of product idea generation comes from the Home of The Future Group, whose history will be described in more detail later. Strictly speaking, its focus includes but is not solely on home automation. In addition, a number of the Group's members are involved in the emerging intelligent homes industry.

In forecasting social and cultural trends, the consultancy firm who originated the project, Applied Futures, used the 'Social Value Group Model,' a close derivative of the VALS market segmentation system. Based on analysis of questionnaire data examining people's attitudes and activities, this scheme divides the population into groups of people with different orientations, the most important general categories being 'outer-directed' and 'inner-directed.'

Through a series of brainstorming workshops, the participants in HOF developed two opposed scenarios on a 20 year horizon — one where a majority of the population were inner-directeds, one with the majority outer-directeds. The aim was to then look for product ideas which were robust enough to exist within both of those scenarios. An example of the scenario building process was the view that inner-directeds would be expected to move towards larger houses, more varied housing, to make more imaginative use of homes including a good deal of refurbishment and flexible use of rooms, use of basement space etc.

None of the companies involved had used the VALS based segmentation, and therefore the HOF approach appealed to many because it provided some new ideas, especially given widespread marketing arguments about the need to consider demand factors as well as technological ones. The current project leader noted:

> For most of the companies involved at this stage, the attraction of this project was, and to some extent still is, at least as much that it was different as that it was right. Different in the sense that it was creatively different.[22]

Evidence of a market

Even taking into account the fact that VALS is based on some empirical data about daily life, it is clear that on the whole consumer research has not been used directly in product

idea generation. Two examples of exceptions were Smart House and GPT in Britain. In their first marketing studies the Smart House researchers asked people about the types of intelligent homes they might want to inhabit.[23] Later, the telecom equipment producing firm GPT (GEC) tried to develop product ideas for home automation by asking about the problems and wishes of users in relation to existing household appliances. But mostly consumers have been absent from idea generation, although they have had some, albeit limited, role to play in evaluating product ideas. This has been in terms of assessing both the particular home system features which have be suggested by firms and evaluating the whole concept of home automation.

Visitor interest at exhibitions have constituted one important source of feedback for producers. But for most companies, more systematic interrogation of consumer attitudes has involved discussion groups (known as 'focus groups'). Yet, the product managers who were interviewed for this study were generally very wary of putting too much emphasis on the results of consumer research relating to new products. They felt it was marginally better to ask such questions when demonstrating the equipment than just to provide discussion groups with verbal descriptions or images. On the other hand, these producers were concerned that radically new technologies were a type of commodity which did not readily lend itself to this form of evaluation. Given the imagery of home automation, several staff mentioned that descriptions would probably 'frighten consumers to death' and thus evoke a negative response.

However, consumer research had a bearing on some issues. Staff in-volved in home system development pointed to ways in which focus group had provided them with certain data: mainly relating to potential consumer profiles and to product pricing. One defence of such research was that while it might not show which products would be successful, it could highlight some potential failures:

> Market Research, I think, can establish whether you've got a product which is plainly laughable and you may amend your offering fairly considerably. It very rarely tells you that a product will be a success. At best, it stops you making some obvious mistakes.[24]

Honeywell were one example of a company which used research in this manner, to ascertain which features of home automation were unsuitable. Smart House researchers changed some of their plans when consumer studies revealed that end users would want far less information about the status of appliances and sub-systems than had been anticipated in early designs. They also used the consumer research to derive very general pictures of the main themes in future homes which may appeal to purchasers — e.g. the idea of 'making life easier.' This was then translated into particular applications such as putting the house into certain 'modes' as regards heating security etc. when on holiday, at work, at home etc. Finally, participants in the Smart House initiative felt obliged to return

to consumers before implementing the wishes of home builders by launching their Smart Ready homes.

On the other hand, other staff were critical of even a limited role for consumer involvement prior to product launch. They argued that there were cases where market research did not predict the interest which actually came to exist. For example, one interviewee pointed out that the success of home computers could not have been anticipated. Some product managers also suggested cases where consumer research might mistakenly favour products for which little actual demand emerged.

Nevertheless, for larger firms such as Thorn EMI and Philips, market research was considered to be a necessary, indeed automatic, stage in product development and marketing. In such instances, consumer research could play a legitimising role at a number of levels. Firstly, where it could be interpreted positively, this ‘evidence’ could be cited to justify to their superiors within the firm the new product launches which R&D staff wanted.

Secondly, market research could be important in terms of reinforcing the existing expectations of staff. While some producers interviewed were critical of market research precisely because it supplies the ‘obvious,’ expected answers, for others such confirmatory research appeared to add to confidence to their predictions. Thus, several interviewees cited market research (and trials) as evidence for their own arguments and viewpoints.

Market reports and home automation conference presentations have provided other sources of evidence. Market reports on home automation have tended to aim at firms which might consider entering this market but which have not yet thoroughly examined the field. Since home automation covers so many application areas, the audience is potentially very wide.

Often, such reports are chiefly comprised of a summary of technical developments, an explanation of concepts, an outline of innovations which may be in the pipeline and of routes by which home automation could develop and what products currently exist. In other words, when examining ‘the market’ such reports are often mainly concerned with the activities of producers, including collaborative undertakings. But, the reports and presentations can also cover social trends which might have some positive bearing on the development of home automation (e.g. teleworking, state funding for distance learning in education or for facilities for the handicapped) and evidence from past purchasing (e.g. how security in homes has not such a buoyant market to date).[25]

Evaluating the market

One finding of this research was that interaction between producers has been more influential in shaping evaluations of the feasibility of products than any more direct consumer feedback. Before describing European home auto-mation collaborative initiatives in detail, this section outlines some of the general processes by which those in the producer community influence each others judgements.

The role of producer interaction

One first mechanism which aids the circulation of ideas about potential products consists of industry trade media and market reports. We have just noted how market reports marshal evidence concerning potential consumer demand and product opportunities. With some qualifications, these reports have been positive in the field of home systems. In Britain, the conference organising agency RMDP Ltd diversified from its original specialism of retail automation to work in collaboration with NEDO on a market report in 1988. Apart from organising home automation conferences in 1987 and 1988, RMDP went on to arrange a consumer research report in 1989 and publish the UK's first quarterly trade magazine: the *Intelligent Home Newsletter*.[26] Although neutral as regards supporting any particular company, the policy of such publications is to point out positive aspects and promote interest. On the Continent, the main journal is the French based *Domotique News*.

A second mechanism for producer interaction lies in the various associations, working groups and European programmes which have functioned at different times. If we take an early example: when the NEDO Task Force was first convened, many of those attending were initially very sceptical as to whether this form of home automation had 'real' benefits. However, the enthusiasts, including some major firms, were successful at persuading the majority to consider the plausibility of the innovation. Subsequently, NEDO, and the various European trade associations which later arose, developed programmes to raise awareness of home automation amongst a wider producer audience. Given that innovations in home systems cut across so many existing product areas, the chances of commercial success are improved by widening the constituency of manufacturers who can supply relevant products. Hence, the significance of such promotional activities in 'building a new industry.'

In addition to such formal forums, producers interact through networks of contacts. For example, once developmental work on home systems was under way, teams in several firms felt it to be important to invite not only staff from other parts of their own company to see their prototypes but also staff from other companies. Here was a particular instance where feedback from peers was more significant than from potential users.

Sometimes, such invitations were understandable when the development teams were testing opinion and support from firms offering complementary assets and services.

Hence, Creda invited house builders and distributors to see its demonstration house, while Mullard, as a components supplier, invited appliance manufacturers to see its work. But in addition, more direct competitors would be invited to see each others' ideas, such as in the case of Thorn and Philips. And it is perhaps a measure of the uncertainty in this whole area of home automation that the Japanese and Europeans have visited each others' laboratories and asked for opinions about the chances of product success.

Supplementing such visits are the informal contacts between firms. For example, some participants recalled one dinner where directors from a number of key British firms discussed the viability of home systems at the time of the early NEDO Task Force. Members of the Esprit consortium meet constantly at standards committees, conferences and other presen-tations and have noted that they iron out many points outside formal meetings — which includes discussing on-going evaluations of how market might develop.

Exhibitions, either for the public or as part of a trade show, offer another chance to gauge responses from other producers. And there are other opportunities for meeting. The market research firm EGIS, which had conducted work in this area, was asked by subscribers to arrange a presentation on the topic. Once again, it seems that contact with the other firms attending, including competitors, was one of most worthwhile aspects.

Lastly, conferences provide a significant venue for producer interaction. The formal presentations have been mostly positive, with the occasional critical remark. As with market reports, they are occasions to cite evidence that the innovation has potential. Also, as with the reports, some figures are usually floated concerning the potential market size and value. The implication is that few big companies can afford not to monitor the area given its enormous potential.

Venues such as conferences and exhibitions provide an opportunity for contacts to be made outside the main presentations. A number of participants felt this to be at least as important as the formal content of the proceedings. As an example of the behind the scenes negotiations which sometimes take place on these occasions, some NEDO Task Force participants first floated the idea of a Eureka project to their European counterparts at a conference on new technologies. In private, participants talking to each other appear to raise far more doubts and reservations about home systems than are voiced in public, even amongst those overtly committed to development. Nonetheless, the conferences have helped to capture the attention of a range of producers and to reinforce the sense that something is happening in this field.

The above examples indicate some of the mechanics though which producers meet and share ideas. Larger firms may look to sources of pro-ducer contact more than to consumers, but at least they have the option of market research. Smaller companies

cannot usually afford to organise con-sumer feedback, outside of personal experience gained in installation or from particular customers. For such firms, these various forms of producer inter-action provide virtually the only basis for evaluating products.

The activities of other firms

Amongst all the arguments and evidence introduced in the publications and events noted above, one particularly striking theme was the way in which the involvement of competitors has leant credibility to this whole area of home automation. In Britain and on the Continent, firms were aware that Japanese producers were already involved in the area and the fact that that MITI was providing government funds persuaded them to take an interest.

Apart from a certain amount of respect for Japanese ability to pick successful innovations, Japanese activity also raised the fear that the British companies and other Europeans could not afford to be left out of potentially lucrative markets in case the Japanese proved successful. This argument was also repeatedly evoked in market reports. As an ex-product manager from Thorn EMI noted, this factor enabled staff to argue for resources within the company:

> Because the Japanese took it seriously, it was easier for me to get the money to run our own project. The fact that so many companies were taking it seriously and putting weighty resources into it gave the whole project more credibility.[27]

But it is not just the presence of the Japanese. GPT were initially attracted to this area and joined the Eureka programme partly ‘because of the other ‘big names’ who were participating. GPT staff said that they would have paid less attention to the home automation if only smaller firms had been active. Similarly, the Creda product manager noted:

> I think that the fact that our competitors in appliances, Philips, Siemens, Thomson, etc. were all taking an interest in home automation was a spur to our involvement.[28]

Part of this spur may be the fear of being ‘left behind’ but part of it is also a ‘bandwagon’ effect: the view that the more producers are involved, the more home automation is likely to ‘take off’ — that a market could be created because of the sheer weight of producer efforts. In fact, this argument was also presented to Japanese firms in early Japanese market reports on home automation. While this may appear to ignore the acceptability of products to actual consumers, the point is that because the home systems innovation cuts across so many products, with few of even the large companies being in a position to

delivery all the parts, the degree of support is a critical consideration for firms in deciding whether to develop products at all and in determining how much visibility intelligent homes products might have for end users.

Collaboration within and between firms

> Home Automation blurs boundaries which tend to be organised around concepts of technology which are 50 years out of date.[29]

As this product manager noted, the appearance of home systems, and with it some new functions, required some redefinition of product boundaries — concerning how firms should classify an application and under whose area of competence it should fall. For example, when the staff at Thorn EMI's Central Laboratories were designing a demonstration house they had wanted to connect motors to curtains to allow them to be remotely controlled on the network, and they had asked the lighting division to set this up since they saw control of natural lighting as an aspect of lighting in general. But the lighting division argued that they only made lights, that this application did not count as 'lighting' and was therefore not their responsibility (as a result of which, Thorn's demonstration house did not acquire remote curtain opening).

This type of issue later spilt over into inter-firm collaborative efforts. In Esprit, in determining a list of application areas there were debates about whether control of natural light should come under the heading of lighting or whether it should be subsumed under environmental control (along with heating and air conditioning). There were also questions such as where does a security system stop and a lighting system start (where lights coming on provides both a deterrent to and a warning of intruders).

Hence, as the Thorn EMI example illustrates, the nature of how automation generated some problems for collaboration within firms, in bringing new sections into partnership and determining areas of respons-ibility. Inter-firm collaboration in this field was even more ambitious, some-times bringing together diverse interests who had previously had little contact. This section examines the main formal channels of inter-firm collaboration which have formed such a significant part of home systems activities to date. Clearly collaborative initiatives in Britain are of interest to firms operating in this country. But in addition, it is worth starting with the early British initiative since it played a role in setting up later European programmes.

NEDO sector working party[30]

The sectoral working parties set up by NEDO originated under a Labour Government as

part of its industrial strategy to bring together companies, trade unions and Government representatives. Under the subsequent Conservative administration, NEDO's function was transformed into being a forum where British business interests could meet and collaborate — although unions were still represented.[31] The various subsections of NEDO, such as the old Consumer Electronics Sector Working Party (SWP), offered the potential of a wider membership than could be achieved through trade associations like BREMA. This was of particular salience in the case of an innovation such as home automation. As one representative from Mullard noted, apart from NEDO, there was no other natural forum where brown and white goods firms could meet. Some other participants later described the Task Force as a new experience because of the vast terrain that was covered.

The starting point for NEDO interest in home automation followed a consultancy report on the crisis in the TV industry. Its recommendations for rationalisation of TV production capacity added a particular incentive to think about alternative products to utilise the excess manufacturing capacity. 1980 saw the first public discussion of home automation in a report which raised the possibility of adding value to TV sets by converting them to the 'intelligent terminals' of a 'home system' by providing the TV with more memory and processing power.[32] (This TV centred emphasis was later dropped in NEDO discussions of home automation). The Report reflected discussions about home systems which the SWP secretary at that time had been having in 1979 — mainly with Thorn.

Over the next few years, this interest stayed on the back-burner as other commitments such as the Teletext campaign took up the SWP time. In 1984, a new secretary took over what was by now the NEDO Consumer Electronics Economic Development Committee (EDC). Informal meetings involving a number of key firms eventually led to a new NEDO initiative. The EDC set up sub-groups to focus on four specific areas: TV and related products, Home Computing, Personal Communications Terminals and the Interactive Homes Systems Task Force which is the relevant body for this chapter.

One early decision concerned the companies which should be invited to participate apart from the original core group of members, which included many of the large consumer electronics firms. Additional invitations went to microcomputer producers such as Acorn, as well as representatives from the utilities, such as Electricity Research Council. Later, other firms submitted a request to join the Task Force meetings: for example, Honeywell. Hence, membership lists varied at different times during the life of the Task Force.

Early discussions considered the various product possibilities as well as the feasibility of a home automation market in general. The firms which were independently making plans in this area, such as Mullard and Thorn, took a leading role. It is clear from interviews that not all participants were totally convinced about the prospects for some of the home automation scenarios being discussed, even if they kept reservations to themselves. Most

often, there were differences in the assessments of which product configurations might be successful and of the time scale of developments.

To the extent that the Task Force members moved to some consensus about the importance of the area, a significant factor was Japanese involvement in the field. General Japanese government financial and organ-isational support for the area was announced at about the same time as the Task Force started to meet. This, together with the activities of various Japanese companies, was described by many as a catalyst to action. In particular, the view that the home computer standard MSX could form the basis of a home automation system had stimulated a prior meeting of the NEDO EDC in September 1984. This was one of the meetings which led to the original formation of the Task Force. This interpretation of the role of MSX had previously been voiced in Japanese and British market reports. In retrospect, this avenue into home systems was not developed, and MSX was a rare Japanese failure in consumer electronics, but the important point was that MSX took on a particular salience for the Task Force at that time. The 1985 Report from the Task Force conjured up the scenario of Japanese standards becoming de facto ones for Europe, with the possibility of significant Japanese market penetration if the Europeans took no action.[33] While a number of participants were also impressed by the degree of co-operation that was achieved, including between competitors, there were limits to disclosure and to collaboration. Some interviewees, particularly smaller firms, described the larger companies as ‘keeping their cards close to their chest’, and would clearly have preferred even more disclosure of marketing plans and technical developments. These limits to disclosure were also acknowledged by the larger firms and agencies. Some, having spent money in the field already, felt that they did not want to provide too much detail. As the Thorn EMI representative noted:

> Certainly larger companies would worry about giving out information on the work that they had done on the standard away too early because small companies could possibly react more quickly and produce products first, even though they had not put research money in and faced all the difficulties. [Therefore] they had always had a slightly ambivalent feeling about handing out information.[34]

Lastly, there was the tricky question of finance. Firms involved in home automation, and this applied particularly to Thorn EMI, were interested in getting outside additional finance to support projects. Such funding would not only enable more to be achieved, but would lend credibility to the project within the company. Certainly, speculation about possible further finance was an added incentive for some firms to join the NEDO initiative. Yet, government money proved to be in short supply — NEDO had no such resources available. In addition, the Task Force could be a potential drain on firms’ resources. Some company representatives felt that NEDO was trying to play the role of the Japanese MITI but without the financial backing which that institution enjoyed.

The first output from this forum was the 1985 NEDO Task Force Report on IHS which outlined market opportunities, noted foreign initiatives in the area and provided a set of recommendations about where to focus standardisation efforts. The 1987 and 1988 NEDO conferences organised in conjunction with RMDP followed. By this time, after Eureka had started, NEDO's role had become focused on disseminating the idea of IHS to a wider audience in order to prepare the ground for home automation by the time a standard emerged. This role also justified partial funding of the two market research reports from RMDP.

Arguably, the most significant outcome of the NEDO work was the transition to a European initiative. The Task Force had originally started with a UK orientation, as was reflected in their terms of reference and in the 1985 Report discussion of the specificities of UK market, of UK areas of expertise, and of which British agencies might best develop UK standards. But, in Task Force meetings it was recognised that home automation might require a wider market than the UK to be viable and that other European firms needed to be involved in standardisation. By 1985, the Task Force Report was encouraging collaboration with other European countries. Behind the scenes negotiations, combined with more formal contacts via the Department of Trade and Industry, led to the emergence of a Eureka programme on IHS (with the initials now standing for 'Integrated Home Systems').

Eureka

The Eureka initiative had emerged in 1985 as a non-military European response to the US Strategic Defence Initiative (Star Wars) programme. Championed by the French, this high-tech industry-led programme embracing European countries beyond the EC aimed to promote collaboration between firms and governments in areas where development costs were very high. The result was a series of programmes for such fields as communications, biology, lasers, robotics, and energy.

The DTI suggested that there was possible funding to be found for IHS development under this Eureka umbrella — or certainly a number of firms came away with impression that the DTI had made this suggestion. This led some NEDO participants to hold informal talks, particularly with Thomson, Siemens and Philips in Holland.[35] A two-year Eureka IHS project was agreed in December 1986 and work started early in 1987 — finishing in Spring 1989. Thorn EMI proved to be an acceptable leader for the project. The main aim of Eureka was to produce standards specifications for the IHS network.

Issues

Initially, there was the issue of which firms could and could not join the Eureka initiative. Several interviewees from the eventual Eureka firms put the argument that limited

participation was necessary to make the programme successful. Thus, the project came to involve a consortium of larger firms which together held over 60 per cent of the European market for consumer appliances and electronics (see Table 3.1). Examples of firms and agencies who wanted to join and who were refused included BIMSA in UK, Philips' French subsidiary, Bang and Olufsen from Denmark, and Honeywell UK. Some of these expressed discontent in interviews at being excluded.

The next contentious issue was the relationship between Eureka and non-Eureka NEDO Task Force members. In the debates which led up to the Eureka initiative, non-Eureka members had been promised feedback on development. Clearly both sides had different views of how much feedback was expected. While the non-Eureka firms continued to demand briefings they felt that very little detail emerged with feedback remaining at a very general level. Hence, some of these representatives remained ambivalent about the 'success' of NEDO in leading to Eureka.

The bigger British companies in Eureka also expressed some grievances. They received very little of the Government funding which had been intimated. Certainly, they received no support from the British Government. Several firms felt that they had been misled by the DTI. In fact, the Thatcher government had been opposed to additional state funding when Eureka was initiated, and the British governments towards Eureka projects came from money already allocated to DTI support programmes. Later it modified that policy, and gave some additional money to the High Definition Television project, for example.

One argument why the British government failed to supply money was that when Thorn EMI had sold off most of its capacity to produce home automation systems, the application for Eureka money fell foul of a regulation which stipulated the funding must be linked to a manufacturing capability in Britain. Others argued that the more significant factor was the general climate where funds for industry became scarce. The home systems work in general was simply not so important to attract funding under these circumstances.

The original plan had been that each participating company should be given matching funds by the host government. Hence, several of the Eureka partners were affected by the British decision: Thorn EMI, Mullard (the UK branch of Philips Components) and Philips UK. As a consequence, goals had to be revised and the final output of Eureka was a little less developed than members had anticipated. However, Eureka achieved its main goal of producing specifications for a rough standard.

Esprit

Esprit (European Strategic Programme for Research and Development in Information Technology) was an EC Commission programme to develop 'basic IT technologies' for

the 1990s, while at the same time promoting standards and European co-operation. Esprit 1, lasting from 1984-1987, had included 201 projects under broad headings such as microelectronics, office systems and computer integrated manufacturing. The second phase of the programme, Esprit 2, focused on microelectronics and peripheral technologies, information processing systems and IT applications technologies.

EC interest in home automation dates back a few years. In about 1986/7, there was a proposed Esprit 2 project on 'Home Systems'— known as project 'L.' At the time, some Eureka companies had even wondered if this initiative might become a competitor to their own work, but the formulation of the EC programme proved to be a lengthy process. Consequently, Esprit 2 was ready to start at about the same time as Eureka was drawing to a close, with its participants seeking further funding. By this time, whatever their reservations, the firms were more amenable to using Esprit as a vehicle for funding.

Eureka members were confident that their application would be successful since they had already done so much work in the area. But there were other bidders for the money: one Italian consortium and the 'Hitec' group of smaller companies led by BT. Although the Eureka Consortium won the contract, they had to accept a compromise where the competing applicants also participated in the Esprit 'Home Systems' programme (see Table 3.1).

The consortium had originally put in a bid for three years, anticipating it would get two — which was indeed the case. The project started in January 1989, building on the Eureka input. Now led by Philips, it attracted an EC contribution of ECU 7m. Following the public launch of initial standards at an Amsterdam conference in 1991, the Esprit Consortium put in a successful bid to continue standardisation efforts, chip development and work on the human interface financed by further EC money, although this has proved to be far less than expected given a more general shortfall in funds within the Commission.

Standardisation

Standards debates in the UK

Apart from brainstorming sessions to generate ideas for potential product configurations, the first meetings of the Task Force led to a decision that it was desirable to formulate UK standards for home automation. The point was not lost on a number of members that such standards would constitute a potential non-tariff barrier to foreign home automation products — or rather a hurdle, since non-British firms could still produce goods to British standards. This same theme was expressed in European projects, although not everyone subscribed to this perspective. But, there was shared concern that standards should not be

shaped and imposed from outside.

Apart from hindering competitors, it was felt that standards were necessary to get home automation off the ground. The argument put by those involved in NEDO, Eureka and Esprit has consistently been that the market would simply be too small if it was to be fragmented by incompatible standards. While there were differing opinions as to how much of IHS to standardise and what forms that standardisation should take (i.e. official versus unofficial), participants reached a clear agreement on the need to specify areas for standardisation efforts. The Task Force decided that it should not aim to develop designs suitable for 20 or 30 years' time but should look forward to the next 10 years. This influenced the transmission media being considered — i.e. those media which were already fairly well developed. This led to an emphasis on the need to develop further standards for mainsborne signalling (a field where British based firms where at the forefront), for co-axial cable (used for audio-visual distribution), and for cordless media (infra red, radio). Twisted pairs, using the D2B standard, could also be integrated into the planned IHS network. The telephone was to be the external means of communication. Although other media were considered, the decision was made not to recommend that effort be put into standardising, say, broadband cable for external communication, or fibre optics within the home.

The decision to have a British standard (and the same arguments were later to apply to a European one) was not only influenced by commercial considerations. In some respects, the British/European, US and Japanese markets were regarded as being different in nature, and thus required different home automation products and more important different technical specifications. Some of the perceived cultural differences concerned the importance of product areas: for example, that consumer interest in security varied between the these markets. But one key issue, which was reiterated in the 1985 NEDO Report and in the subsequent RMDP market research, was the difference in housing stock.

Table 3.2: Home Automation Collaboration Initiatives

Housing in Japan, and to some extent the US, was built to have a shorter life-span than UK (and Continental) equivalents. Hence there are fewer new-builds in Britain. Whereas the emphasis in Japan (and in the Smart House Project in the US) was seen to be on designing systems which could easily be installed into new houses, this approach was felt to be inappropriate for Britain. In the UK, the retrofit market would be more important. This had a number of implications:

&μιδδοτ; The housing issue provided another justification for designing standards differently from the Japanese and Americans.

· To some extent, the difference might make home automation networks less exportable to Britain, and so give British producers an advantage in their own market. (This same rationale was extended to European producers more generally when discussed in the Eureka programme).

· Retrofits strengthened the argument for designing a network so that products, or rather sub-systems, could be purchased incrementally, as opposed to installing a complete home automation package in new housing. This approach was strongly recommended in the final report.

The other major decision taken at this time, which arguably fitted in well with the incremental approach, was to have some degree of decentralisation designed into systems. In contrast, many of the Japanese firms had moved towards more centralised systems, which were technically easier to develop. However, the trend towards cheaper microprocessors facilitated this distributed intelligence option.

The move to European standardisation

One line of thinking in the Task Force was that the UK should aim to establish standards which might also become *de facto* ones for Europe, given that the British initiative seemed to the participants to be further developed than on the continent. Running counter to this view was that of several of the larger firms in the Task Force who had always seen the need for a greater European dimension.

Their fear was that continental partners might reject standards in whose formulation they had not participated — the ‘not invented here’ syndrome. And if British standards were not able quickly to establish themselves as European ones, so that competing national standards for home automation developed, this could actually delay reaching a consensus about a Europe-wide joint standard, since each country would have an established system to defend. When this argument prevailed, it was decided to explore the possibility of European collaboration.

Eureka

Once the Eureka project was in operation, its members had debated whether to aim for an unofficial or official standard. An unofficial family of standards had some appeal, since they would be champion by a tightly knit group of companies which controlled much of the Western European market. It would also be easier to establish such standards quickly and so help to get off the ground the applications which the companies were developing. The Consortium might also be able to capitalise on their developmental work by licensing such standards to third parties, whereas with official standards members would be required to be more open about standards information. This was particularly appealing

to some firms, like Thorn EMI.

The disadvantage was that *de facto* standards might provoke alternative systems and lead to a long term fragmentation of the market. The result was a compromise. The Eureka firms continued to work towards official standards and planned to report to Cenelec if they did not release any products in the near future. But they would develop specifications which would be sufficient as industry standards. Hence, if the companies decided market conditions were advantageous, they could release and promote these specifications as unofficial standards.

Each company had to produce demonstrators which would test and validate these specifications, and these demonstrators would have to be compatible with those designed by the other companies. There was also some work done on the components for the system and on interfaces. The Eureka programme was divided into 8 sub-projects, each lead by one company. There was never intended to be co-operation on developing actual products and applications — this remained the province of individual companies. However, the participating firms were keen to make sure that the common network fitted with the application areas on which they were individually working. Therefore, each application area had a 'champion' to ensure that the instructions necessary for that application (e.g. security) were present in the higher level protocols. The companies' existing products, together with those under development, shaped the standards in this way.

Eureka achieved its main goal of producing rough specifications, which were described as 'only needing some fine tuning.' But the reduction in funding meant not all aims were met:

- The demonstrators were less comprehensive than had originally been planned.
- Part of the project had been to disseminate information to trade bodies, other interested companies and standards organisations. Only the latter was achieved, although the specifications never reached the stage of actually being submitted to Cenelec.
- Some media, such as low power radio, received less attention than had first been anticipated.

Esprit

The first difference in emphasis to the Eureka standardisation effort was the Esprit

programme has a far clearer stress on official standards. This stems from the EC Commission's general commitment to harmonise standards in Europe. That commitment dated back to the early 1980s, but also reflected a more recent renewed effort with the EC to provide further financial support for the European standards body Cenelec — which has increased its staff over the last 3 years. Esprit support for R&D stipulates that firms must aim to develop official standards from the beginning of their work. Some of the firms involved were also beginning to reassess the merits of *de facto* standards, as the Consortium leader noted:

> A company like Philips is used to asking the question, 'Is it possible to work as fast as possible by setting a *de facto* standard?' Sometimes that is possible in more or less isolated products. If you can gain speed, why not do it that way? [But] with a systems standard covering so many different applications it was not possible to do that, deciding with only one or two firms. It's impossible to surprise the world and say 'here is the standard.'[36]

Thus, there was more effort than under Eureka to package up the standards for Cenelec. However, it is worth noting that the Eureka consortium still exists as an entity and retains certain intellectual property rights, so keeping its options open. The Eureka companies could always launch unofficial standards if they felt it to be appropriate.

The second difference from Eureka was that Esprit took a longer term view and did not gear its efforts so rigidly to the industrial base of participating companies. Hence, attention was also given to new media which Eureka had not previously considered: for example, infra red, plastic fibre optics and millimetric wave radio.

Towards the end of Eureka project, the participating companies made two lists: information which was to be kept as property rights and that which was to be handed over to the standardisation process. The latter details were passed on to Esprit. A main goal of the Esprit programme was to develop more complex demonstrators (multi-brand, multi-application). In fact, the aim has been characterised as being to create one demonstrator for all the technology. Other goals included the dissemination of information and installation guides.

The proposals for official standards which were made public in January 1991 concern only the common interface between products — i.e. the minimum information other firms must have to design an external interface to a system. What is actually in the system is not described by the standard. Thus, the demonstrators or prototypes designed to test the standard remain the property of the firms.

All companies participating financially in a project are entitled to share amongst

themselves any intellectual property rights arising in a project. The organisation which actually produces the prototypes is the owner of such property, while the others, in effect, have a free licence to exploit the whole of the rights and include the designs within their own products. However, only the owner is entitled to license the rights to non-participating third parties.

World standards

Although some European companies have been aware that regional standards could act as a form of protection, a non-tariff barrier, especially against Japanese goods, others have become more wary of this stance. For multinational companies with potential markets abroad, such as Thomson and Philips, regional standards may provide a hindrance to sales outside Europe. In fact, because Philips has an eye to global markets for its products, the firm has made sure that its D2B system has gateways so that it can function within all three regional standards. Therefore, such companies have shown more interest in a world standard for home automation, although an official world standard would imply that licence rights would be relatively minimal.

Eureka partners had always attended the committees dealing with world standardisation, but once they became Esprit partners the consortium became more committed to working in this direction. In addition, the consortium has been approached by Japanese standards proposers requesting further harmonisation. In part the capability to harmonise depends on who much compatibility already exists. Certainly the European system was originally based on an altered version of Japanese specifications and thus shared a similar design philosophy — in contrast to CEBus. Throughout the development of European home systems specifications, the consortium have ensured that the departure from the Japanese approach is not too great and thus some compatibility, at certain levels in the command structure of the network, already exist.

Forums

European Trade Association

The idea of a European Trade Association for home automation was first mentioned during the Eureka programme. However, the Consortium as a whole was not convinced that such an agency was necessary, even though some of the parties involved thought that it would be useful even at that stage.

There was a shift of opinion within Esprit to the view that once the standard had started to appear, it would signal end of the Consortium’s work. The partners agreed that it would be appropriate to hand over responsibility for the area to another body with a

different structure from Esprit. Such an agency could support the standard, promote it and give guidance without being constrained by the finite time limits of an EC programme. The European Commission also favoured this arrangement. It was felt that a trade association could also handle the intellectual property rights belonging to the existing Consortium, while encouraging a wider audience to participate in starting up a home systems industry. As a result, the European Home Systems Association (EHSA) emerged in 1992.

Table 3.3: Forums in which British firms can participate to discuss home automation

National Trade Associations

A number of national trade associations started to appear towards the end of the 1980s. In Japan, the *Alice* Forum ('Programme for Agreeable Living with Intelligence, Communications and Electronics') was formed in August 1988 to promote the 'Home Information House.' So far, its activities have included organising a consumer research questionnaire, sending a study group to look at developments in the US, and, in December 1989 holding a Symposium on home automation.

The French *Association pour les Maisons du Futur* (House of the Future Association) has been the most active trade body in Europe, organising the Eurodomotique symposia in 1988 and 1990 — the main pan-European conferences. The Association has also promoted what it calls 'Domotique' through reports on developments in Japan, US and Europe (following fact-finding missions). The Association also issued publicity brochures to the general public and sponsored the demonstration house 'Maison du Futur' at La Défense, Paris — which has been open to the public since October 1989. Another French body involved in promotional activities, but also running an experimental testing centre for home automation products, is the *Association Pour le Développement de la Domotique* (Association for Developing Home Automation).

Abitare Domani (Living in Tomorrow's Home) brought together Italian interests, also in 1988. Its projects included listing all the relevant exper-iments and products on the Italian market in a directory, developing a glossary of Italian home automation terms, definitions and applications and setting up a centre for research and for training on home systems — to be called 'Abitare Domani 2000.' There were also plans for an Italian news-letter, a scholarship for students and information seminars.

In the UK, a *Home Services Institute* had first been proposed in 1987 when the Task Force was still operating. The idea then was that this trade association would have produced a newsletter, and would have sent representatives to such bodies such as the BSI. But at that time, the business plan proved to be unacceptable because it suggested a body which would have independent commercial research interests. The 1990s saw the

first efforts to initiate a British Association to police standards, arrange con-formance testing labs to check new products, provide information on training courses and perhaps issue some form of badge to new installations. This venture was initially led by GPT, whose GPT staff also felt a need to exercise more control over the image of home automation in the UK, as one of their staff noted:

> One of the problems that worries me so far is that on the one hand it's very exciting to see that there are many groups set up around the place. And there's been a good deal of coverage: like *Tomorrow's World* has touched on the home because the Home of the Future Group is there. Then *QED* had their 10 penny'th as well. But the difficulty is that the stories are conflicting and that is very worrying. I think *QED* did a lot of damage to home automation because the narrator could sit there and say 'This is one month's simple electronics and you just get a simple answering machine and put this bit in the back of it.'.. and then he can state in the papers that 'all the other things on *QED* are serious things, this is just a gimmick.' And we're talking about setting up a full business with this 'gimmick'!
>
> There's no control over the voice of home automation in this country and I think this is very wrong. The *Tomorrow's World* coverage again was a different tack completely to *QED* because that was on their section that was the 'Home of 2020.' Well, that puts it too far away. That means that half the population that see that [programme] think that home automation is something that isn't going to be around for ages. Then you've got the little *QED* man, who's also involved in *Tomorrow's World*, telling you look at this lovely gimmick that you can perhaps buy next year.[37]

Hence, they wanted a single agency to provide one message to installers, electricians, telecom installers, builders, architects — and also to consumers. As another GPT representative remarked, such promotional activities, as well as policing standards, all contributed to the broad infrastructure needed to support home automation. They constituted the ways in which producers 'put the market together' and were as important as technical development and actual marketing. By 1992 GPT had decided to withdraw from develop-ing home systems, complaining that the whole process of collaboration had been too slow.[38] After being co-ordinated briefly by NEDO, the drive to create a UK association finally passed to the Electrical Contractors Assoc-iation, the trade association for installers. From these labours, BAHBA — the *British Automated Homes and Buildings Association* — appeared in 1993.[39]

NEDO Home Automation Steering Committee

The Task Force as such came to an end in 1987 when the Consumer Electronics Goods

EDC was wound up. But in Spring 1989, an initiative emerged within NEDO, called the Home Automation Steering Committee. With mostly new members, this group has held regular meetings to continue the exploration of various aspects of home automation (e.g. the implications of home systems for house building, installation, the disabled, etc.). The central aim of the Steering Committee remains that of raising broader awareness of home systems.

During its short life, the Steering Committee undertook three projects, two of which came to fruition and one of which did not. The third was an attempt to get some media publicity by launching a competition to design an automated home aimed at architectural and technical students in higher education. Lack of entrants undermined that initiative. More successful was the preparation and distribution of leaflets explaining the benefits of interactive systems. These are directed as manufacturers, installers, service providers and housing associations and show scenarios illustrating how different types of people might benefit from home automation. In addition, NEDO commissioned a report on possible routes to market from home systems.

Home of the future group

The Home of the Future (HOF) project originally started in 1987 as a multi-client study initiated by the consultancy firm Taylor-Nelson (which was later subject to a management buy-out in the UK and became Applied Futures). Although at the outset HOF was stimulated by Smart House in the US, the initiative was by no means solely concerned with home automation. In fact, one participant described HOF as in part a reaction to the drive coming from the electronics industry which claimed that the future of homes lay in intelligent systems. Against this backdrop, Taylor-Nelson decided to take a broad multi-sectoral look at the development of the home from a demand perspective rather than a technological one — in order to show the implications for various businesses. In doing this, the consultants adopted a wider brief than that of control electronics, considering developments such as new house construction materials and new leisure facilities. However, for some participants who are also members of Esprit, HOF connected with their thinking and involvement in home automation, providing yet another forum for looking at future homes.

HOF was originally conceived as a three phase project. The first tightly defined phase was intended to generate ideas and it was to this phase that the participants initially subscribed. The idea was that there should be one firm from each sector to make the initiative non-competitive, although there has always been some gaps and overlaps in practice. The participants included British Gas, BT, ICI, Honeywell, DTI, BICC, Laing, Pilkington, MK Electric, Square D, Ideal Standard, Unilever, and later the Building Research Establishment, Marley, the Electricity Council and Creda have joined. There have also been some departures with TSB and Courtaulds dropping out.

Phase two had always been intended to focus on product development, but initially this was supposed to be within the framework of another multi-client study organised by Applied Futures. Instead, the firms wanted to take charge and so in 1989 they formed an association: the HOF Group, with Applied Futures as an honorary member. Its objectives were (a) to develop product opportunities for its members from the HOF concepts; (b) to encourage and provide a mechanism for collaborative development; and (c) (a lower priority) to encourage product compatibility — hence there was some value in each firm monitoring the directions in which others were moving. The HOF Group has a confidentiality framework, but owns nothing patentable. There are no intellectual property rights, although companies might form joint ventures between each other as separate initiatives. HOF members had originally planned a third phase aimed at pulling developments together in a physical way as an experimental demonstration project as part of the Exhibition Energy Park at Milton Keynes in 1994. However, while plans were reined back considerably so that firms mainly focused on demonstrating their existing products.

Apart from the VALS dimension discussed earlier, it was made clear by participants that, as in the other cross-industry forums, the very process of working together was seen as valuable in terms of improving the quality of the inputs to their marketing strategy but also in terms of bringing companies together who might otherwise have little reason to communicate, let alone cooperate. Also, this forum was perfectly legal within competition frame-works. These benefits from working together emerged, rather than having been envisaged at the outset, and were at least as important in justifying continued expenditure as were the details of scenarios.

Bringing home automation to market

As will have become clear from this chapter, there has been far more talk about home automation than product launches — especially in the European context. What we now need to ask is why progress on the collaborative efforts to create standards and products based upon them has been so slow. The intelligent home product space has been the object of speculation for over a decade now. Yet, although there has been on-going technical work, the pace of development has been sufficiently gradual as to have a negative effect on some firms: it is the product that is always round the corner. For some, hearing the same points raised at conferences and meetings has become boring. It is mainly because the whole area of home systems is of potentially great significance that a range of companies feel that they cannot afford to ignore it, even if they only monitor developments.

On the whole, it is not as if there had been a particular impasse: no major technical hitch or conflict of interest (although these do exist!) Most collaborative effort in this field has

taken longer than anticipated. Although the European work has stuck to the official schedules which were set, taken as a whole, even progress here seems to have taken some time. And, even the products of various firms around the world have repeatedly experienced slippage. This can be attributed, as some do, to initial unrealistic expectations about the time involved. While this is undoubtedly true, what we should really be asking is about the general determinants of that slow pace. These relate to the very nature of home systems in general.

First, there were clearly novel demands on producers. Here was a complex product space, with many elements. Apart from perhaps some Jap-anese companies, it was beyond the resources and expertise of any particular firm to develop and deliver all the constituent parts. Some form of collabor-ation looked inevitable. Yet, intelligent homes which crossed traditional product boundaries, required producers to meet who had very different per-spectives, backgrounds and skills. It took time to develop the various forums, not just in terms of officially arranging meetings, but also to build up relations to facilitate effective co-operation. Given the multiple visions of what home systems could and should include, it is not surprising that reaching consensus on the shape of home systems was a lengthy process. Technically, it is not so difficult to arrange for various simple forms of control and programmability. What was more demanding was to develop more sophisticated controls which handled a range of products, which was able to expand in the future and which could anticipate the various problems and unusual patterns of use which might emerge with any complex system.

The second factor is firms' evaluation of the market itself. There was and is simply a great deal of uncertainty about whether consumers will be sufficiently interested in intelligent homes. Producers as a community have had to repeatedly persuade themselves that there is a market, that there is sufficient evidence and, importantly, that there is enough profit to be made. This last consideration is vital since a product promising only a small return would not be worth all the effort that has gone into home systems to date. If it 'takes off' the promise of home systems is great — i.e. a whole new generation of products. What is more, there is the further, and therefore vaguer, promise derived from the fact that homes systems lend themselves to expandability. Those involved look forward to potential add-on products that they have not yet even fully conceptualised.

Yet, although this incentive, this pay-off, may keep the players in the game the uncertainty about demand for home systems has clearly inhibited the emergence of product champions. A key note sounded at conferences has been caution and steady progress a step at a time. The Esprit initiative in particular seems to have involved enormous amount of preparation to produce conditions most favourable to the product's success — as if anticipating very fragile demand. Hence all the attempts at 'putting the market together,' raising awareness, enlisting support, building flexibility into systems and making sure standards are in place to ease consumer worries. All this has clearly taken time, although it sometimes appears that such preparations can also serve as an

excuse while firms wait for some ‘first mover’ to take a risk and test the market.

Competing products and visions

The whole innovation process acquires a further layer of complexity once we start to move away from evaluating the merits of home systems in their own right to appreciating how they compete with other visions of how the home may develop. As noted in the introduction, home automation constitutes only one element among different versions of the home of the future. Others include home information products, interior design and architectural innovation and novel stand alone products. While these may be considered as being potentially complementary to intelligent homes, the alternatives nevertheless compete with networked products for consumer and media attention as much as for producers’ product development funds. This has become very obvious over the years as TV and newspaper journalists have contacted the *Intelligent Home Newsletter* looking for a story about future homes, only to be a little disappointed that home systems was not ‘futuristic’ enough. To overcome this, one editor was only willing to allow an article about home automation as long as the accompanying photograph contained a picture of a robot!

Table 3.4: Possible sources of home automation products

The dilemma of conflicting visions is perhaps most vividly illustrated in the showcase ‘Houses of the Future’ which have emerged in recent years, such as *Huis van de Toekomst* at Rosmalen in Holland and the *Maison du Futur* in Paris. Compared to the spectacle of a roof opened by hydraulics, a multimedia CD-i system, open-plan, spacious rooms with curved walls and a plethora of gadgets, home control functions are certainly less visually striking. Moreover, mixing innovations in these showpieces may actually prove to be counter-productive as far as home systems are concerned. For example, the proliferation of stand-alone products, all with separate remote controls, in the *Maison du Futur* gives the opposite message from that of home systems, where the whole idea is to have a limited number of human interfaces. Some of those involved in the Esprit programme noted that this exhibit was (to say the least) ‘a little misleading because it is not really about home systems.’ Clearly there is some ambivalence about images which combine potentially contending visions of future home life.

A second level of competition lies within the firms. Home automation has always vied for resources against the products being simultaneously developed by other sections within firms. For example, in Philips, HDTV had been prioritised by the multinational before their comparatively late commitment to developing intelligent home standards. CD-i actually started off in the same section of the company as home systems, but then separated. The significance for Philips of CD-i has dwarfed their home systems effort. As

a measure of this, some staff involved in home systems were switched to CD-i during the very course of interviewing for this book, although occasionally the transition occurred in the other direction. One Japanese representative at *Eurodomotique 90* also indicated that, even in Japan, competition for resources, with other audio-visual product innovations in particular, was limiting the pace and degree of development.

Finally, there is competition within the product space of home systems, as different bodies chose their own route to market and their own variant of home control products. So, for example, the European initiative from app-liance manufacturers is only one approach, albeit a significant ones, among several which nevertheless contain home control dimensions. Once again, these may be regarded as either competing with or as complementary to the home systems initiatives. We have already seen routes into home automation such as the X-10 system, the home computer based ones and the environmental controls for the disabled. Now it is time to re-examine in more detail the efforts of some larger agencies: the utilities, commercial building control suppliers and telecoms.

Routes to market: utilities

We noted earlier that the gas, water and electricity utilities have been interested in remote meter reading ('telemetry'), billing and payment for some time. Turning to the specific interest of the electricity utilities, one strategy to support load management involves 'interruptible contracts,' where for a reduced bill, the utility can switch off equipment for a short period of time. Such contracts exist with industry and in the home might include such options as cutting of supply to the fridge or water heater for a short period. Obviously this involves distant control of facilities such as heating systems.

Another policy in operation for some times has been to employ a variety of different tariffs as incentives to shift demand, with the prospect of a wider range of tariffs for finer tuning, and even perhaps 'spot pricing' of electricity whereby at any moment the price reflects the cost of production (and so, for example, is higher on a cold day when more people are using heating and less efficient power stations are coming on-line). The point about this latter approach is that consumers are expected to react to tariffs, and so the electrical utilities and related companies have developed smarter meters and displays to more clearly indicate the costs of energy use when using particular appliances and even to make predictions of consumption based on current usage patterns.

All these initiatives introduce communications, microprocessors, memory chips and displays into the home which could then be used for other purposes — such as controlling appliances. In some instances, the purpose might be still energy related — e.g. in the case of more complex tariffs or spot pricing, the smart meter may be

programmed to switch on appliances such as water heaters or washing machines when it picks up the signal from outside the house indicating that cheaper electricity is available. But more generally, a number of industry commentators have noted that once the technology has found a way into the home, then it may be additionally used for other forms of programming or remote control.

Internationally, utilities have been running trials for a number of years. For example, there are several load management projects in US, some of which have enlisted home automation systems.[40] In Europe, Electricité de France has been active for a while: some of its commercial domestic systems offer control of appliances by controlling the power going to particular electrical sockets. In Britain, Seeboard (South Eastern Electricity Board) initiated the CALMU project (Credit and Load Management Unit) as early as 1978. At the time, its developer saw great potential for smart meters, even if he was not so enthusiastic about a fuller range of home control functions. Some years later, the board experimented with another system in its Oracle project before deciding not to develop commercial products.[41] However, several of the other regional electricity companies have marketed energy management products with some home control options. There are a range of small companies which produce energy management systems and programmable thermostat controls which offer some further control options.

The gas companies have also experimented with technologies which could form the basis for home automation. For example, Gaz de France has attempted to offer customers who lived in apartments which were supplied by collective heating from one main boiler the same type of control as if they possessed individual boilers. To offer users this flexibility, enabling different patterns of usage and billing and providing customers with information about usage and cost, required the gas system to be microelectronics-based in order to compute real time consumption. In conjunction with the firm Synphoric, Gaz de France has promoted a system aimed at (a) the building managers who can have a computer in the basement monitoring energy consumption and (b) the apartment owner, who has a screen in the flat. Although installed primarily for energy usage, such a system can then incorporate other functions: security, panic buttons/help alarms linking the concierge to flats, and sensors (e.g. for gas, flooding).

The US Gas utilities have been very interested in Smart House since its inception, seeing it as a way to develop a new generation of gas appliances. Hence, they have provided considerable test facilities for the programme. Meanwhile, ‘Station 24’ run by Tokyo Gas was a 24 hour central station which could not only read meters from a distance but monitor the state of gas appliances in people’s homes. If there is a malfunction such as a CO_2 build-up, ignition system failure or a gas leak, the microprocessor in the home detects this with sensors and dials up the station. The staff there can then either send a service engineer or they can ring up the home and give advice. Representatives of the company have yet again noted that once a microprocessor based system is installed, it can

be used for other purposes. The company is also considering possible future products such as teleshopping — and potentially home automation.[42]

In the UK, the interest of British Gas in remote meter reading dates back to consultations with the other utilities in 1980. But, despite trials of various systems it remained costly to install the necessary smart meters and maintain some kind of communication link just for the limited benefit of telemetry. When the utility joined the early NEDO Task Force, home automation started to look interesting because here was a way of establishing some of the equipment in the home, including smart meters themselves. Consumers might contribute towards the cost if they were to receive benefits from so doing. But beyond this rationale, British Gas, like other companies, have had to ask what implications home systems have for their business in other respects — e.g. telediagnostics. Hence, different divisions within the com-pany have been monitoring developments.

Routes to market: commercial buildings

It is worth noting that the bus systems developed for the commercial sector are in some respects more limited compared to designs aimed specifically at the home. Commercial networks are based on a single medium: twisted pair and they handle a subset of the domestic applications: those relating to heating, water, air conditioning, alarms and lighting. As noted at the start of this chapter, apartments have provided a more obvious target in the domestic market, being more life office buildings, but larger houses have also been considered. On the other hand, companies in this sector are also concerned about any threat to their own core markets if standards and products devel-oped for home systems become used in small commercial buildings.

In France, Merlin Gerin originally expanded from building security and electricity controls to produce the *Batibus* network which integrated its separate systems. The company then sought association with firms offering complementary expertise, for example, in heating. By the 1990s, the *Batibus Club* consisted of 65 companies, including home builders, manufacturers and electricity utilities with the MK Electric and its sister companies as members in the UK. Here we have an example of companies diversifying into the residential market with a standard different from that proposed by Esprit.

The other system originating from commercial building sector — the EI-Bus — is more compatible with the home systems work. This is due to a degree of contact with Eureka and later Esprit and the fact that EI-Bus' largest supporters. The key figures in the EI-Bus, ABB, Siemens and Le-grand, are all participants in the Esprit Consortium. Siemens originally dev-eloped the 'I-Bus' (Insta bus) which has now been renamed 'European Installation Bus.' An 'Association EI-Bus' emerged to promote the system and work towards developing a kite mark for compatible products.

Routes to market: new house builders

The clearest example here is, of course, the Smart House programme. In the US, Smart House is now actually being launched and certainly its participants feel that they are more advanced than both CEBus and Esprit in terms of having discovered the problems of developing near market products. In other words, there are still many detailed issues to iron out even after general standards have been announced.

While US builders have the highest profile, they are not alone in having an interest in home systems. In France, for example, some builders of new apartments have adopted the building management control facilities dis-cussed earlier. In addition, there have been a variety of experimental pro-jects promoted by the Government and local councils which involve local house builders amongst others. In Japan, some of the earliest examples of home automation actually came from builders. And in the UK, some house builders also look to home systems as being a possible means to give a premium price to new housing. The builders Barratt worked for a while with the utility Seeboard on the Oracle experimental house, while Potton homes have been involved in demonstrating the Creda's prototype network. However, awareness of home systems remains patchy in this sector, while the slump in house building means that what interest there is tends to be on a back-burner.

Routes to market: telecoms

Clearly, telecoms firms already benefit from any version of home systems which incorporate control and monitoring of the home from a distance since this generates extra telephone network revenue. But in addition, the EC RACE programme (oriented to the European telecoms operators and telecommunication equipment suppliers) and Japanese telecoms agencies have discussed a model of home automation where telecoms operators might offer packages of intelligent home functions as an extension of the telecoms public network into the home.

This has a precedent in the commercial world where BT's Centrex service acts as if there was an internal PBX exchange system — but instead of PMBX hardware being on site, the internal communications of a company or other body are handled by the telecoms firm. In other words, the 'intell-igence,' the controlling software, resides in the telecoms network, not in other apparatus which the user buys, and hence the telecoms operator can charge for a rented service. In a telecoms version of the intelligent home, the home bus would be controlled by the wider public telephone network. The RACE programme has a far longer time horizon than Esprit — 20-30 years — but demonstrators are currently being planned under the heading of 'Domestic Customer Premises Network.'

In practice, there have also been a limited telecoms-based initiatives in the US and

Europe. For example, several of the Bell companies are running trials with some of the small firms already producing home systems to see the potential especially for energy load management. In the UK, BT are currently working on an experimental prototype called the ‘Electronic Butler’ where a system which takes messages on answerphones, passes them on to cellphones if the occupant is out and acts as a door intercom can also control heating and lighting (and is likely to be compatible with the Esprit home bus standard).

Telephone hardware suppliers have also produced smart phone related equipment which provides the core of a control system. For example, Gulf and Western Consumer Electronics have been marketing ‘Sensaphone’ since the mid-80s. This is partly an answering machine with automatic dialling facilities but it also provides status reports on such aspects as temperature, what electricity points are switched on and off, and if any security alarms have been triggered. One French product, Discophone, again offers various telecoms functions but also allows remote control of a few appliances. There have been some Japanese interphones which have control facilities, and in the UK, GPT developed an answerphone system to work with Creda’s network.

Component suppliers

To the surprise of the firms who had been slowly developing standards throughout the 1980s, the 1990s saw the Silicon Valley based firm Echelon Corporation surprising many by its sudden announcement that it already had chips available for home automation systems. Manufactured by Toshiba and Motorola, these chips were designed to operate with Echelon’s own pro-prietary codes — which offered a system with more distributed intelligence (i.e. more processing in the actual appliance) than even Esprit. These chips can be used in commercial buildings as well as homes. In fact, they have been used in offices for a few years prior to the announcement. Echelon were not themselves promoting particular product applications, so much as providing a component for others firms to utilise while many of the other initiatives were still at the stage of being ‘paper standards.’ Because they actually had chips available when Esprit and some of the other regional standards bodies did not, Echelon’s entry has caused considerable interest and speculation that in Europe at any rate its standard, rather than the painstakingly devised Esprit one, might prevail.

Competing or complementary products

While the Echelon standard clearly competes against the Esprit one, to continue our European focus, to what extent are the products of the other bodies outlined above potential competitors to the end products based on the Esprit work? Are products from the utilities, say, a threat to the potential offerings from appliance manufacturers? On the

whole, this has not been the perception within what we might call a nascent home systems industry. Instead, these other routes into home automation have been seen as valuable for stimulating demand, for helping to establish the concept of intelligent homes. For example, a variety of commentators have seen energy manage-ment as the ‘Trojan Horse for home automation,’ since there is such a strong economic incentive on the part of the utilities to introduce IT into the home, especially in the US.[43] In other words, home control may initially ‘piggy back’ on other products as added extras. Nevertheless, some have seen such trigger services as potentially bringing about a familiarity with home systems and so providing a platform from which to sell the fuller, more complex net-works of Esprit and the other regional programmes. As one product manager noted:

> I suspect that we may need to have a more highly developed market for home security systems, home control and some of the useful applications not using media properly, but using media badly — i.e. having to put in dedicated twisted pair until people have got used to the application. And then someone can come along with IHS as a technological solution to a problem they know they’ve got. So now we’ve got our second generation products which are easier to use, cheaper, mean you don’t need to have the nasty wiring, and you already understand the application. It’s very difficult doing it the hard way, almost to set these markets up. I almost think these markets are going to be developed by small firms coming in to promote their own little security systems etc. — people doing it not as their main line of business almost. Then, when it’s mature and people understand what they are buying, then maybe you can start selling them some of the advantages of IHS.[44]

It should be noted, though, that by no means all routes leading to intelligent homes have been welcomed. There is evidence of attempts to exclude some alternative trajectories by which home control could develop. For example, from the early involvement of NEDO through to Esprit, most of the participating firms have distanced their projects from control managed via home computers.[45] Apart from the fact that the design involved is totally different, home computers have often been felt to have the wrong type of image for home automation. Also, appliance manufacturers have been wary of a telecoms-based network, some seeing the Esprit work as preempting the longer term plans of RACE.

On the other hand, co-operation with both telecoms operators and the utilities have been sought by the appliance makers who have driven the Esprit work. Telecoms and the utilities were invited onto the early NEDO Task Force. Internationally, telecoms operators have been represented in all the regional standardisation initiatives and both telecoms firms and the utilities take part in schemes such as Smart House and the Home of the Future Group. Commercial building firms are also represented on Esprit. Hence, there have been attempts to enlist the support of these agencies for networks often (but

not always, as in the case of Smart House) developed principally by electronics firms. Certainly, in conferences such as *Eurodomo-tique* large and small firms from these different backgrounds have been invited to make presentations and run exhibits as part of a broader intelligent home movement.

Product plans for the European home systems standard

Unlike the other case studies in the book, home automation provides us with few European examples of end products — or rather sophisticated, multi-purpose end products. As noted in the historical overview, a number of systems advertised as home automation had been launched in Japan and the US before any standards were in place. Apart from the very limited forms of control available with some energy-management products, Europe has seen only a few experiments in marketing systems. But we can at least examine some of the sub-systems and prototypes to see what more complex intelligent home systems may look like.

Philips' D2B audio-visual network provides an example of a sub-system which, after much delay, was due to appear in 1993. It was intended to be marketed as an independent product, but with the potential to be part of a wider home network based on Esprit standards. In fact, the press releases for D2B did not mention home automation, and it seemed that the concept would not be mentioned in the advertising copy. D2B would be sold as something particular to the audio-visual field, and Philips has enlisted the support of powerful companies including Matsushita, Sony and Thomson to support its D2B standard. Yet, Philips was also careful to ensure the exis-tence of gateways to the CEBus, Esprit and Japanese home systems, and many working within field of intelligent homes were expecting D2B to play a potential key role both in testing consumer reaction and in establishing the value of control functions.

Meanwhile, the Integrated Kitchen System (IKS) has been under development at Zanussi's Zeltron Institute since 1980. This sub-system links kitchen and utility room goods — i.e. dishwasher, refrigerator, oven, hood, hob, freezer, drier, washing machine — via a twisted pair medium. IKS will be connectable to the Esprit network via a gateway. Functions include telediagnostics where, if desired, suppliers can run tests on white goods via the phone to identify both the reasons for product failure and the general efficiency of these products. Remote telecontrol and energy saving poss-ibilities have also been mentioned, as have warnings of 'dangerous situations' (e.g. high oven temperature). IKS can also manage stock control in the freezer using a light pen to identify bar codes on products. Yet, despite its long period of development, the integrated kitchen is still in the labs and will not be launched until a standard is in place — perhaps in 1992. Even then, Zanussi's representative thought that the company would probably not market IKS as a whole system at first, but would sell white goods which will have facilities to fit onto this network labelled to indicate this fact. This is a cautious approach, waiting for more of the industry structure to be in place before a low key launch.

Lastly, we have the shelved plans of the fairly autonomous, British subsidiary of General Electric and GEC: the white goods firm, Creda. Through their relation to GEC, Creda staff have been aware of Esprit developments and know the details of standardisation up to the present. Having decided that in the longer term, a systems approach would inevitably find its way into the home, the firm opted to preempt the standard specification release date and to originally planned to launch its 'Credanet' system in September 1990. Credanet can handle mainly security and white goods applications via a mains-signalling network, but it has the potential to be expanded. Creda's system cost as much to develop as a new cooker would have done if starting from first principles. However, it became clear that although they had been willing to be a 'first mover' among white goods producers in past product development, the costs and risks of marketing such a broad concept as home systems proved too much for what was a relatively small company.

Conclusions

Home automation provides us with a rich case study for illustrating the ways in which producers interact. Arguably, the main event to date and therefore the focus of this chapter has been talk rather than action. That is to say, a considerable amount of time has been spent on awareness raising, setting up forums for discussion and designing standards — given the limited range of product launches. This evaluation is not meant to imply some simple criticism of those involved. As was outlined earlier, there are important factors determining the pace of innovation in this complex product space. But a consequence of this public dialogue — between firms — is that we can see clearly some of the mechanisms by which product ideas are generated, evaluated and negotiated.

What is also highlighted by this case study is the ways in which different product spaces (e.g. different visions of homes of the future), and different routes to market can compete, complement each other or simply co-exist. It is precisely because home systems cross so many product boundaries and thus fall into the province of diverse industry sectors that such a range of producers can bring their varied interests to bear in this field. Hence, despite the efforts of programmes like Esprit to present one clear evolutionary path, we still have a murky picture. At times, it is still not at all certain how home automation will develop, which route will prevail and, from the perspective of the companies concerned, whether to count particular innovations as threats of opportunities.

Notes

1 B. Horrigan, 'The Home of Tomorrow: 1927-45,' in J. Corn, ed., *Imagining Tomorrow:*

History Technology and the American Future, Cambridge, Mass: MIT Press, 1987.

2 These observations are based on the fact that apart from interviewing producers for this research, Leslie Haddon previously conducted market research on the topic Home Automation. The results were published in RMDP (1989). Smart House staff also noted that science fiction in particular influenced the ideas and responses of consumers involved in its early market research.

3 A range of European constructions bearing the name *Home of the Future* have appeared over the last few years. The *Huis van de Toekomst*, Rosmalen, The Netherlands lies in a theme park. The Portugese Project, *Utopia*, located in the luxury resort of the Val do Lobo, Algarve, was inspired by the same TV celebrity as its Dutch counterpart: Criet Titular. The *Maison du Futur* is a more modest affair, a permanent exhibition apartment in La Defense, Paris, France.

4 In the UK, the house of Stirling Moss is probably the best known example, although the innovations extend beyond simple home control to moving walls and furniture. For an example from the US, see the May 1985 edition of *IEEE Spectrum*.

5 The Government has paid some funds towards the development of remote controls for the severly disabled. The are also schemes whereby after an assessment their disability, some people can receive subsidized control products. For more on the environmental controls market, see *Intelligent Home* (1993) 'Naidex '92,' Vol.3, No.3, p.9.

6 For example, the founder of Home Automation Limited had first discussed this field as an hypothetical example on a management training course.

7 L. Haddon, *The Roots and Early History of the UK Home Computer Market: Origins of the Masculine Micro*, unpublished doctoral thesis, Imperial College, University of London, 1988.

8 Presentation by Tricia Parks at the *Domotique 90* conference, Paris, May 1990.

9 Further developments in digital compression technology have changed this, so that telcos such as BT are now experimenting with 'video on demand' using the existing twisted pair copper telephone wires.

10 'Butler-in-a-Box reaches the UK,' *Intelligent Home*, Vol.1, No.5 (1991): p.11.

11 T. Heimer, 'Technological development as a process of institutionalisation: The process of technological genesis with 'Intelligent Homes - a Case Study,' *Colloquium on "Research on Technology at Hessian Universities"*, Johann Wolfgang Goethe University,

Frankfurt, 21 July 1991, pp.16-18.

12 'Product News,' *Intelligent Home*, Vol.3, No.1 (1992): p.11.

13 'The Development of CEBUS,' *Intelligent Home*, Vol.2, No.2 (1991): pp.2-3.

14 'Smart House Optimism,' *Intelligent Home*, Vol.2, No.1 (1991): pp.9-10, .

15 *Intelligent Home*, Vol.1, No.4 (1991): p.12.

16 'Product News,' *Intelligent Home*, Vol.2, No.1 (1991): p.11.

17 'How Smart House Evolved,' *Intelligent Home*, Vol.2, No.1 (1991): p.10.

18 Interview.

19 Interview.

20 Interview.

21 C. Boardman, 'Little and large: Problems and potential for the control of domestic energy consumption,' presentation given at the RMDP conference *Automating the Home*, London, 1988.

22 Interview.

23 'How Smart House Evolved,' *Intelligent Home*, Vol.2, No.1 (1991): p.10.

24 Interview.

25 For example, The Yankee Group, *The Wired Home: The Emerging Home Automation Market*, Boston, 1990.

26 Partly because of the academic research for this book, Leslie Haddon became editor of the *Intelligent Home* Newsletter. This has proved a useful means for keeping in touch with developments in the industries concerned and for acquiring some of the insights of an insider. That role does, however, mean that he has been involved in promoting the general development of this product space as well as analysing it. The *Intelligent Home* articles cited in these footnotes were all written by Leslie Haddon, and elaborate some of the points made in the main text of this chapter.

27 Interview.

28 Interview.

29 Interview.

30 We would like to acknowledge the cooperation of ex-NEDO staff in helping with the research which informed this account.

31 For more details of this history, see A. Cawson, et. al., *Hostile Brothers: Competition and Closure in the European Electronics Industry*, Oxford: Clarendon Press, 1990, Chapter 10.

32 Electronic Consumer Goods SWP, *Progress Report 1980*, London: National Economic Development Council,1980, pp 5-6.

33 It was at this time that the Japanese VHS standard for video recorders was establishing itself as the *de facto* standard.

34 Interview.

35 Up until then, Philips's involvement had been solely through Philips UK and Mullard.

36 Interview.

37 Interview.

38 'GPT leaves the Market,' *Intelligent Home*, Vol.3, No.1 (1992): p.7.

39 'UK Association Launched,' *Intelligent Home*, Vol.3, No.4 (1993): p.11.

40 Examples are: The House of the Future (Southern California Edison Co.), The Transtext system (Bell South and others), Energy Management Service (Teletimer and Bell Atlantic) and Personal Automated Lifestyle (Square D and Bell Atlantic). See also 'Eurodomotique '93,'*Intelligent Home*, Vol.3, No.4 (1993): pp.3-4.

41 'The Oracle Project,' *Intelligent Home*, Vol.2, No.3 (1992): p.9.

42 Presentation by Tadaakai Maeda at the *Domotique 90* conference, Paris, May 1990.

43 Presentation by Tim Schoechle at the *Domotique 90* conference, Paris, May 1990.

44 Interview.

45 This distancing from home computers comes across both in discussions with producers and their plans for marketing home systems and during the numerous presentations given on the topic to different audiences.

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Table 3.1

Participants in European initiatives

Eureka	**Esprit**
Electrolux	Electrolux
Philips	Philips
Philips Components	Philips Components
Siemens	Siemens
Thomson	Thomson
Thorn EMI	Thorn EMI
Zanussi	Zanussi (+ 5 associated partners)
	(+1 sub-contractor)
	BT (+ 6 associated partners)
	ABB (+1 sub-contractor)
	AEG (+1 sub-contractor)
	GEC
	Legrand SA (+1 sub-contractor)

Note: The number of associated partners working with BT and Zanussi in the Esprit project reflects the incorporation of competitors to Eureka consortium.

Table 3.2

Home automation collaboration initiatives

Date	**British**	**European**	**US**	**Japanese**
1981				Home Bus programme
1984	NEDO task force		EIAB CEbus programme NAHB Smart House programme	TRON programme
1987		Eureka IHS programme		
1989	NEDO Steering committee	Esprit Home System Programme		

Table 3.3

Forums in which British firms can

participate to discuss home automation

Promotional bodies

NEDO Home Automation Steering Committee

e.g. Creda, Thorn, Shaye, Honeywell UK, British Gas, Electricity Council

Commercial builders' associations

Batibus Club

e.g. MK Electric

Association El-Bus

European standards programme

ESPRIT

e.g. BT, GEC, Thorn

Industry Associations

BEMA Mains Signalling Association

e.g. Home Automation Ltd

Discussion forums

Home of the Future Group

e.g. Creda, BT, MK Electric, Honeywell UK, British Gas, Electricity Council

Table 3.4

Possible sources of home automation products

Commercial building suppliers	Control of heating, lighting, ventilation, security by hand/wall interfaces
Telecoms firms	Control of all appliances, security, lighting, heating by telephone equipment, within the house or remotely
Consumer electronics firms (‘brown goods’)	Sophisticated control of audio-visual sub-systems
Home appliance manufacturers (‘brown’ and ‘white’ goods)	Control of all appliances by hand/wall interfaces, intercommunication between appliances, sophisticated control of audio-visual sub-systems
Home computer firms	Control of appliances, heating, lighting by home computers
Utilities	Control of appliances by smart meters - mainly lighting, heating, security
Remote control suppliers	Control of appliances, lighting, security, by hand/wall interfaces
Component firms	Supplying appliance manufacturers with chips from which to make systems
House builders	Working mainly in collaboration with remote control and household appliance firms
Suppliers of disability equipment	Remote control of appliances, lighting by hand interfaces

Chapter 4

Home Electronic Messaging

The original focus of this case study was a specific facility called ‘electronic mail,’ which has existed in institutional and later commercial forms since the 1960s. However, during the course of the research it became clear that we needed to contextualise this service. This entailed locating it amongst a range of other products which could deliver messages (i.e. stored communications) by electronic means (i.e. not voice messages), thus ruling out facilities such as answering machines, and more recently voice messaging systems.[1]

This meant widening the brief to cover the messages relating to bulletin boards, chatlines, and multi-user games. But, we also looked further to con-sider other messaging arrangements which did not use a microcomputer as a terminal. Hence, this chapter also examines fax and forms of e-mail which might be deliverable by cable (rather than via the telecoms network). Within this broader product environment, e-mail remains our anchor point in much the same way as the home systems emanating from domestic appliance producers are a focus for discussing home automation.

Apart from being a network-dependent innovation, domestic electronic messaging is different from the other case studies in several respects. It is an innovation which can be managed by a single company and which does not require collaboration between firms. On the whole, messaging has never been expected to bring in revenues in the order of those expected in the case of CD-i or home automation. Finally, messaging has already been marketed for some time — especially to professionals. Nevertheless, there remains scope for reaching new consumer audiences, for changing patterns of usage and for further product innovation, including establishing new means of messaging.

While the links between commercial and domestic markets have been explored in the case of home automation and multimedia optical disc technology, e-mail (and fax) provide the clearest case of attempts to transfer a business product to the home. Therefore, it is necessary to provide a background commercial history of these services, fax being covered later in the chapter. When considering home e-mail, most attention is given to BT's Prestel based service, especially their Micronet service, since this had the largest residential user base. The Micronet service was closed down in October 1992, a few months after the completion of the fieldwork for this research.

History of E-mail

General commercial development

By the early 1970s, the US Department of Defense had developed a means to transfer files among member computer systems via the research network 'Arpanet.'[2] This connected Military and NASA computers with the universities and with equipment suppliers contracted to work for the US Department of Defense. Arpanet gradually took on the characteristics of a general research network. Shortly after its initial development, messaging capabilities were added as an afterthought. At first being used to transfer files between different computers, these facilities became orientated towards memo-like traffic. Both the different computer technologies employed on many systems belonging to this network, and the use of messaging facilities mainly for memos, meant that there was limited incentive to develop more sophisticated e-mail standards. However, it is acknowledged that much of the pioneering and early standardisation work arose from the Arpanet system.

At the same time as the Arpanet network was developing, messaging facilities were starting to be used between terminals attached to the same computer. Such use of e-mail, as a means of communication within large companies, (unlike telex which was mainly inter-company), was taken up more widely by the end of the 1970s. In other words, this form of e-mail was an extra service on a general purpose time-sharing system. These in-

house facilities, which were geared to particular computer systems, were varied in their design. In addition to moves to inter-network the various systems, specifically public systems emerged to enable company-to-company communication using the telephone network and modem technology.

Some of the more business-orientated companies, such as Cable and Wireless, have continued to offer what has been termed ‘basic messaging.’ But most others, including Telecom Gold in the UK, have packaged their e-mail with other services, such as access to databases or office automation facilities (e.g. electronic filing), and Electronic Document (EDI — for exchanging standard format documents between computers). Participants at the workshop sponsored by the European Commission in 1987 (called Kiosk) also appeared to be looking towards future scenarios where e-mail is part of a package of on-line services.

At one time, industry analysts gave optimistic predictions about the potential growth of e-mail, including for the home market. Sometimes, these arguments pointed to the growth of PC use as being an important factor. But from the mid 1980s, it became clearer that all public e-mail services in the US were losing money. More pessimistic writers have suggested that since most e-mail use is within companies, there is a limited need for public systems. In fact, they argue that the benefit of e-mail to business has always been of an unquantifiable nature. And more recently, many argue that the rise of fax as an alternative to e-mail has hindered growth potential. Meanwhile, others have remained optimistic about growth in the business market, drawing comparisons with the slow take up of the telephone until it reached a critical mass.

A more important route into e-mail for the purposes of this study lies not with the dedicated services noted above but through videotex initiatives. Videotex first emerged in Britain in the late 1970s and was subsequently taken up in a number of other countries. This interactive service was mainly geared to delivering information via the telephone lines at the user’s request to a TV screen or monitor. Most videotex services were at least initially geared to a domestic market, although some, such as the UK Prestel system, later found commercial niche markets. Many of these systems also came to offer messaging capabilities which proved to be more attractive to subscribers than had been anticipated.

Lastly, it is worth drawing attention to the fact that other electronic services are also starting to offer messaging facilities as an extra feature, even if they are not examined in detail within this account. On-line database services which deliver electronic texts via the telephone are themselves starting to converge with videotex. These on-line services, such as ‘Dialog’ and ‘Lexis,’ initially provided information such as scientific and legal reference and abstracts to commercial and institutional markets — often through an intermediary specialist who conducted the computer search on behalf of a client. These services have moved to allowing direct access to users, they have started to cover wider

ranging newspaper and magazine articles, and in some cases aimed at home-based users. An example would be Dialog's 'Knowledge Index' which offers reduced-rate evening and weekend access. Such services have also started to offer e-mail facilities: as with Dialog's 'Dialmail.'

Meanwhile, transactional services such as teleshopping provide another potential route into messaging. In the US, the IBM-Sears, mainly tele-shopping, service 'Prodigy' has e-mail and bulletin board options, while in the UK, the providers of the planned 'Keyline' service intended to add e-mail facilities at a later stage.[3]

US history

Some of the biggest e-mail service providers were originally outgrowths of the parent companies' other telecoms activities: for example Western Union has been offering telex for decades, and e-mail was simply an extra service. A different route into e-mail was provided by smaller companies offering time-sharing facilities who developed the messaging facility to communicate with their clients. These bureaux were acquired by larger firms when the prospects for e-mail started to look promising. The best known example here is Dialcom, which was founded as a computer time-sharing bureau in 1970, and then developed an electronic mail system. The company was bought by ITT in 1982.

On the whole, commercial e-mail is more developed in the US than in Europe. Clearly, the existence of the Arpanet system in the US, which devel-oped sub-systems such as Educnetwork and Commnetwork, contributed to the fact that early commercial initiatives took place in that country. For example, the system 'Telenet' was developed by Bolt, Berenek and Newman, who had been the designers of the Arpanet system. But there were addit-ional factors. For example, in Europe far more effort went into developing Teletex, a more advanced form of telex. A number of analysts have also attributed the early initiatives in the US to the fact that private companies and not nationalised PTTs were the driving forces — whereas in Europe, these PTTs had slowed development.[4]

Although most of these e-mail providers were geared principally to commercial clients, some, such as GTE Telenet, have offered cheaper pack-ages to encourage domestic users. However, it is the various videotex type and on-line database initiatives which have gone furthest to develop a home user base.

For example, CompuServe, founded in 1969, was originally a computer time-sharing operation which developed its Information Service in 1979. As in the case of Prestel, e-mail and bulletin boards were part of the package offered by CompuServe. The same was true of The Source (now owned by CompuServe), an on line service founded in

1979, and of the various other initiatives such as Viewtron, Gateway, Delphi etc. — some of which failed as videotex services. All of these appear to have found that messaging was very popular, if not the most used service.[5]

Other international developments

Several other countries have developed videotex systems, often with e-mail potential, e.g. Canada, Germany and Japan. But arguably the most signif-icant, high-profile innovation has been the Minitel (or Télétel) system in France. Initial work on the system started in 1972, a year after R&D on Prestel commenced, and the system was launched, after trials, in 1982. What was particularly notable about this innovation was the decision to try to achieve a critical mass of users by giving the terminals away — ostensibly as replacements for the paper telephone directory. This rationale was the basis for getting Minitel into the home where it might then by used for other on-line services. By 1989, 5 million terminals were in French homes.[6] Minitel also proved very profitable for many service providers, although whether it is for France Telecom is a matter of considerable debate.

Of special interest for our case study is the fact that, although Minitel was originally envisaged as being, like Prestel, mainly geared to providing infor-mation services from databases, other services have proved unexpectedly popular — including various forms of messaging.[7]

Right from the early trials, and significantly between 1985 and 1986, customers showed an interest in the communication services. Although it is only recently that a full national e-mail system, Minicom, has been established,[8] some service providers supplied mailbox facilities — for example, Antigel had 16,000 mailboxes in use in 1987.[9] In the original trials of Minitel, e-mail accounted for 12 per cent of all calls made on the service.[10] Other messaging service have also proved popular — such as bulletin boards and interactive games, but the one that caught public attention was the chatlines (‘messageries conviviales’). Although these cover a range of different topics, ‘Minitel Rose,’ which contained messages with a sexual content, proved to be very popular and attracted news coverage. Such a service is noteworthy since, as we shall see when looking at regulation issues, this is not the type of public service which BT would currently be willing to tolerate in the UK.

UK history

Public e-mail in UK was first introduced as an addition to the GPO’s videotex system, Prestel, which was initially targeted at domestic users. Although it has a sizeable user base, various analysts have documented the fact that Prestel never remotely fulfilled the original optimistic expectations of millions of users. Micronet 400, however, which was

launched within Prestel in 1983, enjoyed a modicum of success before being closed down in 1991. This was a service which was specifically geared to the home computer-owning ‘community,’ offering a combination of telesoftware, electronic publishing and access to Prestel facilities — through this including e-mail and bulletin boards.

As a separate initiative to Prestel, the Post Office had also been developing its own implementation of an e-mail system, but the sophis-tication of its design led to long delays in development. After telecoms and postal services were separated, the new company, British Telecom, finally scrapped these plans: by then they were aware of the poor returns on Prestel and with privatisation in sight it was not thought to be the moment for the expensive pursuit of another new data communications experiment. In 1981, BT started looking for an off-the-shelf system tailored to business users. In 1982, the newly privatised company licensed such a system from Dialcom, and set up an arms length subsidiary ‘Telecom Gold.’

In the US, Dialcom had been orientated towards corporate clients and so when BT licensed the system it had expected to attract the same kind of commercial users in the UK, and experience moderate growth — in contrast to the hopes of a mass market for Prestel. However, after a slow start-up, Telecom Gold proved to be far more popular than expected, drawing interest both from small business users and domestic subscribers (probably home-based workers in the main). In consequence, BT had to add more computers to its Telecom Gold system in order to keep up with demand. Subsequently, following the classic ‘S curve’ pattern of adoption, demand levelled off in the late 1980s. Part of this has been attributed to the growth of a competing messaging service — fax — at that time, which confounded early views that electronic mail would replace fax and other paper-based services.

In 1986, BT bought Dialcom from ITT.[11] Telecom Gold was later to host what was for several years the main alternative to Micronet: Microlink. This package of services, which was offered by Database Publications, moved to the Istel network in 1989, before being closed down in February 1991.

Istel originated as the computer systems division of British Leyland, and later became an independent company offering e-mail and related services. It was taken over by the American communications giant AT&T in 1989. In addition to the Microlink service which it ran for a time, Istel gained another entry into a potential home market by hosting the service of the UK subsidiary of CompuServe. This commenced operation in March 1990.

A range of other firms offering network services have also either been set up or taken over by US firms: for example, One-to-One, Mercury Link 7500, Quick Comm and GeoNet. These systems were essentially directed towards commercial and institutional

markets, including the spread of e-mail facilities into higher education system (e.g. the JANET system and the use of e-mail on Open University courses).

Technological configurations

Dedicated E-mail

Electronic Mail refers to the facility to send text which has been typed into a computer system between two terminals in the form of electronic signals.[12] Originally, the terminals were ‘dumb’ in the sense that they were just input and display devices connected to larger computers which contained all the electronics for processing the data being keyed in. The advent of personal computers has added another dimension, since the terminals were no longer dumb but contained the internal electronics to process the initial text and software to control the sending and receiving of data to other distant computers. Both types of terminal coexist — i.e. dumb terminals, as well as PCs connected to larger computer systems, are still used to send messages within firms. In this case study of actual and potential home use, communication between PCs is the main focus of interest.

The most common form of e-mail, including that offered by the telecoms companies, involves a central computer which contains electronic mailboxes allotted to users. Those sending the message send it to the e-mailbox assigned to the person they want to contact. At some stage, the recipients ‘log on’ to the system (i.e. turn on their PC and establish a connection with the main computer) and check to see whether they have any messages in their mailbox. This arrangement, involving the centralised storing of messages, reflects the way in which e-mail evolved as a form of communications between users of mainframe systems.

In the case of dumb terminals permanently linked to mainframes, the fact that they have a message waiting might be displayed when the user switches the machine on. But certainly in the case of the use of home computers, it is necessary to phone the computer system and go though a logging on procedure in order to discover whether any messages are waiting. One alternative, which is sometimes used in business circles, is to have a separate paging system to indicate when a message is waiting in the e-mailbox.

Videotex e-mail

In some respects the e-mail on videotex systems such as Prestel parallels the dedicated e-mail systems. Users are again allotted a mailbox which can be accessed by logging on to a distant computer. The key difference lies in the length and layout of the message itself.

In dedicated systems such as Telecom Gold, messages of letter length, or even longer documents, could be sent. It was easy to prepare text on- or off-line simply by typing continuously. The text usually appeared on screen in the form of pages which could be 'scrolled' — which meant that when viewing a text which was longer than could be seen at once on a single screen, that text could be made to move up or down to see a different portion of it. Videotex was designed for a different purpose: displaying database information. The standard screen, known as a 'page' or 'frame,' allowed less text (being 40 columns as opposed to the 80 columns of Telecom Gold so that text was legible on a television display) and could not scroll — users accessed the next section of the message by writing on or reading a new frame. The analogy would be that instead of being able to send a long letter as with dedicated e-mail systems, videotex forced that message onto a series of 'electronic postcards.' At first, the number of such postcards (frames) which could be sent on Prestel to convey any one message was very limited — initially just one. Hence, the system was geared, or restricted, to shorter messages which were less manipulable than in the case of the texts on dedicated e-mail systems.

There were also several other drawbacks to videotex e-mail. It was difficult to convert texts already typed in scrolling form into the videotex frames. If users wanted to send these existing texts, they would usually have to type them out again into videotex format. Secondly, while it was possible to buy the software to prepare text off line before sending it (and so incur reduced telephone and online charges) many of the commonly used packages of communications software (e.g. some of the ones that can be supplied with Micronet) did not have this facility. And because Prestel was designed principally for downloading information, the rate at which information was sent to users was far higher than the rate at which users could send messages — a baud rate of 75/1200. This was therefore not ideal for sending other than short messages from point to point (i.e. sending a longer text would be slow).

Other telecoms messaging services

What characterises the e-mail services outlined so far is that they deal with predominantly one-to-one messages: i.e. sent from one person directly to another. One-to-many messages (where a single sender can direct the same message to several named recipients whose e-mailbox numbers are known) is also possible with both videotex and dedicated e-mail systems. However, there are other types of one-to-many messaging arrangements which are more public and accessible to unnamed users. Such one-to-many services are in some respects analogous to broadcast messages. Although not the main focus of this case study, it is worth noting that such one-to-many systems often generate one-to-one spin-offs. An initial public message may then generate further private electronic correspondence between some of the recipients. Examples of these one-to-many services are discussed below.

Bulletin boards (BBs) carry public messages which can be browsed and replied to by anyone. Message content may include items for sale, recomm-endations, requests for advice, snippets of information etc. Message senders transmit their messages to the BB in a manner akin to sending it to a private electronic mailbox. These boards exist on most major e-mail supporting systems. In addition, many of these services are run by enthusiasts on their own micros. As early as 1984, there were over 2,000 such boards in the US and by 1990, it was claimed that there were 500,000. Several hundred BBs are currently operating in the UK. In some respects, bulletin boards have been seen as having ‘alternative’ or progressive/democratic possibilities. The 1970s attempt at counter-cultural forms of using computing power — Community Memory — featured bulletin boards as a means of bringing together those with related interests, either to provide assistance or enhance communication in the community. Certainly, bulletin boards have always been popular with those microcomputer hobbyists who took an interest in the telecoms aspects of these machines.[13]

Although not strictly defined as bulletin boards, computer conferencing systems offer a related service where participants contribute, sometimes substantial, messages to on-going discussions recorded on the computer system. In the US, BIX offered one such system for those with an interest in computers (e.g. programmers), while the equivalent in the UK is Compulink’s ‘CIX’ (Compulink Information Exchange) service.[14]

The ‘chatline’ concept emerged from teleconferencing systems where participants could access the messages left in an assigned computer space over a period of time. The messages could then act as contributions to a discussion to which newcomers could add their own thoughts. The idea with chatlines was to move in the direction of making this one-to-many system more like real-time conferencing. In other words, instead of checking the state of messages intermittently, those joining the chatlines would reply within a short period of time.

On chatlines, messages are usually displayed on the system for a limited amount of time (e.g. the last week) or only a limited number of messages are stored (e.g. the last ten). Prestel normally runs several chatlines, which differ in the number of messages which are stored. As users who are on-line begin to reply immediately to messages, the service becomes increasingly akin to the voice chatlines which are conducted over the phone.

Multi-user interactive games involve the participant taking part in a game scenario via messages transmitted from (usually micro) terminals. While logged onto the game, players adopted identities (not always of their own sex) though which they interact with other players who are on-line and who are also following the rules and goals specific to different scenarios (e.g. searching for treasures in an adventure game, building an empire in science fiction space settings).

Obviously the fact that this is participation in a game shapes and constrains the nature of messages, but it is worth noting that there are often areas of the game where players can ‘stand aside’ to discuss game tactics. On one occasion, such communications enabled one group of users to adopt a joint strategy to task over the game and form their own Empire! (which led to the game having to be restarted with new rules). But apart from game-related communications here and elsewhere in Prestel, participants can discuss any other topic once contact has been established initially for game-playing purposes.

Home e-mail: Prestel

The important point to appreciate about Prestel, and later Micronet, is that unlike commercial e-mail services, electronic messaging on videotex is only one small element within a package of services. So the development of messaging services needs to be contextualised within the evolution of the broader product ensemble.

Early Prestel and e-mail

Sam Fedida, the main innovator behind Videotex, always foresaw e-mail as forming one part of his system in the long run — as noted in his book on the videotex revolution and earlier papers.[15] However, e-mail was not present on the first version of Prestel, and was not seen as an integral part by some of those designers working on the system. One of the development staff involved at this stage noted:

> It wasn’t felt that Prestel was set up to be either a store-and-forward messaging system or an on-line chat medium. It wasn’t viewed as being a key aspect of the service. We were about delivering inform-ation and to some degree a transactional capability came second...but it was very much second.[16]

That emphasis was reflected in a range of design decisions concerning the architecture, interfaces and presentation of the system. For example, the original input device was an alphanumeric keypad which was not especially suited to sending messages since a complicated pattern of key presses was needed to send an alphanumeric character. Another example is that in the main computers, the tasks allotted the highest priority were those concerned with accessing frames of information, not communication. As we shall see, many other such initial technical decisions were to burden Prestel’s e-mail with a range of undesirable features which have proved difficult to change.

Within the basic Prestel system there had always been a facility which allowed information providers (IPs) to put a particular type of frame on the system which

allowed a brief communication from Prestel subscribers (e.g. for brochure request or ordering goods on teleshopping services). When the idea of e-mail was revived shortly after the launch of Prestel, the Prestel development team used this response feature as the basis to develop a user-to-user messaging system. In fact, the innovation proved to be a major addition because the designers had to make available a substantial increase in the disc space storage capability. The Prestel staff expanded one of their main computers ('Enterprise') to support the extra disc and developed a new type of screen frame for the Mailbox.

Initially, Mailbox was only available in London and did not appear nationally until 1982. The delay was due to having to develop a centralised information retrieval centre into which all of the local centres were linked so that the account number for all users could be held centrally. The sheer logistics of how to pass messages across this network presented problems. In the original design of Prestel virtually all information passed from IPs to users — the amount of information that came back from users was very limited. The new messaging system meant that far more information was transmitted by subscribers. Since the network was not designed to support this pattern of usage, data queueing problems emerged, with the channel into the central messaging centre becoming blocked.

One measure to counter this involved developing buffers in the retrieval centres to control the flow of data. This was fine under normal circum-stances, but failed when the main messaging centre went out of action for any reason. As they brought the centre back up into service, all the buffers sent the messages which they had accumulated and the centre crashed again. All these flow problems, some of which remain, were very new to what was then the GPO:

> It was pretty pioneering stuff since nobody we knew had designed a network to do this kind of thing before on a national basis.[17]

In fact, there were mixed views within the GPO as to whether this messaging service really fitted in with the particular ambitions for videotex:

> When we ran the trial on the Enterprise it became very popular. And clearly we had to do something about it, because people started to report it in the press and it became of interest. We had to take a view as to whether it was a feature of the service which we wished to promote. It took some doing because there were a lot of people in the business who thought that it wasn't core and we shouldn't really get involved in this — it was too much of a problem to do it. I think the pundits prevailed. There was a lot of press support and an amount public support and a lot of internal lobbying went on for the messaging system to be developed properly.[18]

Telecoms and microcomputers

When hobby and later home microcomputers started to appear in late 1970s and early 1980s, both hobbyists and the GPO staff saw their potential as terminals for various telecommunications purposes: be it messaging or, from the GPO viewpoint, as an interface to Prestel and other services. But for computers to make use of the public phone lines required a device called a modem. In the late 1970s and early 80s, potential users were only allowed to rent GPO modems at fairly high prices. Despite the fact that it was illegal to use any other modems, enthusiasts nevertheless acquired them, and some even converted the subsidised Prestel TV adapters into modems (so that at one stage, there were more Prestel adapter sales than Prestel accounts).

Even when BT was separated from the GPO and experienced a degree of liberalisation, for some time modems still required approval from the official body (BABT) before sale, which entailed a lengthy and potentially costly procedure. Hence, outsiders have consistently complained that the GPO/BT hindered the telecommunications side of microcomputing by inhibiting both UK producers and importers of US products.

On the other hand, staff within the GPO, argued that once they became interested in the possibility of connecting microcomputers to Prestel they considered developing low-cost modems. First they tried in-house experim-entation, but the designs were never sufficiently cost-engineered:

> We wanted a device that would turn a computer into a terminal for less than £100. And we were frustrated because the in-house people were saying ‘No, it can’t be done.’.. because they’re not used to engineering down to a price point.[19]

Subsequently, the GPO initiated a number of ‘experimental seeding exercises’ one of which was to run competition in 1980 to develop a low-cost modem. None of prize winning devices was ever manufactured, but GPO staff saw the exercise as a means of raising in the industry’s consciousness the idea that you could turn a computer into terminal.

Later, with the appearance of the BBC microcomputer in 1981, BT further supported home computer telecommunications by employing pro-grammers to develop the software for use with various modems. Some of this software was sold, some was late given away with modems, again ‘to seed the market place.’

Micronet: origins

The main service emerging from Prestel which was to make use of micros was ‘Micronet’ — of particular significance for messaging. Its origins lay in a number of different trends.

The first of these was ‘telesoftware,’ the telecoms version of which involved transmitting software down telephone lines to end terminals or to micros. The concept had originally been discussed within ITV’s teletext service, *Oracle*, from 1975, where it involved broadcasting programs as part of the teletext signal. Besides that, there had been trial broadcast trans-missions of educational software to schools since 1978. There proved to be an interest among teachers in transferring software between schools, so the Council for Educational Technology (CET), which was organising the trials, set up a telesoftware educational database.

Subsequently, BT published its own telesoftware database, not so much of educational programs but more of public domain software. BT obtained much of this material from computer clubs. Meanwhile, International Pub-lishing Corporation (IPC) had started to put together its Telesoftware Project. In the light of the rising popularity of games in Britain in the early 1980s, IPC initially had the idea of producing listings of programs on Prestel frames. Later, several publishers developed the idea of downloading games programs as an alternative method of distribution to using retail outlets.

The other strand was experiments in ‘electronic publishing’ — i.e. magazines delivered by telecom lines. Again, IPC initially looked at this prospect as an alternative means of delivering the contents of their pub-lications. When the company pulled out of Prestel in 1981, the staff who had been working on the project broke away to team up with another publishing house, EMAP, in the form of a subsidiary ‘Telemap.’ The new company initially published a farming magazine on Prestel, but when this proved to be a loss maker, an entrepreneur, Richard Hease, who had worked closely with EMAP and had sold a number of magazines to the publishing group was invited to assess the future of this venture.

With more of a marketing than technical background, Hease assembled the package which became the ‘Micronet 800’ service.[20] Subscribers could access some telesoftware free of charge and could acquire games telesoftware at extra cost; they could go on-line to view an electronic magazine which was geared to a readership interested in developments around home computing; and they acquired access to parts of the Prestel database — including the messaging service. In fact, the Mailbox facility hosted this interactive magazine, providing the means by which users posted their contributions to editors, to the bulletin boards and to the micro-specific magazines. By 1985, Micronet had grown to be the biggest information provider on the videotex

service, the vast majority of non-business Prestel users were brought in by this route.

Initially, Micronet was owned by EMAP and Hease, with BT selling access to Prestel and other services to Micronet. That same year, Hease pulled out to concentrate on other concerns and BT took 25 per cent of the equity. Bell Canada also showed an interest in this novel service and took a 20 per cent share, EMAP retaining the remaining 55 per cent. In 1986, the ownership was reorganised to give BT and EMAP 40 per cent each, with Bell Canada retaining 20 per cent. At that time, BT took over the day-to-day running of the service. By 1989, EMAP and Bell Canada decided to sell their shares to BT in a context where British Telecom benefited most from Micronet, deriving income both from subscription and network revenue. However, by 1991 BT had moved to a system whereby the Micronet operation was required to generate revenue as a profit centre, regardless of network revenue. Micronet had never achieved this, and by then the number of users had fallen from its peak. As the rest of Prestel became more orien-ted towards offering commercial packages, Micronet became an anomaly, and BT ended this particular commitment to the residential market in October 1991.[21]

Launching Micronet

The consumer research conducted before Micronet was launched had suggested that telesoftware would be the most significant trigger service — although it has subsequently proved to be less significant than the messaging service and the magazine. The research consisted of discussion groups with users of home computers, who almost unanimously said that they wanted a telesoftware library available all year and, when asked how much would pay, came up with a figure not very different from the eventual Micronet sub-scription. However, the first advertising video sent to computer clubs stressed the multiple benefits of the new service, where the electronic magazine and information on Prestel were emphasised as much as the telesoftware component. Later advertisements addressed a wider audience:

> The ads ran from about 6 weeks before Christmas 1984 till 4 weeks after, and they were inserted into old movies [series] which Channel 4 were running ... of a semi cult nature like the ‘Prisoner’ series, because the [advertising] agency that we were using at the time felt that it was a product which lent itself to a particular lifestyle. They thought it was the late teens/early 20s semi-nostalgia freaks really, who liked gadgets, liked the idea of the ‘Prisoner,’ liked fantasies. And it was felt that Micronet could match up to this.[22]

From the start, Micronet offered a package including a cheap modem produced by Oracle Electronics Limited, the development of which had been funded by the DTI. To promote the service, BT further subsidised early sales. This entailed either subsidising

the cost of the modem to the end-user to achieve a price of £50 or funding conversion of people's existing phone sockets to the new BT square sockets which were just appearing in 1983 and which would normally be necessary for using a modem in the UK. The total subsidy (of modems and conversion) was paid for the first 10,000 customers, amounting to approximately £20 per subscriber.

In addition to a mail order operation, Micronet accounts were for a while also available through retail outlets. At the time of their block of TV adverts in 1984, EMAP and BT persuaded retailer chains such as WH Smith, John Lewis and Laskys both to demonstrate the service in their shops and to sell modems alongside Micronet accounts — which was a new departure. This arrangement arose because BT and EMAP staff recognised that commun-ications was a complex product to sell and required some demonstration to the public. During this period, BT staff also visited the shops as customers to check on the quality of the service — with mixed results.

While it lasted, the retail experiment was as much if not more successful than the earlier mail order exercise. But shelf space has to generate a certain amount of revenue for retailers — which was not met by the sale of modems and the space and effort involved in demonstrations proved not to be justified by the account sales generated. Hence, the retail effort disappeared after a year.

In general, Micronet proved to be one of the more successful means of attracting new Prestel users, although Micronet itself has still remained a loss making operation. Following considerable and enthusiastic coverage in the computer magazines, the take up of Micronet was initially rapid. In the first month the service recruited 1,000 subscribers, predominantly BBC micro users whose machines already had a built in facility for displaying Prestel and Teletext screens. As one of the staff involved observed about those early adopters:

> They seemed to be sitting on the touchline waiting for this service to be offered. That's partly because they'd been primed by Acorn who'd been saying 'we're going to have this Prestel adapter' in all their publicity. So they were well aware of services of this type. But once we got to around 10,000 users the focus shifted.
>
> People bought BBC micros because they were interested in the use of the machine as a tool and because of the educational aspect, not so much for games playing. I think you could almost profile BBC owners as separate from Spectrum owners, Commodore owners and so on. The other strand in the early development were computer hobbyists. They were people who joined computer clubs and were interested in computing for its own sake and therefore in communications for its sake. And they would buy

> anything that married those two technologies together. But I think we ran out of those real enthusiasts in the early adopters.[23]

After about 1985, growth slowed, with membership peaking at somewhere between 20,00 and 25,000 (bearing in mind that Micronet had actually had a high turnover or 'churn' rate). Part of that slower growth can also be explained by a combination of relative saturation of the home com-puter market, the growth of other information sources (e.g. paper based magazines) and the advent of directly or indirectly competitive on line services (e.g. Compunet, CIX and Microlink).

By the late 1980s, membership started to decline, especially because of increases in charges. When launched, the incremental cost of using Micronet has been small, around 55p per hour for the local telephone charges. These were to increase, as discussed below, as were the basic subscription charges (e.g. in 1989, Prestel lost a fight with the treasury and all Micronet charges became subject to Value Added Tax).

Micronet and messaging

Mailbox was used substantially by 'Micronetters,' who were the largest single grouping of users on Prestel and who used messaging heavily. BT reorganised its operations so that 'Consumer and Business Publishing' en-compassed all Prestel and Telecom Gold aspects where publishing was a factor. This led to further consumer research among users to establish future trajectories — and confirmed that Mailbox remained very important to Micronet users.

In fact, for many years the peak usage in the evening approached the daytime peak for (mainly business) use of Prestel messaging. The statistics collected by the software in the Prestel system showed a difference, however: business and residential users who sent e-mail in the daytime tended to send single frame messages, requesting or supplying information — i.e. they were functional short messages. Off-peak evening users treated mailbox more as a chatting medium.

In the late 1980s, the use of Mailbox via Micronet changed radically. The original remit of Prestel had been to encourage the public to use the tele-phone more, and therefore the Prestel system itself could be a loss leader while promoting network traffic. But, the telecommunications regulator Oftel ruled against such cross-subsidies, and decreed that different parts of BT should work as separate profit-making companies. This made the exist-ing Prestel arrangements non-viable, so BT had to restructure its pricing.

The lobby within for BT for charging for messaging, a notion influenced by the success of Telecom Gold, was successful. Hence, for some years use of messaging during the evenings and weekends was no longer a free part of the package (access between

midnight and 8am remaining free). Although this charge was small — one penny per minute — it doubled the incremental costs of access for most users. This change led to the system becoming less attractive with a severe a drop in traffic, a subsequent evening usage being far below the day time peak, and a general decline in Micronet membership — although this eventually levelled off. But the damage was done: given the heavy reliance on user input, this reduction in both subscribers and usage has reduced the perceived value of the service to those remaining. At any rate, as a result of this user response, free evening and weekend messaging was reinstated in February 1991, but this was short-lived, as the service closed that October.

Another form of messaging, chatlines, were first proposed by one of BT's staff. He was allowed to design some software on the BBC and it was simply tried, without further consumer research. As one of the Micronet staff commented:

> This often happens. It's difficult to test a concept like chatlines, and the easiest thing to do, given you've got a user population as guinea pigs, and providing it's not going to cost you an arm and a leg to do it, is to just go at it that way. We as a central business decided we weren't going to develop it as a facility initially, we wanted it as a prototype. It was successful, it was very popular. So we decided to bring it on board.[24]

BT subsequently improved the system, adding a number of variants to the idea. Although beginners always try out the facility, chatlines are mainly used by a limited number of heavy regular users rather than the facility being a major attraction for all. BT found from its surveys that often commun-ication which started on a chatline, with a Micronetter asking for someone to talk to, then goes over to one-to-one e-mail messages once contact is established.

Games provided another opportunity for messaging. The game 'Multi User Dungeon' (MUD) was developed at the University of Essex partly to demonstrate some of the principles of artificial intelligence. From the start, people outside the university were allowed to phone in, and many did so, especially from the US, via Arpanet. In fact, MUD was at one stage the major destination of Arpanet calls to the UK. When the originators at Essex came into contact with BT, they showed an interest in running MUD as a Prestel feature. The manager of a different section of BT:

> took a flyer on it, threw a fairly substantial sum of money at them and launched at the PCW Show in about 1985.[25]

MUD was reasonably successfully, but was limited to local call access from London and there were technical problems in translating the game from its existing DEC 10 system to the Vax environment on Prestel. This led BT staff to search for alternatives. The

found a small firm running a multi-user game called ‘Shades’ and adopted this system. Again:

> We didn’t do any market research. But it just seemed a self-evident truth that if we launched this on Micronet it would be successful — and it has been, absolutely. We were overwhelmed with success. We only provided the capacity for 32 simultaneous users and we had to double that — it just filled up.[26]

It is worth noting that there is more to these multi-user games than messages about actual games play. Players send e-mail to one another con-cerning the games, there are bulletin boards, and there are chatlines in the games section. In fact, half of the messaging is not about games play itself, but is some form of chatting — not always about the games.[27]

E-mail on Prestel: later developments

Mailbox itself virtually remained unchanged for some time until several improvements were made in 1989, including acknowledgement facilities, facilities for creating mailing lists and multi page messages. BT staff argued that this was due to cost and complexities of development. The plans for improving Mailbox had already been defined by 1986, but then BT arranged a contract to deliver an advanced Prestel system with Singapore. Because the Singapore deal was so financially attractive, it swallowed up many of the resources which might otherwise have been used to speed up the devel-opment of Mailbox in the UK.

One major development was that of gateways to other computer systems. Gateway technology was originally developed by the German Bundespost, and was bought by BT as a means to offer large database at fairly low cost, as well as facilitating teleshopping and telebanking. Instead of the infor-mation providers on Prestel having to translate their information into Prestel pages, the IPs’ computers could be accessed directly. Gateways laid the basis for communication between Prestel and other e-mail systems such as Telecom Gold, and for sending fax messages.

When Prestel and Telecom Gold were amalgamated in 1987, the services were simply told that the two systems should now interconnect. Thus a specific gateway had to be designed to convert the page structured videotex format into the scrolling system of Telecom gold. But the system was structured only to translate messages from Prestel to Telecom Gold — not vice versa. BT staff felt that Micronet users in particular were well aware of communications, and would have an interest in access to Telecom Gold. Indeed, when the gateway was launched several thousand Micronetters acquired Gold mailboxes. In contrast, it was felt that Telecom Gold users would have little interest in

accessing Prestel mailboxes. The fax gateway appeared to be a ‘self evident’ step.

Finally, there has been much discussion about connecting the various commercial e-mail systems, because e-mail in general might become a more attractive messaging medium when more people are reachable on a network. This argument has not been persuasive in the area of domestic e-mail: no gateways were developed to Microlink, BT’s main rival in the home market. One member of staff noted that BT ‘did not wish to do anything to help the competition.’ Obviously, one consideration here is that e-mail is only part of a wider package of services in Micronet as opposed to dedicated e-mail services where interconnectablity is a key issue.

Role of consumers in product development

We have already seen that British Telecom have sought consumer feedback on a number of occasions. When launching Micronet, BT examined the attractiveness of telesoftware and other services. But in defining the advertising campaign we also see an example of BT’s advertising agency looking beyond the particular benefits of the service to locate the whole product in terms of people’s lifestyles and orientation:

> The agency felt that the time was right for a product like this in terms of style. If you look at the advertising at that time, it was actually projected around an image of a human being reacting to a service which was presented as being ‘mind blowing.’ And there was a style thing around the Richard Gere type of character — sort of young, smart, funny... probably out of date now.

Admittedly, this involved little consumer response and a good deal of intuition:

> They did a certain amount of writing to computer clubs and talked to people about the service. They did some straw polls amongst them-selves. They just had a number of people who fitted that sort of profile within the company. That was about as close to the customer as they got.[28]

Once the service was in existence, Micronet users appear to have provided an unusual degree of feedback to BT, compared to other types of on line information systems. Clearly, this reflected the fact that a key ele-ment of the whole service was the idea of communication. Certainly a ‘club’ atmosphere was fostered and helped by the magazine component of the product and also by the hobbyist orientation of many consumers and staff:

> It’s always been foreseen that the users would determine the shape of the service by one means or another. In fact, they don’t as much as we thought

> they would. Clearly they send messages to the editor and complain, and they are very vociferous about what they feel is important or not... a very small number are, I should say. It's not quite as democratic as it might appear. But yes, it was always envisaged that there would be a strong user feedback path. It was more like an on-line club. It was an electronic magazine for enthusiasts, written by enthusiasts. I mean, the first editor, David Bambsky, was an out and out enthusiast. In fact, his concept of the whole thing was that the service should be as unpredictable as possible and as quirky as possible. He would actually put databases together which were deliberately badly routed, badly indexed, simply because he felt people would enjoy spending time browsing round the system, stumbling over things they didn't know were there.[29]

It should be noted, though, that feedback can sometimes be misleading. When BT wanted to find out about user views on what new functionality an improved Mailbox should have, they conducted on-screen research (a poll on Micronet) through such vehicles as 'celebrity chatlines,' where user suggest-ions often concerned potential new facilities. Although this contact prompt-ed BT to provide for longer messages (up to ten frames), the network software monitoring usage shows that Micronetters rarely seemed to use more than four or five frames in practice and the most common usage remained the one frame message.

Despite the claim that users should shape Micronet, BT (and EMAP initially) clearly provided the framework for determining the overall structure. For example, their staff had developed the formula for the sort of product that would appeal (information + communication + telesoftware), they decided which machines to target at various points in time (e.g. BBC micros), and they had decided which elements should comprise the publishing side. Often, as we have seen, new facilities were introduced simply because BT staff thought they were useful — and sometimes these features were launched without trials. An example of an idea originating from BT would be the 'Gallery' on Micronet, where on member of staff felt that subscribers should be able to publish their own information using the response facility.

BT's 1990 consumer research of Micronetter's usage (via telephone interviews and in depth discussion sessions) has consolidated some of the views that BT staff held. There were some minor surprises: for example, Micronet subscribers were much older than staff had expected, and stayed members longer than anticipated. A very high percentage of them were members for longer than two years, some of them as long as five years. Although Micronet users were predominantly single males, the survey research also showed that in addition to the registered name of a subscriber whole families sometimes used the service: fathers first, then children, then wives — and girlfriends in some cases. Also, the chatlines, as judged by the names which appear, had quite a few female users. On the other hand, in later group discussions involving Prestel users which were

organised by a market research agency, most groups had to be male because the agency could not locate enough female users to run a parallel group! The agency eventually solicited opinions from a group of female non-users.

Issues: messaging on Prestel

There are a number of key, non-technical issues influencing whether and how e-mail on videotex might be developed further. The first of these concerns the location within videotex and the fact that electronic messaging forms part of a package. Then we have the questions of how messaging might be expanded both in terms of attracting new audiences and in terms of increasing usage by existing ones. Finally, we discuss the regulation of the content of these messages.

The role of messaging

Although Telecom Gold and other dedicated e-mail systems were increas-ingly packaged with other services, the basic messaging service was a sufficient trigger in itself to attract users — it was valued enough to justify subscription. As we have seen, this was not so in the case of e-mail on videotex. In contrast, buying information was the main factor in the case of Prestel, while Micronet packages several components along with messaging.

Although, e-mail was well used by Micronetters when it was part of a package, traffic declined severely when BT moved in the direction of treating messaging as a separate item commanding a price per use. This difference from dedicated e-mail services provided the context for determining how much effort should be put specifically into developing the messaging facilities further, as opposed to innovating in other parts of the videotex package.

Further possible user communities

BT had always been interested in locating other potential segments of the market, apart from the home computer users who supported Micronet. The search for other packages, sometimes including e-mail elements, had led BT to consider the information and communications needs of other possible groupings. For example, some consumer research was conducted where participants in focus groups discussed the hobbies they followed, and whether BT could do anything to facilitate those interests. Chess proved to have some potential, because it can be conducted at a distance over a messaging system as is done using the post.

Some initiatives, involving tightly defined audiences, were set up: for example, a database to aid small pilots run by the Civil Aviation Authority. This contained information about the facilities and problems that are encountered when flying between two points. BT also examined women's interest areas — where a service might be developed which was the equivalent of women's magazines — and an electronic business travel magazine with comprehensive and up-to-date information. The problem remains, however, that although there is a general interest in various pro-posals, in many cases it proves difficult to find people actually willing to pay for particular packages of services.

Active users

One general problem with e-mail systems concerns the degree to which subscribers log on to check their mailbox. This is not just question of a phone company wanting to generate extra messaging and phone call revenue, although that would be desirable from BT's perspective. But from the viewpoint of current or potential subscribers, the degree to which other subscribers log on frequently — i.e. are 'active users' — is vital for the attractiveness of the whole service. If others fail to log on to read mail quickly enough, other forms of messaging, such as the post, may be more effective. In other words, there is an extra dimension to the critical mass problem: the quality of participation.

In case of Telecom Gold, part of the aim of trying to sell other services alongside e-mail was to provide users with sufficient reason to log on more regularly — although even Telecom Gold faced problems on this count. On Micronet, the introduction of the paper magazine 'Log On' was, similarly, part of attempt to encourage Micronetters to use the system more by advertising features on the service. In practice, Micronetters were relatively good at clearing messages out of the system.

BT's understanding of general Prestel users was that they sent a message and expected someone to pick it up sometime. BT made less of an effort to encourage logging on to check messages, partly because there was a good deal less direct contact with general Prestel customers.

> In fact, because you don't have an identifiable user community amongst the general Prestel users, it's actually difficult to know how you can go about generating that active use.[30]

Regulation of messaging

At one stage one of the information providers on Prestel ran a section called 'Timefame,'

which managed to solicit some in-depth discussions about subjects such as politics, religion, racism — i.e. often controversial topics. That IP left some years ago, and since that time BT staff have considered trying to revive such discussions as a ‘serious’ use of telecommunications, as opposed to what are sometimes seen as the more trivial social messaging.

However, the ambiguities around any such move are illustrated by the case of ‘Freespeech.’ This discussion section initially started up on the airline Pan Am’s database on Prestel, without BT’s being aware of it. Freespeech later came to the computer conferencing section on Prestel run by Netreach, the computer conferencing service. When this service ran out of space to maintain Freespeech, someone at British Rail offered to host the service. In each case, the person running Freespeech on their host computer, almost as a hobby, checked that it was ‘legal and decent’ before putting up the message. Discussions would cover such topics as the TV programme on the shooting of IRA suspects, ‘Death on the Rock.’

Following some adverse comment about BT in a TV programme which was critical of some of the items on Prestel, BT staff searched and found the service on British Rail. For a short while BT then closed all access to BR’s computer and told them to remove Freespeech from their system. It then moved off Prestel to a private system. One member of BT showed the mixed feelings about unregulated discussions:

> We decided we didn’t want it because it’s a little near the bone. I mean, it is actually controversial and we needed the protection of a main IP contract around the publishing area... to protect, I suppose, customers and ourselves from abuse on the system. I mean, BT's very sensitive these days about getting involved, getting an image which is at all tarnished with the popular press. Every time there’s an article in the ‘News of the World’ there are shudders of horror. So, Freespeech was an area we wanted to keep away from. So we’ve had some uneasy relationship with some user facilities in our time. We’re not in the area the French are in — the moral climate’s different.[31]

It is worth noting that BT were also worried by earlier adverse comment concerning the content of discussions on their voice chatline services over the phone — especially ‘Talkabout,’ which was discontinued in 1988. In June 1990, BT suspended all their main electronic chatline services while they considered how they could better regulate message content — and then dropped them completely. This further diminished the perceived value of the Micronet service, with some members reacting immediately by cancelling their subscriptions.

Other systems

Microlink

Microlink, Micronet's main competitor, was for some years part of the publishing group Database Communications. By 1985, Database Publications, itself part of Europress, owned several magazines and organised conferences for BBC users. The publishing company wanted to enter the electronic publishing field, as EMAP had done with Micronet. But instead of operating through a videotex system, Microlink initially operated through a dedicated e-mail one: Telecom Gold.

Database Publications had originally approached BT with a plan to resell Telecom Gold boxes to niche markets, including residential users, which BT could not reach. This marketing strategy was be aided by publicity in the Group's magazines. At first, Telecom Gold staff had been doubtful when Database promised to add on new users at a rate of 1,000 a month. But over the first two months of operation Microlink reportedly achieved a total of 2,000 subscribers. By 1989, observers estimated that there were about 8,000 users, although Microlink suggested a figure which was substantially higher. This user base was built largely on the basis that Microlink was the cheapest way to access Telecom Gold, and in a period following summer 1987 it was particularly attractive when its tariffing principles diverged from that of mainstream Gold.

Partly because of the BBC connection, the majority of early Microlink users were BBC owners, although PC owners later became predominant. Microlink was promoted both for home and business, and BT estimated that residential users made up 20 per cent of the service's audience.

The Microlink package consisted of various messaging facilities (e-mail, telex, fax), with electronic mail possibly playing more of a role than in the case of Micronet. One of the original aims of company was to 'demystify e-mail.' As with Micronet, bulletin boards, chatlines, and telesoftware were included. While Prestel was not available, those databases accessible on Telecom Gold were on offer, as was a news service. As with Micronet, domestic messaging in practice consists mainly of subscribers comparing equipment, making recommendations (e.g. where to buy equipment) and asking for help and advice concerning micros.

The change from Telecom Gold to Istel

By 1989, Database Publications were starting to become disillusioned with the high licence fee and some of the limitations of working on Telecom Gold — such as lack of technical support. For example, Microlink staff had wanted to abolish charges during cheap rate but BT would not allow this. As a result of a number of such conflicts,

Microlink left BT that year and moved onto Istel's e-mail network. Apart from obtaining data on usage via software in the e-mail system, staff at Microlink, like Micronet, claimed that they obtained a good deal of feedback from users in terms of on line recommendations and criticisms from subscribers. In addition, staff con-ducted occasional questionnaire surveys, achieving reasonably good response rates. For example, they conducted one such survey when they first moved over from Telecom Gold. However, there is another version of this story. One complaint from subscribers, apart from over issues like high charges and failure to deliver promised new services, was that in practice questions, comments and suggestions from users were ignored.

After reaching a peak membership in summer 1988, Microlink started to lose customers steadily. This process started at the beginning of 1989 following price rises and continued when the service moved to Istel. The break in connection between Microlink and Telecom Gold Mailboxes (January 1990) and its subsequent restoration (June 1990) appeared to have had little effect on this trend. It has also been suggested that staff at Europress were perhaps too thinly spread amongst diverse operations, only one of which was Microlink, to provide adequate support and marketing. Clearly, they were not able to stop the decline and in February 1991, AT&T Istel issued a statement saying that there was no place for Microlink in their global strategy. The service was closed down and subscribers were offered the option of joining the CompuServe service which they also operated.

Telecom Gold

There was no place on the Telecom Gold application form, unlike with Micronet, to classify oneself as a business or residential user. However, from BT surveys, Telecom Gold staff knew that they had very few domestic users who sent messages from home to home. In fact, staff considered home user to be a somewhat vague category, when subscribers may access their mailboxes from a phone at home or at work. Telecom Gold staff said that they have made no particular push to acquire users who send mainly home to home messages.

Others

Most of the other specifically public e-mail services apart from Telecom Gold have also enticed few domestic users, and appear to focus their publicity mainly on business applications. The exception is Istel which had been considering promoting domestic users for some time before hosting the Microlink and CompuServe services.

The second largest e-mail system, after Telecom Gold, is Mercurylink 7500. The network was originally launched to target small businesses, but Mercury found this to be expensive in terms of supporting many users with advice and help. Also, these users

generated limited revenue. They have now refocussed on fewer corporate users who generate the same revenue for less effort. The direction of this move is clearly away from any home market where potential users may require even more back up. On the other hand, Mercury staff have been willing to negotiate the delivery of their network via cable — as we shall see presently.

One small company which has had some domestic users is Compunet, a service run originally run for Commodore users. In 1987, this service broadened to cover other systems and for a time moved to Istel. It is now defunct. As noted earlier, the American service CompuServe has become available in UK, whereas British users previously had to dial the US. This service again has e-mail facilities, chatlines and bulletin boards.

Other routes to electronic messaging

This last section examines other forms of electronic messaging besides the ones run by the various telecommunications firms which have been discussed above. In particular, it deals with fax and cable as potential means of delivering electronic messages to the home.

Turning to fax first, this product has an entirely separate product history compared to e-mail; it involves a very different technology and it has been driven by manufacturers of office equipment rather than telecoms firms. Nevertheless, in many ways it occupies the same product space as electronic mail. Both fax and e-mail offer essentially the transmission of text-based messages (stored, not real time), and face similar network-dependence issues such as that of obtaining a critical mass of users. In fact, facsimile's potential role as a domestic product was discussed (as was telex's) earlier this century. More recently, the prospect of home fax has been seriously raised again. Hence, it merits discussion.

When turning to alternative means of delivering e-mail, it becomes clear that several alternatives to the phone, the modem and the system of mailboxes organised by telecoms firms have been discussed repeatedly this last decade. For example, although the idea never left the labs, when Seeboard (South Eastern Electricity Board) were investigating intelligent meters (CALMU) there was some speculation that the apparatus might also be used for processing e-mail messages.

In fact, whenever a potential product involves introducing a processing power, some memory chips, a display and communication facility into the home there is usually further discussion about other possible future applications beyond the immediate innovation — and e-mail is a frequent candidate. Arguably, the service which has most regularly prompted discussion of messaging possibilities is that of cable. Thus, even

though there is little sign of e-mail services emerging yet, this field also merits some further analysis.

Facsimile history

Facsimile is the oldest technology with which we deal, even if it appears to be a more recent innovation. The first facsimile machine was developed shortly after the printed telegraph by a Scottish clockmaker called Bain in 1842. The central principle in facsimile technology which distinguished it from printed telegraphy was that a text, which was placed on a revolving drum, was scanned. Whereas telegraphy was somewhat like the later e-mail in that signals representing characters were transmitted by Morse code, fax scanners sent information about the shades of light and dark on a page.[32]

The concept of 'picture telegraphy' was contemporary with that of printed telegraphy, and appears to have been the main goal of these early machines. In fact, the first devices were not sensitive enough to discriminate written text, although the idea that facsimile might one day be a possible alternative to the Morse system for written messages appears to have been around from the early days. Between 1863 and 1868, there were experi-ments with this 'facsimile telegraph' in England.

The possibility of a commercial application for this scanning system first became more apparent in 1873. The year 1901 saw the first international fax where a picture of the Pope was sent from London to Paris. During the 1920s, fax was improved, and by the middle of the decade systems were set up by AT&T, Western Union and RCA. Newspapers established the principal early role for this technology: transmitting news photographs. In addition, fax was used to send such items as engineering diagrams and weather maps.

In these early decades of the century, the possibility of using fax to transmit text was again considered, in particular as a method of electronically publishing newspapers. At one time, several major newspapers invested in R&D on the radio delivery of facsimile newspapers.[33] Meanwhile, as early as 1931, ITT gave a demonstration whereby 60 pages of printed matter were sent by fax within an hour — indicating how this technology might be cheaper than ordinary telegraph for long documents. However, at this stage fax was not widely conceptualised as a piece of standard office equipment suitable for businesses.

Recent history

In the 1960s, the demand for the instantaneous transmission of pictures as well as written information became normal practice in the area of computers, and manufacturers re-examined fax technology. The first digital data compression was achieved by the

Japanese firm Ricoh Corp, through which a one page document could be sent in less than a minute. The demand emerg-ing for this new facility led to the development of several different intra-company proprietary fax systems.

Work on standards dates from this period, with, successively, Groups 1, 2, and 3 standards. Group 4 standards are currently evolving which will add teletex facilities, as well as specifying different speeds and reliability para-meters. The Group 3 standards were widely regarded as being an important factor enabling the ensuing popularity of fax. Moves towards deregulation in various countries meant that fax could now be sent over public phone lines as well as dedicated communication lines.[34]

While the use of fax has grown generally in recent years, it has experienced a particular boom in Japan, where half the world's fax machines are now installed. The popularity has been partly attributed to the nature of Japanese script: keyboard inputs for message sending were a more problem-atic alternative than facsimile.

There are currently several trajectories in which facsimile is developing in the commercial sphere. In many companies, it has progressed from the postal room so that each department has a fax, with the prospect of the one per desk fax looming. On the one hand, we have the 'portable fax,' on the other, the integration of these previously separate devices with other office equipment such as PCs, printers, feature telephones etc. This gives rise to the possibility of reconfiguring fax. For example, PC interface cards are available which enable PCs to send and receive faxes, or to provide 'virtual fax' — i.e. to use the PC's printer to provide 'fax lookalike solutions.' More recently, miniature fax/modems have been developed which allow PC users to access to e-mail and fax through the same piece of equipment, which is small enough to fit inside a notebook computer.

Meanwhile, the Japanese electronics trade press has for some years speculated about a potential market for domestic equipment. Japanese manufacturers have talked about fax as an part of a general extension of homeworking, migrating from office to home office just like other equipment such as PCs.[35] But there is also the possibility of other non-office type applications as well. For example, NTT conducted an experiment in Mitaka to test potential useful home applications of fax equipment — e.g. printing information shown on TV screens.[36]

Fax in the UK

Faxes first appeared widely in the UK in 1980, and started to take off with the emergence of Group 3 fax in 1984/5. Within Europe, the UK has experienced the largest growth. This has occurred despite a relatively good postal service, although much effort has gone into alternatives in other countries — teletex in Germany and Minitel in

France. Sales of fax machines increased dramatically during the Post Office strike of 1988. In 1990 sales started to decelerate, which led some industry commentators to regard earlier growth forecasts as over-optimistic, and to anticipate some restructuring of the industry due to oversupply.[37] However, other analysts retain their optimism about the longer term, and indeed fax sales recovered and continued to increase as prices fell.

The main suppliers of fax in the UK are Japanese subsidiaries — mainly NEC, Panasonic, Canon and Sharp. At various times British firms such as BT and GPT have considered developing fax, and Plessey even produced its own prototypes. But these companies could not produce fax machines as cheaply as the Japanese who have much experience with the relevant tech-nology. A number of companies, such as BT and Philips, have badged Japanese machines. The only European producers are the French company Alcatel and, more recently, Amstrad.

Fax had first been bought directly from suppliers mainly by very large companies who needed to communicate internally. Subsequently, there was a move to selling fax mainly as office equipment through dealers and dis-tributors. The latter continue to provide the main source of feedback about consumers to suppliers. When new machines developed in Japan are being considered for the UK market, distributors and dealers often play a role in judging their potential suitability. On the whole, the Japanese subsidiaries have had few funds to conduct market research. Often, the Japanese parent companies look to the US as a test market for Europe.

More recently, fax has made an appearance alongside the photocopier in many high street shops as a service available to customers. In some locat-ions, such as airports, machines have been installed to offer ‘public fax,’ the equivalent of a public telephone where fax can be paid for by credit card inserted into a slot. Both of these have been seen as helping to make fax more familiar to the general public.

Lastly, some fax machines have been sold by the consumer departments of the Japanese subsidiaries (e.g. Panasonic) via dealers rated as consumer outlets — e.g. John Lewis and other high street stores. Up to 1990 these outlets had sold a limited number of machines, but continuing price reduc-tions are making more possible the idea of fax in the home.

Home fax plans

By 1990 some suppliers had already pulled out of the low end (home) market due to the lack of sales through domestic retail outlets.[38] However, expectations are mixed and other manufacturers of low price machines, especially Amstrad, have already entered the field based on projections that the home market was going to be opened up. Amstrad called its machine the ‘Personal Fax,’ a name which suggests that, as with its earlier

micro-computers, part of the target was the professional conducting some paid work at home — not just using fax for non-work-related messages.

In February 1990, the British Facsimile Industry Consultative Committee (BFICC) — the trade association relating to manufacturers of fax machines — held an extraordinary meeting to discuss the future of home fax. This was indicative that some considerable interest in such a domestic product remained, as were discussions in the trade press. However, one participant put this into context by noting that:

> With unit sales not actually growing at the moment, they're discussing anything they can get hold of!

It was recognised at this meeting that the problem with the home fax was that it offered limited benefits at that time relative to telephone messaging (plus answering machines) and to the post. In addition, as a network-dependent product there was, as with e-mail, a critical mass problem: it was felt that there was not a sufficient installed base via people working from home and there were not enough meaningful things that users could do from home with a fax.

In addition, comparisons were made to the telephone answering machine (TAM) which also offers message store functionality. It was argued that since the TAM was both easier to use and did not rely on other people having machines, the fact that sales of TAMs to the home were still limited was a poor omen for fax.

The most common view among fax manufacturers was that faxes might reach the home via teleworking or the home office of professionals. Sometimes such a view has been based on very optimistic market and newspaper reports of the future of home work, and some interviewees drew on their own experience of teleworking and their need for fax. In fact, most faxes in the home were bought by companies for staff, or by freelancers. Once established in the home via this route, then users might find other applications — such as sending social messages from home to home. However, while other producers thought that the home office would materialise on a larger scale eventually, they were a good deal more pessimistic about the short term, and critical of the size of teleworking forecasts.

Another route into the home involved firms in general accepting domestic orders and bills by fax. For example, this might mean a company such as the water board faxing out its bills, or the local grocery shop accepting fax orders. In fact, we are already seeing take away restaurants receiving orders by fax to catch the office lunch market. One line of thought was that once fax became more established for such transactional purposes, especially for home to company communication, home to home messaging might follow.

However, there were still reservations about the potential of this avenue to the home. Fax producers noted that apart from the cost incurred by companies who deal with customers via fax, there remained the critical mass problem, in that the current 'minuscule' installed base of home fax mitigated against many firms initiating such billing and ordering arrangements.

It has often been anticipated that new services making use of fax may emerge if fax were to be established for point to point messaging. In addition, such services have also been seen as a way of initially promoting home facsimile. For example, fax could used to provide all the information services currently offered by Prestel or Teletext. BT has already experi-mented with consumer fax orientated service: during the Whitbread yacht race, there were dedicated phone numbers that users could dial which would send back charts by fax showing the position of all the boats. This worked extremely well according to BT (albeit with most callers probably using the company fax). On the other hand, BT had also tried faxing greetings to Australia at Christmas — which attracted little interest. As with trans-actional services, the issue remains that service providers want an initially large enough installed base to make their innovations worthwhile.

A final route into the home is through 'facsimile telecasting' (or 'faxcast'). The idea here is to use some of the spare radio wave space to broadcast still images: text, charts, photos etc. Since 1972, the Japanese Ministry of Posts and Telecommunications has been investigating the possibilities of facsimile telecasting along with other interested parties includ-ing broadcast companies, TV manufacturers and national newspapers.[39] The concept is also being developed in the UK, although not at first with a home market in mind.[40]

As in the early history of facsimile, faxcast has been sometimes conceptualised as means to deliver 'radio newspapers.' But in addition to news items, this facility could also be used to print out background infor-mation about programmes, items such as recipes, more details of sports events etc. Such facilities could be part of a package of new television facilities such as being able to hold broadcast frames in storage. Possibly, such a package would fit in with the wider vision of TV as a home data terminal. While faxcast only involves one way electronic messaging and is not home to home, it might be a way of getting some of the core technology, some of the fax kit, into the home.

Whatever the route, one important factor effecting adoption is the ability to utilise existing installed public phone lines rather than having to lease a second telephone line dedicated to fax. The obstacle here has been that the switches which detect whether incoming calls are voice or fax massages were still costly (being made mainly by small firms). On the other hand, prices continued to fall, and had reached £75 by 1990. The other concerns related to the reliability of current switch technology. There was been some discussion about setting new standards for switches, but this lacked some impetus

given the fact that the fax producers do not themselves produce these devices. In the last three years, however, phone/fax switched have been incorporated into nearly all low-cost faxes, and the price of the combined unit has fallen below £300, which suggests some possibility that the fax will find a large home market.

Some observers take the view that other office equipment could also migrate to the home if prices fell low enough — that the general transition of products from the office to the home is not so problematic. Once the bandwagon is rolling, one interviewee even pointed to comparisons with the home computer: that people would feel left out of a communications rev-olution if they no longer possessed a fax. Running against this perspective is the view that the home is not like the office, and consequently clearer ben-efits specifically for home users need to be shown before a transfer from office equipment would take place.

Cable

Cable dates back to the 1930s when it was first used to relay radio broadcasts to homes where reception was poor. Later, from the 1950s, the same use was made in relation to TV transmissions. In the late 1960s, there had been the first talk, originally in the US, about cable as a technology being able to provide a range of new services under the concept of 'wired nation.'[41] The invention of fibre optics in the early 1970s further fuelled speculation about this potential.[42] However, this notion was never really the main theme discussed by the actual people involved in UK cable industry at the time.

This lack of interest was also reflected in the British Labour Government's thinking at that time. Its first concern regarding cable was about was effects of cable TV on existing broadcasting structures. To the extent that the administration was aware of other potential uses of broadband media, it argued that the Post Office was the appropriate organisation to lay any such infrastructure for non-TV data communication and services.

Following the appointment of a Minister for IT in 1981, ITAP, the Information Technology Advisory Panel, was set up to examine a number of areas. ITAP's report on cable in 1982 was important because it was the first attempt at British policy level to think about cable as a technology with communications potential rather than as a television service. ITAP sugg-ested that whole new industries providing innovative services could be built up round cable, with implications, for example, for the electronics industry which would support these developments.[43]

The ITAP report received a great deal of media attention, being supported by the Conservative Government enthusiasm. Kenneth Baker, the IT Minister, referred to a 'Third Communications Revolution.' However, although in the longer term 'interactive

services' on an 'electronic grid' were the most important aspect, in the short term broadcast material, particularly entertainment, was to be the trigger service to establish and finance cable development — with no need for Government investment.

The ITAP report and subsequent debates had mentioned services not dissimilar from the home automation list, (e.g. remote alarms), as well as e-mail. Some pundits described e-mail on cable as having a good growth potential[44] with the BT representatives citing the use of messaging on Prestel, Minitel and in other videotex experiments as favourable omens.[45] Other interactive services included home shopping, home banking and enhanced videotex services (since cable could transmit data more quickly than the phone).

The initial enthusiasm for cable soon wavered. Even in 1982, some financial analysts had been expressing doubts about revenue, referring to the fragile economics of cable. In some quarters there were doubts as to whether there would be sufficient demand for more TV channels, especially given the high standards of British broadcast TV relative to other countries and the implications of the emerging VCR market. A further blow was dealt in 1984, when the Government ended certain tax concessions relating to cable laying.

Originally eleven consortia applied for franchises. However, the process of laying cable and getting systems up and working proved to be much slower than expected, being compounded by both administrative and technical problems. In addition, the companies concerned soon discovered a lower level of interest than had been anticipated. From the early days, a number of initial applicants had pulled out of the field, including firms such as Rediffusion and Visionhire,[46] and with cable continuing to lose money a certain disenchantment set in. The medium, and with it any prospects for interactive services, was at that time cast by some as a 'failure.'

However, more recently there has been some renewal of optimism about cable in general and about interactive services in particular. One example, Westminster Cable, has drawn some attention, claiming to be the most sophisticated system using a fibre optic, star switched system. This franchise, with BT on its consortium, offers its own local viewdata, teleshopping, and a videodisc library.[47] Meanwhile, negotiations between several cable firms and Mercury have led to cable firms delivering phone connections into the home. Subsequently, Mercury Link has started to make arrangements to deliver teletext and its e-mail system via cable. And a further positive omen has been provided by the money which is now being spent on UK cable by American and Canadian cable firms — including ones with telecoms interest such as the (ex) Bell companies.[48]

Finally, the firm Cabletime, a manufacturer of broadband cable and switches, have even produced prototype system capable of carrying e-mail messages which consist of only

one or two lines of text. According to this arrangement, messages are sent directly to the memory of control boxes which would sit on top of the TV, and which can then display the message content on a small LCD. Nynex, the former New York ‘Baby bell,’ uses messaging to notify consumers of new services, or lateness in paying their bills. A ‘message’ light appears on the control box to alert the consumer, who then uses the remote control to bring up the message on the screen. So far, however, there is no sign of Nynex equipping their systems to permit inter-personal messaging, although the wiring could later be upgraded to allow interactive television as well. Thus, we can see scope for significant variations in the configuration of e-mail; these versions do not make use of electronic mailboxes in a computer system nor can consumers themselves send messages.

Obviously, one extra consideration in the case of cable franchises is that unlike the telecoms network, they are not nation-wide. Hence, contact using cable-borne e-mail will be limited to those reachable locally until gateways are developed between cable systems. The other side of the coin, as foreseen, for example, by Thamesmead Town Corporation, is that precisely because it is local, such e-mail capabilities may facilitate development of a sense of community, allowing community groups and residents to keep in contact, as well as providing a means of communication between the council and local inhabitants. Clearly, the cable route to e-mail may introduce a range of further issues and innovations beyond those relating to the existing e-mail services hosted on the telecoms system.

Conclusion

In many respects it is difficult to define the product space of electronic messaging. The term ‘messaging,’ subsumes a wide variety of different forms: social, work related and transactional; memos, letters, discussions and chats; one to one, one to several named people and one to many. This has given rise to a range of interrelated services from telecoms firms. What they do have in common, however, is the incorporation of text.

Secondly, while dedicated e-mail services have existed, messaging facilities have often been packaged with other services, sometimes in a way which makes them difficult to price separately. We also have the prospect of combining fax messaging and fax services with e-mail, or telecoms based messaging in general with messaging and other interactive services offered via cable.

Thirdly, these various forms of messaging have been achieved or remain achievable by very different routes and technological configurations. Although they might be considered comparable in terms of functionality, telecoms based e-mail and fax are more

different from each other than are the various products within the spaces of home automation and interactive multimedia.

There is a final sense in which this case study provides different insights from the others. That is, in some manifestations domestic messaging is already with us and has been for some years. We can thus see post-launch innovation and the role of feedback from actual users. Yet, messaging has never managed to fulfil predictions — at best, with Prestel, it remains a niche market for computer owners, especially for enthusiasts, and not the mass market which has repeatedly been forecast. On these grounds it is comparable to our other studies, a potentially significant domestic innovation which is still on, or perhaps near, the horizon.

Notes

1 Although they deliver text, we have also excluded pagers since this is only one way communication.

2 On the history of e-mail, see P. Vervest, *Innovation in Electronic Mail: Towards Open Information Networks: Perspectives on Innovation Policy*, Amsterdam: Elsevier Science Publishing Company, 1986,. pp. 43-44; on the origins of e-mail companies, Applied Telematics Group, *Integrated Message Systems: Developments and Opportunities*, Tunbridge Wells: Applied Telematics Group, 1984 (and for Arpanet specifically, p.42 and p.67); also, K. Silver, *Electronic Mail: The New Way to Communicate*, IOL, 1985, p. 323-30, and M. Banks, *Understanding Fax and Electronic Mail*, Carmel, Illinois: Howard Sims, 1990.

3 Keyline was eventually abandoned before its launch. The product space of electronic home shopping remains elusive, even after the launch of the QVC shopping channel in 1993 which has not proved as successful in Britain as in the US.

4 J. Horsley, 'UK attitudes towards EMS,' *Data Processing*, December 1982. Also in Europe at that time, far more research effort was being spent on teletext, especially in Germany.

5 J. Aumente, *New Electronic Pathways: Videotex, Teletext, and Online Databases*, London :Sage, 1987, pp. 62, 72 and 73.

6 H. Dixon, 'France Hooked on Minitel,' *Financial Times*, 13th December 1989, p.29.

7 Open University, 'Télétel: a case study of Videotex' in *Information Technology in the Home*, DT200, Block 2, Part A, An Introduction to Information Technology: Social and Technological Issues, Milton Keynes, 1988, p. 43.

8 H. Dixon, *op.cit.*

9 Open University, *op.cit.*, p.60. See also, J. Hedke, *Using Computer Bulletin Boards*, Portland, Oregon: MIS Books, 1990.

10 Open University, *op.cit.*, p.46.

11 As with many of the other US e-mail providers, ITT was finding this field not to be as lucrative as it first thought. J. Angel, 'How BT serves the President,' *The Guardian*, 18th September 1986.

12 E-mail is also sometimes referred to as CBMS - Computer-Based Messaging Systems.

13 On bulletin boards in general, see J. Schofield, 'Electrifying letters,' *The Guardian*, 16th August 1984.

14 Both systems have now been dwarfed by the Usenet groups on the Internet.

15 S. Fedida, and R. Malik, *The Videotext Revolution*, London: Associated Business Press, 1979, pp. 49-51. References to services making use of e-mail also appear in Fedida's earlier articles of 1975; see G. Thomas and L. Haddon, 'A promise postponed: development, non-development and potential development of electronic messaging in the UK,' paper presented at a meeting on Videotex in Comparative Perspective, Amsterdam, December 12-13 1990.

16 Interview with an Operations Manager. BT Managed Network Services, 20 December 1989.

17 *Ibid*.

18 *Ibid.*

19 *Ibid*.

20 For accounts of Micronet at the time when it was first set up, see A. Burkitt, 'Gathering Users into the Micronet,' *Informatics*, May 1983, pp. 56-7; C. Bourne, 'The Micronet Story,' *Sinclair User*, November 1984, pp. 65 and 70; M. Burton, 'Micronet 800: an electronic magazine?,' *Personal Computer World*, July 1983, pp. 184-7.

21 Telephone interview with an Operations Manager, BT Managed Network Services, 10 December 1991.

22 Interview with an Operations Manager. BT Managed Network Services, 20 December 1989.

23 *Ibid*.

24 *Ibid*.

25 *Ibid*.

26 *Ibid.*

27 C. Bourne, 'Shady social life exposed,' *Log On*, Issue 9, (Autumn 1989), p.9.

28 *Ibid.*

29 *Ibid.*

30 *Ibid.*

31 *Ibid.*

32 For a more detailed early history of fax, see especially D. Costigan, *Fax: The Principles and Practice of Facsimile Communication*, Philadelphia: Chilton Book Company, 1971, and C. Jones, *Facsimile*, New York: Murrey Hill Books Inc., 1949. Some further points were derived from C. Crawley, *From Telegraphy to Television: The Story of Electrical Communication*, London: Fredrick Warne & Co., 1931; E. Larsen, *Telecommunications: A History*, London: Frederick Muller Ltd., 1977; J. Keive, *Electrical Telegraph: A Social and Economic History*, Plymouth: Latimer Trend and Co.Ltd., 1973; and E. Eastwood, *Wireless Telegraphy*, London: Applied Science Publishers Ltd., 1974.

33 Applied Telematics Group, op.cit., p.18.

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Journal of the Electronics Industry, February 1989, pp. 33-36.

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37 P. Williams, 'Bye bye, boom,' *Electrical and Retail Trader*, 25 January 1990, pp. 10-12.

38 'Faxes still looking for a domestic market,' *Electrical and Retail Trader*, 10 May 1990, pp. 16-17.

39 'Facsimile telecasting: closer than you think,' *Journal of the Electronics Industry*, March 1987, pp. 56-57.

40 M. Day, 'Faxcast: tuning into satellite channel fax,' *Communicate*, April 1990, pp. 18 and 20.

41 For a history of international cable developments, see W. Dutton et al. eds., *Wired Cities: Shaping the Future of Communication*, London: Cassell, 1987.

42 T. Forester, 'The cable that snapped,' *New Society*, 24 January 1985, pp. 133-5.

43 See J. Blumer, 'Live and let live: the politics of cable,' in Dutton *op.cit*., p. 357.

44 'Potential for non entertainment services,' in *Cable '83*, On-Line Conferences Ltd., pp. 451-460.

45 R. Hooper, and E. Williams, 'User reactions to non-entertainment services,' *Ibid*., pp. 495-500.

46 Forester, *op.cit*., p. 133.

47 'Cable in the City,' *Home Entertainment Design*, Summer 1988, pp. 89-91.

48 *Screen Digest*, November 1988, p. 243; December 1988, p.266; January 1989, p.5.

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Chapter 5

Interactive compact disc-based multimedia

This chapter focuses on part of a product space we can define as *interactive multimedia*. The main product we examine is *CD-i* — Compact Disc-Interactive, the product of an alliance between Philips and Sony, co-developers of audio compact disc (CD-A) technology. But we also look at some competing products within the same space: principally *CDTV* (Commodore Dynamic Total Vision) and *VIS* (Video Information System), as well as a range of software products based on the coupling of CD-ROM (Compact Disc-Read Only Memory) players to PCs and Macintosh computers. Since our main concern in this book is with the home market, we devote more space to products such as CD-i, *VIS* and *CDTV* which are specifically targeted at the home.

A brief history of optical disc technology

CD-based multimedia technology derives from research on the application of the laser to the recording and retrieval of information from a spinning disc. In the recording process tiny pits are burned into the surface of the aluminium disc, which is then protected by a plastic skin. On playback, differences in the refraction of the laser between the pits and the shiny surface are detected and converted into a signal which can then be processed in different ways according to the information content.

The original research programme began in the late 1960s. At its central R&D laboratories in the Netherlands, Philips engineers identified three possible uses for this technology, and began parallel projects concerned with data storage, video and audio (see Figure 5.1). The first of these was concerned with mass data storage for professional applications, and has been marketed as the Megadoc system. The second was the Video Long Play project, which later became LaserVision and finally LaserDisc. At the same time a joint venture between MCA and IBM in the United States — Discovision — was working on exactly similar lines, and the final specification for LaserVision was jointly agreed between Philips and Discovision and launched onto the consumer market in Britain in 1982.[1] A double-sided 12 inch optical disc stored video and soundtrack in analogue form, and up to 72 minutes of video could be recorded on the disc.

The launch of LaserVision in Europe coincided with the surge in sales of videocassette recorders (VCRs), and it managed to achieve only a very limited penetration of the domestic market. However, the ability of the technology to permit random access to any point on the disc allowed for the coupling of the LaserVision player to a computer so that video sequences could be accessed interactively. In May 1985 Philips announced a shift towards professional markets and interactive applications for LaserVision.[2]

The research on the application of laser technology to audio recording followed a slightly different path, but again the parallel research being conducted by other

companies resulted in collaboration and the pooling of technology.[3] Whilst the formidable storage requirements of moving video pictures constrained LaserVision to analogue formats, recording audio alone permitted the signal to be stored digitally which allowed for much more accurate reproduction than was available from long playing records or audio cassettes. The disc could also be smaller (12 cm rather than 12 in) and still hold considerably more than an LP record (72 minutes rather than 50).[4]

While Philips were developing CD along a parallel path to LaserVision, Sony were busy adapting LaserVision technology for audio applications. By 1976 Sony had achieved an optical audio disc with 30 minutes playing time on each side; two years later they had stretched it to 2.5 hours per side.[5] Philips announced their own ‘compact disc’ format in July 1978[6] for launch in the early 1980s. The following year Philips and Sony signed a co-operation agreement, and submitted a common standard to the Japanese Digital Audio Disc Committee. At that time it was known that several other companies were developing digital disc technology, including RCA, Pioneer, AEG-Telefunken and JVC. Sony had strengths in digital-to-analogue conversion techniques, and had developed a method of error correction based on the Reed-Solomon code, and Philips had unrivalled expertise in laser technology. The final jointly agreed specifications (known as the ‘Red Book’) were released to licensees in 1982, and the first products reached the market in 1983.

CD-Audio, unlike LaserVision, achieved dramatic success in the consumer market, and became the fastest selling product in the history of consumer electronics. Philips had learned from its earlier failure with its own VCR technology (the V2000 system) that there were enormous risks in trying to push its own product against competing formats.[7] The decision to collaborate on the CD-Audio standard was the immediate consequence of this failure, and the need to collaborate to avoid this fate was to become almost an article of faith in shaping Philips’s strategy on the development of other products within the CD family, including CD-i.

Both Philips and Sony appreciated early on that CD could easily be applied to data storage, and they agreed a provisional standard for encoding data on compact discs — CD-Read Only Memory, or CD-ROM — in October 1983. This product was envisaged as a computer peripheral which would be developed principally by third party suppliers within the computer industry. The Philips/Sony standard (known as the ‘Yellow Book’) covered the physical aspects on recording on the disc and error correction; it did not extend to file structures and file handling, so that initially not all CD-ROM discs were compatible. A full standardisation was achieved by an *ad hoc* industry group in the USA (the High Sierra standard) and adopted by the International Standards Organisation as ISO 9660.

CD-ROM has developed as the most significant technology in the new industry of

optical publishing, and is widely used to distribute large databases, principally to professional users, but since 1992 the market has taken off for individual PC and Macintosh users. The 550 megabyte capacity of the disc permits some 100,000 pages of A4 text to be stored on a single disc, with any part of the text selectable within one second.[8] CD-ROM players have been marketed to existing personal computer users as an add-on, but in 1990 Sony launched a hand-held unit, the Data Discman, which uses a liquid crystal screen to display data retrieved from an 8 cm disc containing 300 megabytes of text, and later the Bookman using conventional 12 cm CD-ROM discs.

During 1984 Philips and Sony began independently to work on another derivative of CD which would combine audio, text and graphics. The two companies joined forces to develop a draft standard at the beginning of 1985, and later that year Matsushita joined in to work on the development of integrated circuits.[9] The first public announcement of the new product — Compact Disc-Interactive — was made at the first industry conference convened in March 1986 to promote CD-ROM in the United States. A provisional standard (the 'Green Book') was issued in May, followed by a full functional specification of the system in March 1987. CD-i discs and prototypes were demonstrated to licensees in June 1987, and the first working samples of players were distributed to developers in Autumn 1988.

The technical characteristics of CD-i

CD-i is an interactive multi-media technology; that is, it combines sound and pictures (including still and moving pictures and of course text), and allows the user to control what information is retrieved from the disc and how it is displayed. Unlike television or film, which are linear media in that they unfold in a fixed sequence predetermined by the producer or author, interactive technologies allows consumers themselves to determine many aspects of how the material is 'read', although within the limits built in by the software designers. As such CD-i resembles the newspaper which can be read in the order and manner desired by the consumer. In this section we will briefly outline in technical terms how this interactivity is achieved, noting that technical choices are often constrained by marketing goals, and vice versa.

CD-i is an all-digital medium; that is, unlike LaserVision, all of the audio and visual material is encoded on the disc as digital information. This aspect of CD-i allows for world-wide compatibility of software, since the visual information is independent of any of the existing television transmission standards, and permits the CD-i disc to be perceived as fully compatible in the same way that the LP record, the compact audio cassette and the CD-Audio disc are, but importantly *not* computer disks or programs.

The initial specification of CD-i allowed for very limited full-screen full-motion video

images because of its prodigious storage requirements — even 550 megabytes would allow only for five minutes of full-screen video. The original designers of CD-i coped with this limitation by restricting motion video to a window which occupied only a fraction of the screen,[10] but subsequently, as we shall see below, sophisticated techniques for compressing video pictures have been developed. The decision not to release CD-i in its original form, but to wait for the perfection of the video compression technology, was prompted by the announcement by RCA in 1987 of a potential rival to CD-i which combined CD-ROM with video compression. *Digital Video Interactive* (DVI) comprised two chip sets which could be used together with an IBM personal computer and CD-ROM player to display up to 72 minutes of video which had been compressed (using a mainframe computer) onto a standard CD disc.

CD-i is a derivative of earlier CD-Audio and CD-ROM formats, and some of the technical parameters of those formats have been carried forward into CD-i. CD-DA specified how the audio information was to be stored on the disc, as well as basic parameters such as disc size, linear speed of rotation of the disc, the laser read-out mechanism, and the detailed format by which data can be recorded on the disc. CD-ROM extends these basic CD system specifications by dividing the basic data stream into discrete units called sectors, each of which contains 2352 bytes of information. Any sector can be specified as one of two modes: a mode with less user data but more error correction, which is essential for accurate storage of text and numerical data; and a mode for audio and video information with less error correction permitting faster transfer of data from the disc. The CD-ROM specification permits audio and data to be stored on the same disc which opens up limited multimedia (text and sound) applications. A further enhancement of the CD-ROM specification, announced in 1988 as CD-ROM XA (for extended architecture) specifies how graphics can be coded and interleaved, thus permitting the development of applications within the PC world of multi-media applications originally designed for the standalone CD-i system.[11]

From a technical point of view the CD-i specifications are based on CD-ROM, but the conception of the product derives from CD-Audio, that is, as a world-standardised product. As with CD-Audio, any CD-i disc can be played on any CD-i player. Given that part of the original product design was that CD-i players would plug into domestic television receivers (and thus not require the purchase of a specific monitor), video information must be handled in a way which is independent of the three television standards (NTSC, PAL and SECAM). Such compatibility — a basic principle of CD-i design — required that CD-i be specified as a combination of hardware and system software. Besides this, the standard (‘Green Book’) allows for the mixing of CD-DA and CD-i tracks on CD-i discs, and requires that all CD-i systems are able to play CD-DA discs.

There were three further basic principles — or as Philips engineers put it, logical

requirements — of the system. The first of these was self-contain-ment: all that is required to play a CD-i disc is contained in a single unit which plugs into a TV set; software designers must not assume the presence of other peripherals such as a floppy disk drive — all the software to run the application must be contained on the disc itself. Secondly, CD-i should connect to and build on existing mass produced consumer electronics products. CD-i players use the basic drive mechanism of the CD-Audio player, and clearly this requirement is intended to permit rapid progress to high volume manufacture for the consumer market. Finally, the system should be made as 'future proof' as possible, allowing for future enhance-ments of the system whilst always maintaining compatibility with existing systems.

In the CD-i specification audio, graphics and text can all be recorded on the disc in different ways to suit different applications. Each has different space requirements, so that, for example, a combination of moving video and high quality sound will make heavy demands on disc space. If the quality of the audio is reduced, or video confined to a portion of the screen, there is more space for graphics, and so on. Software designers make their choice within the constraints summarised in Table 5.1.

CD-i as a software-dependent technology

The brief technical overview given above demonstrates how fundamental choices in the design of the system follow from the basic principles adopted by Philips and Sony at the outset, which in turn were the sediment of experience of both successful (CD-Audio) and unsuccessful (V2000 VCR) product innovation. CD-i shares with CD-Audio the characteristics of a software-dependent product; that is, the hardware is the delivery mechanism for the application contained in the software. CD-Audio had the advantage of an existing software base (in the form of the back catalogues of the music companies) which could quickly be converted to the new format once the publishers were persuaded of the market potential of the product. Besides that, Philips owns PolyGram, one of the largest music companies in the world, so that at least one company was already converted. The experience with other similar products such as record and tape players also suggested that as the market developed the proportion of total sales accounted for by software rose constantly.

Thus it was clear at the outset that the production of software would be a key determinant of the success of the product. The problem faced by Philips was that no-one had any experience of writing interactive multimedia software.[12] Some of the relevant skills could be found in the computer software industry, but other equally important skills involved in handling video and audio were more likely to be found in the broadcasting industry. CD-ROM's orientation as a form of electronic text publishing had in the beginning been clearly towards major book publishers and database providers, for

whom CD-ROM's advantages could relatively easily be compared to their existing activities. Such publishers were among the actors likely to be interested in multimedia publishing, but to what extent were they likely to emerge as first movers? As we shall see later on, the problem of securing software development was the most critical part of the introduction of CD-i and entailed the creation of a series of joint ventures in which, in effect, the risks of entering this new field were underwritten by PolyGram and Philips. The uniqueness of CD-i lies not in its software-dependence, but in the specific character of the software itself, and the complexity (and cost) of the tasks involved in producing it. The temptation for any innovator in such circumstances is to exploit the proprietary nature of the technology, and seek to maximise the rent obtainable from the value added to the technology in the software production process. It is perhaps not surprising that Philips at first succumbed to that temptation by seeking to retain proprietary control over the authoring tools necessary to develop CD-i titles. At first it was envisaged that Philips itself would establish the studios to which software producers would come with their programme material, so that in effect Philips would be a partner in every piece of CD-i software.[13] Later it was recognised that this would have a crippling effect on the growth of the software industry, and that more was to be gained by trying to maximise the number of players by lowering the barriers to entry.[14] Thus in 1990 Philips introduced a range of hardware options and developers' tools to encourage small software houses to enter the industry.

Software-dependence has other aspects besides the problem of ensuring software availability when the hardware is launched. The 'product' is the combination of hardware and software, but in this case the identity of the product was thought to be more strongly influenced by the nature of the launch software. Because of the greater availability of the relevant expertise, Philips had decided to locate almost all of the early software development in the United States, where Philips and PolyGram had formed American Interactive Media (AIM), based in Los Angeles. AIM had itself negotiated joint ventures with a wide range of developers in order to produce the thirty or so software titles which Philips had estimated to be the minimum necessary for a successful launch. Having done this, the marketing strategy for positioning the product was in effect constrained by what would be available, although efforts had been made to produce a range of titles that encompassed 'serious' material such as encyclopaedias as well as games. This aspect of software-dependence will be discussed more fully below.

The process of designing CD-i as a product

It is perhaps misleading to speak of CD-i as a 'product' at all. It is better understood as an enabling technology, which permits the development of a number of different product configurations according to intended applications and markets. The most important feature, to which we will return again and again, is hardware-software interdependence,

but also significant is the distinction between consumer and professional applications, which leads to separate but overlapping requirements.[15] Moreover, the definition of the ‘product space’, and the more precise parameters for potential products within that space, is a continuous process which does not come to an end at the launch of the product.

Like many electronics companies in the late 1970s, Philips was faced with the prospect of a convergence between the previously discrete technologies of computing, telecommunications and consumer electronics. Computers were increasingly being linked through telecoms networks, telecommunications switches were becoming giant computers, more and more consumer products were embodying microprocessor control. Moreover the advent of the home computer at the end of the 1970s, and its emergence as a mass market product in the early 1980s, suggested a range of possibilities (i.e. a ‘product space’) for new information technology products targeted at the home.[16]

The most common designation for this product space is ‘interactive multimedia’, or, increasingly, just ‘multimedia’ — that is, the simultaneous and complementary use of audio, textual and visual material which can be stored and then retrieved interactively by the user. Different companies have settled on different generic descriptions for this product space, like ‘hypermedia’ which Apple prefers, or the more cumbersome ‘AVCC’ (audio, video, computers and communication) which is favoured by Matsushita.[17]

Philips’s organisational response was to set up a new corporate group, Home Interactive Systems, intended to develop new products based on the opportunities offered by technological convergence, outside the existing product division structure (which had separate divisions for audio, video and data systems). The project to develop interactive compact disc was located within HIS, and was initially conceived of as only one element of a home system.[18] The component parts of the system would allow for a number of different functions, and consumers would be able to build up their own network. A senior executive in HIS described in 1985 what the consumer could expect to have in the near future next to the stereo system and the video:

> You will get a telephone modem, I think, which will allow you to communicate with other computers outside your home, coupled to your telephone and possibly with a built-in screen. Then I think you will add a home computer, but I am not sure you would recognise it as a home computer. And then you would get a Compact Disc Drive which would play both normal audio and interactive CD-ROM discs. That would be the basic system. You could expand it with a printer and a video camera, then you wouldn’t need to buy any films any more, but could print pictures in colour and black and white on the printer... I think that your first purchase

> should be a high quality Compact Disc Player. Later, you would add the computer, connected to the telephone.[19]

Thus at this stage interactive CD (or as it was then known, interactive CD-ROM) was one building block in a home system,[20] and the progression to interactive CD was seen as through an add-on for a CD-Audio player. At this stage it was not yet clear just how successful a consumer electronics product CD-Audio was turning out to be, so that the 'image' of the product was still defined in terms of it being a computer peripheral. In late 1985 it was anticipated that the first interactive CD product to be marketed would be a player with a digital input/output connector so that it could be hooked up to a computer and player. Later on, there would be 'a kind of viewer with sound, where the user simply slips in a CD-ROM disc and gets pictures on the screen. All the microelectronics will be built in. Operation will be very simple.'[21] Interestingly, at that time it was expected that the first interactive CD products would reach the market in 1986; in reality it has taken five years from that time to design a hardware-software combination ready to launch.

It was, however, recognised that the 'computer' element would need to be disguised as a result of early experience of consumers with home computers. An American HIS group was formed at Knoxville in January 1984, and as its first task it analysed the home computer market in the US. It used a clinical psychologist to conduct in-depth interviews with owners and potential owners of home computers:

> We found that typical consumers were totally dissatisfied with home computers. Many people who bought home computers had done so because they thought it would help with their children's education and within a year they found out that these children were only playing video games on the computer. It was not at all playing a role in their education.[22]

This research had two effects on HIS strategy. First it helped to convince the design team at Eindhoven that interactive CD products would sell only on the demonstrable appeal of the software; and second, that the home computer boom had left an unwelcome legacy of incompatibility and com-plexity in the minds of consumers.

The need to dissociate interactive CD from the home computer quickly became a fundamental design principle. In the early discussions it was recognised that the large majority of consumers found computers difficult to use, and part of this lay in the use of a keyboard for input. However, since the 1970s, and especially since VCRs became widespread, hand-held remote control devices had become increasingly popular. The design solution to user friendliness lay in a combination of familiar hardware (the remote control) and software which took advantage of the sophisticated graphical user interfaces

such as that developed for the Macintosh computer. To reinforce the identification with familiar consumer electronics products, and further distance the product from the computer, the screen icons often chosen in software programmes are the now standardised symbols from tape and video recorders: > for play, >> for fast forward, << for fast back, [] for stop, and so on.

A further development of the user-machine interface arose directly from the requirements of software development. One of the first joint venture agreements signed by American Interactive Media was with Children's Tele-vision Workshop, the producers of the phenomenally successful children's television show *Sesame Street*. The objective was to produce a title which carried the dual education/entertainment nature of the television show into an interactive format. Pre-school children would be able to learn letters and numbers by interacting with the same characters that they knew from the screen. But CTW thought that the target group of very young children would find the hand-held prototype remote control that Philips had designed in Eindhoven difficult to use. As a condition of the contract CTW insisted that Philips finance the $200,000 development costs of an entirely new trackerball remote control the size of a briefcase which children could have on the floor in front of them, or operate from their laps.[23]

Professional hardware product development

Philips's initial strategic assessment of its technology was wedded to the idea of a proprietary asset which it would control — albeit by necessity in partnership with Sony — in order to maximise the expected income. The dominant theme was monopoly, where control of a smaller market was preferable to a minor share of a large market, even if in absolute terms the latter was greater than the former. Even after the idea of monopolising all software production was abandoned, this mode of thinking dominated the decision to develop authoring tools only within the chosen operating system of CD-i. In this way it was expected that software developers would have to come to Philips for a complete hardware and development software package. Thus the first professional CD-i players, which were released to potential developers in 1988 in order that they could evaluate the technology, were complete development platforms, rather than designed as peripherals for existing computer equipment (see below).

The announcement of a rival interactive multi-media technology, DVI (Digital Video Interactive) by RCA in 1987 forced a reconsideration, but not at first an abandonment, of this strategy. DVI comprised a chip-set which would handle the decompression of previously compressed video images, so that 72 minutes full-motion full-screen video could be stored on a compact disc. It was designed to work within the IBM PC environment, so that potential software developers would be able to make use of their existing equipment.[24] This context led Philips to the view that it was unlikely to mount a serious challenge to CD-i, which was at that time firmly targeted at the mass consumer

market. But when Intel, a major semi-conductor manufacturer and supplier to IBM, bought the rights to DVI in 1988, Philips began to take the potential challenge more seriously, especially as Intel invited developers to consider mass market applications for DVI. As late as mid-1989 Philips was continuing to insist that it had no plans to market a CD-i board[25] so that software developers working within the Macintosh or IBM environments could develop CD-i and other multimedia applications whilst using the same installed base of computer equipment. Product management within Philips remained wedded to the idea that CD-ROM XA would provide the bridge between the PC world and CD-i. As we shall see, however, by mid-1990 the position had changed completely and Philips were offering CD-i tools designed to match whatever equipment developers were already using.

The decision to abandon exclusivity was market-led. In order to provide a wide range of software, applications developers had to be encouraged to switch to the new format. The longer the lead time between concept and launch (which as we have seen was lengthening all the time), then the more real was the prospect of competing technologies, and the less credible a monopolistic strategy was likely to be. So from the initial idea of marketing professional *players*, but being the only source of software development, Philips found itself entering the market as a producer and seller of hardware and software for applications development.

The first actual hardware product sold to potential developers was a three-box player, designed in Eindhoven but manufactured by Kyocera in Japan, which began to be available from September 1989. The CDI-180 player worked with the CDI-181 Multi Media Controller to play CD-i discs, and could be hooked up to the CDI-182 Expansion Module, which in addition to adding floppy disc storage, provided interfaces to conventional computer equipment such as printers, hard discs, modems and MIDI equipment.[26] The CD-180 was not sold by itself, but as part of a ‘starter pack’ to include some development software. The rationale for doing that again reflects Philips’s proprietary and paternalistic inclinations:

> If you want to get into CD-i you are going to have to buy the starter pack because we don’t want people just buying the CD-i hardware and a disc, demonstrating it to someone and saying ‘isn’t it a jolly clever thing?’ and then putting it away again. We want them to get involved in actually thinking about the issues when you start to use a multimedia product.[27]

This product was aimed at users who wanted to evaluate CD-i, both through playing back existing software, and/or use the supplied software to emulate a CD-i disc. The package, launched in February 1990 in the United States, and from mid-1990 in Europe, comprised the 180 player/controller/interfaces together with a monitor, a 100 Mbyte hard disc, and basic authoring software which allowed the user to put together graphics,

text and audio using a sequence editor. The price also included limited studio services for processing images and audio, as well as one place on two training courses for designers and programmers. For users who were already experienced at software development on PC systems, one of the erstwhile ‘taboo’ products — the PC Bridge — enabled video, audio and text files to be created within the PC operating system MS-DOS, and then converted to CD-i format.

The second level of entry into the development of CD-i software was what Philips refers to as a ‘personal publishing system’ which allowed for the development of complete CD-i titles which could then be pressed onto a disc. The initial product launch included two versions — one for the PC and one for the Macintosh — and further versions were announced for Sony and UNIX workstations.[28] The PC version was a complete system costing £50,000 to include a dual processor computer and 766 Mbyte hard disc; the Macintosh version was an upgrade kit for £10,000 which comprised an emulator card and software and required standard audio and video capture cards to provide the same functionality as the PC version. It was envisaged that these products would sell to large corporations deciding to adopt CD-i for in-house applications, such as training or parts information, but who did not themselves intend to become CD-i publishers to a wider market.

For those who did intend to become CD-i publishers, Philips designed a third level of entry which was intended to be run as a network of workstations, so that the various tasks of audio and video processing could be done simultaneously by different people connected to the system. (In Levels 1 and 2 only one person can use the equipment at any time). The heart of this was a Sun SPARC workstation, which could be linked via an Ethernet to additional Sun workstations, or to PCs or Macintoshes used for video and audio processing.

The hardware players which were intended for sale to institutional users, as opposed to software developers, took some time to define, since there continued to be uncertainty as to the likely uses for CD-i. Part of the appeal of CD-i for institutions, however, was expected to be that it would be a mass market product rather than a product for professional users only. In this respect CD-i is the equivalent of VHS rather than U-Matic in terms of video recorders, and compared to current interactive videodisc technology, it would be cheap — £1,000 rather than £3,000. The only technical difference between the consumer machine and the base-level desktop professional machine would be that the latter is likely to have a floppy disc drive and more interfaces. Above the base case, the principles rather than the details had been formulated. These relied on a threefold distinction drawn from types of applications:[29]

1 Open applications, where basic players would be used for generic software. An example might be for basic computer training, where a company buys, say, ‘Learning Lotus 1-2-3’ on CD-i for interactive learning by users.

2 Semi-open applications, involving educational or training tasks where communication would be required between a master console and the student or trainee. Additional software on floppy disk would allow for monitoring of individual use through the allocation of personal codes, and the user might have a smart card for storage and retrieval of data and access control. The players could be linked through an RS232 interface, or a network such as Ethernet.

3 Closed applications might involve company-specific training using a unique configuration of products. Software would be developed for in-house use rather than outside markets, and each disc could be coded so that it would not be playable on other players.

Applications of the third kind were expected to be developed by ‘systems integrators’ who handle different kinds of technologies (interactive video, CD-i, DVI or others) and provide a ‘turnkey’ solution in consultation with a client.

These products signified ‘a radical shift away from the big centralist studio concept’ towards a design philosophy for professional products which is ‘more in tune with the real developers’ community.’[30] It was the culmination of the evolving awareness that CD-i had to be sold first to software developers if there was to be any hope of it reaching a mass market, and is a clear example of how marketing considerations impacted on product design during the pre-launch phase.

Consumer hardware product development

Product design issues specific to the consumer version of the CD-i player can be conveniently discussed under the headings of *technical issues* — those relating to the configuration of the hardware for domestic applications; *user interface issues* — relating to how interactivity is put into effect; and *physical design issues* — the appearance and ‘image’ of the consumer product.

The overriding technical issue concerns the significance of incorporating full-frame full-motion video (FMV) into the consumer product. As we have seen, the original technical specifications of the CD-i standard allowed for a limited amount of FMV (5 minutes), but in practice applications developers tended to incorporate part-screen FMV in their prototypes to permit disc space to be conserved for stills and computer generated moving graphics (as well as text). The announcement of the DVI chipset in 1987 presented a direct challenge to the initial assumptions, and initiated a crash programme by engineers in Philips (and Matsushita — see below) to develop a video compression technology to match DVI. The perceived necessity of meeting the challenge from DVI was sufficiently overriding to set back the proposed launch date of the product by over three years.[31] The compression algorithm was fixed in April 1989, with production samples of the chips due in Autumn 1990 and full production was due to start in early 1991.[32]

The development team at Eindhoven considered the possibility of launching CD-i without FMV, and then offering an upgrade to consumers when the FMV chips were ready. This option was rejected for the consumer version, but as we have seen remained part of the programme for professional models. The fundamental design principle of full compatibility would have been compromised if the upgrade path had been followed, since discs incorporating FMV would not have been fully playable on early machines. The simplicity of the message to consumers (all discs are playable on all players) would have been lost. But this consideration was later overruled by the pressing need to market the product, once Commodore launched its own rival CDTV product. Philips decided to delay the final design for the FMV chip until the international standards body's (ISO's) Moving Pictures Experts Group (MPEG) adopted a standard for video compression technology. CD-i was launched in the UK in the autumn of 1991 at £699, with players containing a slot in which a promised £130 FMV upgrade could be fitted.

Much more uncertainty, however, surrounded the relationship between CD-Audio players and CD-i players. The basic laser assembly and the motor drives are common to the two, and it would be feasible to offer CD-i as an attachment to CD-Audio players. Indeed the inclusion of digital input/output sockets on top-of-range CD-Audio players makes enhancement a possibility for at least part of the existing stock of CD-Audio players in consumers' homes. This option was strongly supported by A.D. Little in their report to Philips UK, and they suggested that such CD-Audio players be marketed with a 'CD-i ready' label — a route that was in fact chosen for certain CD-Audio discs (see below). Philips's own product plans for CD-i players did not (as of March 1990) include provision for such a product, but managers argued that they could quickly be developed if a demand was foreseen.

Another issue which divided the design team concerns the relationship between CD-i and other optical disc technologies, and whether a single product might be offered which is capable of playing a range of discs. The CD-i specifications ensure that all CD-i

players will play CD-Audio discs, but not LaserVision videodiscs. In 1988 Philips 're-launched' their LaserVision consumer technology as 'CD-Video' offering 12 cm discs containing CD digital sound together with up to 5 minutes of (analogue) video aimed especially at the pop music market. The CD-V range also included 8 inch and 12 inch discs, and Philips and other companies produced combination players to accept all sizes of CD-Video discs. Whilst CD-V failed to give the boost that Philips had hope for to its flagging LaserVision sales in Europe,[33] sales of combination players in Japan and the United States, especially by Pioneer, have been strong. Recognising that the attempt to link a failed consumer product (LaserVision) to a successful one (CD-Audio) had itself failed, in 1990 Philips announced that the name CD-V would be dropped in favour of Pioneer's term 'LaserDisc'. Perhaps not wanting to add to this confusion, Philips had no plans to market a combination CD-i/LaserDisc player at the time of the A.D. Little report,[34] but only a few months later a combination player was planned for introduction to the consumer market as its second CD-i product a few months after the launch.[35]

A further technical issue in CD-i product design was a clear illustration of the conflicting pressures from technical and marketing staff. The intention was to market the CD-i player for use in conjunction with the domestic television set, rather than as a complete unit with its own monitor. In addition to allowing for its introduction at the target price of $1,000, this design embodied the image of the product as a way of enhancing television, rather than as a new kind of home computer. The technical issue concerned how the connection to the television was to be made. Video recorders and satellite tuners use the aerial socket (RF), as do most home computers. Picture quality is improved if video signals can be connected directly to the TV circuitry without RF modulation, but this requires both sets of apparatus to be equipped with special sockets. Recently televisions have been sold with SCART sockets, but it was estimated that in 1990 only 10 per cent of televisions in British homes had SCART connectors.[36] CD-i engineers wanted to maximise picture quality; CD-i marketers recognised that for consumers to have to buy a new TV set to play CD-i would constitute a barrier to adoption. In 1990 the issue was still unresolved, but launch plans suggested that CD-i players sold in Europe would *not* have an RF connector. Had this happened, 'take it home and plug it in' would not have been possible for the majority of British consumers in the crucial first few years. In the end, the marketers prevailed, and launch models did have RF connectors.

The hardware aspects of the design of the user interface were much less problematic, especially as the keyboard was ruled out almost from the beginning as a means of 'interacting' with CD-i. The technical constraint is that the user must have some means of moving a pointer across the TV screen and registering a choice. Graphical user interfaces on modern com-puters solve the same design problem through the use of a mouse or trackerball, and early discussions of CD-i included these as possible user

interfaces. But the PC-user works at a desk close to the screen, where adjacent flat surfaces allow for a mouse or trackerball to be used. The first CD-i users would be using a television set, often in the living room, where there is no convenient surface for a mouse to work on. As we have seen, the infra-red remote control was chosen early on as the interface to consumer CD-i players. The design of the remote control was the same size as those used for TVs and VCRs, but included a small thumb-operated joystick which can be used to move the pointer on the screen; buttons are used to 'click' on the desired object. Once this decision was made, it remained only to settle such issues as size and complexity — as we have seen even the simplest version was considered by software developers as too complex (and small) for operation by young children. Design mock-ups available in 1990 suggested a relatively uncluttered model with, in addition to the joystick, buttons for stop, pause, play, fast forward and fast reverse. The launch model's remote control was almost unchanged from these mock-ups.

A further user interface issue concerns the design of system software which controls what the viewers sees when they turn on the machine. The professional version, like a PC, reports on the configuration of the system and its status. The prototype consumer version 'booted up' to a menu which asks whether the user wants to play a CD-i disc, a CD-Audio disc, or perform some other function. The third alternative is argued to be necessary to cope with future enhancements — for example using the CD-i system as a controller for other equipment such as the VCR, the hi-fi system, the satellite tuner etc. It is not difficult to envisage the CD-i player becoming the graphical interface for coping with currently frustrating tasks such as setting the time-shift controls on a VCR. It is clear that the design of the appearance of the user interface will quickly evolve, but at the beginning it can be used as a way of identifying the technology through the use of the CD-i logo on the opening screen, and of course different manufacturers may wish to differentiate their products from each other by designing the opening screen in different ways. Given that there is little room for product differentiation through technological diversity within such a tightly defined standard as CD-i, the issue of differentiation through different designs of the user interface becomes critical for hardware manufacturers.

The evolving paradigm for the physical design of the consumer player has reflected the developing consensus of the 'image' of the product — principally that it should be distanced from the home computer.[37] In the early 1980s, when the first target was hobbyists, home computers were sold as much on the basis of their technical specifications as on their potential applications. But experience with marketing, and the shakeout amongst manufacturers, firmly identified the importance of the software dimension, and in particular the importance of games as the key application.[38] The lessons for CD-i were apparent: hide the technology, and stress ease of use, compatibility and the content of the software. But further: stress the broad educational and entertainment angle, and avoid the identification of the product with games playing.[39] In part this reflected a view within Philips that games playing was not a

‘serious’ application for the technology, and in very early brainstorming sessions at Eindhoven the seriousness of purpose was emphasised by the shocked reaction to a suggestion that interactive soft pornography might help to open up the market for CD-i in the way that it had for VCRs.[40]

The success of CD-Audio strengthened the view that CD-i should be designed to appear as a machine for home entertainment, like the CD-Audio player and the VCR, but not like the computer. Product mock-ups prepared by Philips’s industrial design centre were variations on the theme of a matt black case the size of a VCR, in keeping with the prevailing (in 1990) dominant design paradigm for audio-visual products including hi-fi. The front of the casing was to be kept as simple as possible with an LED panel and the minimum possible number of buttons. The dominant theme for the consumer is familiarity — a ‘natural’ extension of the consumer electronics products already present in every home. This ‘matt black’ orthodoxy seemed to be as strong for the consumer product as the grey (IBM colour) casing was for the professional model. The former was designed to be distanced from the image of a computer; the latter was designed to symbolise it.

The concept of the ‘professional image’ also extends to the means by which the disc is inserted into the player. Philips’s market research suggests that the shiny CD sold in a ‘jewel case’ is a very important part of the appeal of the format to consumers, and helps to justify the price differential between CDs and vinyl discs or tapes. As with CD-Audio, the consumer will put the disc in a tray on the machine. But the professional version uses a ‘caddy’ which transfers the disc to the machine without the disc being touched by the user. This is reckoned to protect the disc, since institutional users will not handle the discs with the same care as domestic users, but it also helps justify charging such users some 30 per cent more than mass market customers for the same product in a different case.[41]

What is interesting about these design decisions is that they have developed through market experience of what are considered to be paradigm products, rather than through direct consumer research. It was the *market* success of the infra-red remote control, rather than ergonomic research with consumers, that led to the consensus on the user interface. Likewise it was the *market* success of CD-Audio and the mixed fortunes of the home computer which was the justification for settling on the black box design. Future product design, or, rather, the evolution of product design as market experience with early CD-i products becomes available, is more likely to reflect market research amongst early purchasers. Tentative product plans from both Philips and Sony include portable versions with built-in screens,[42] and the early focus on the living room is likely to give way to distinct products for different locations within the house (the study, the bedroom, the kitchen) as the marketing strategy becomes more refined and feeds back more directly into the design process (i.e. through actual sales rather than projected sales).

Sony had demonstrated in 1990 a prototype CD-i Walkman-type product with a 4 inch colour LCD screen, and was already marketing a miniature CD-ROM player (the Data Discman, later the 'Electronic Book') which uses 8 cm CD-ROM discs.

Software design

The cardinal principle that the fate of CD-i as a consumer product will lie in the quality and mass appeal of the software is deeply embedded in the CD-i community. Evidence from the experience of other software-dependent products appears to confirm this, and reinforces the need for first-mover hardware manufacturers to become involved in software design and development.[43] Market data from Japan indicate that the value of software sales outstrips hardware sales threefold for VCRs, sixfold for Nintendo computer games, and by ratios of 25:1 for CD-Audio and 30:1 for LaserDisc.[44] Thus the issue for consumer electronics manufacturers is not only that software development is necessary to open up the market for hardware, but that a presence in the software market is a pre-requisite for obtaining a satisfactory return on investment from the new technology.

CD-i is posing far more complex problems for innovators than did the VCR or CD-Audio. In those cases there was a readily available supply of software in the form of feature films and sound recordings which could easily be transferred to the new medium. By its nature multimedia involves bringing together a range of skills locked into different professional communities: programming and computer graphics skills from the computer software industry; editorial and presentational skills from the book and magazine publishing industry; and audio-visual skills from the film and television industry. The key task is the integration of these different processes, and the key constraint is the reluctance of any individual actor to shoulder the risk of first entry into a new technology and a new market. The dilemma is neatly summed up by the president of a small software house in California:

> Our initial concern two years ago was getting involved in CD-i at all. We were those guys that you hear about. We were involved with RCA with a needle in a groove disc, remember that? We were involved with the Philips interactive player and did the first interactive cell-animated adventure. We did the first live-action interactive movie. We did the first LaserDisc kiosk that was supposed to explain high technology. And what we have for all those efforts is four very attractive plaques on the left wall in the office.[45]

Philips decided early on that it would have to subsidise those risks, and play a catalytic role in fostering software development. It formed three joint ventures with its subsidiary

PolyGram: in the United States, Europe and Japan. *American Interactive Media* (later Philips Interactive Media America, or PIMA) was formed in 1985 with its headquarters in the heart of the US movie industry, Los Angeles, and by mid-1986 was in discussion with 50 partners who had expressed an interest in producing CD-i software.[46] The bulk of the 30 or so titles which were available at the consumer launch originated through AIM. *European Interactive Media* was based in London, but did not play a direct part in software production, and was never much more than a letterhead from an office within the Philips organisation.[47] In 1991 Philips reorganised its operating structure world-wide for CD-i as in Figure 5.2.

The design issues which arise in software production for the mass market can be illustrated in the production of one of the first CD-i discs — *Caesar's World of Gambling* — which was produced by a partnership between AIM and CD-i Systems Inc. of Los Angeles. The idea for the disc originated in the popularity of casino parties in the United States, where people meet in each others' homes to play roulette, blackjack and other games for small stakes.[48] The disc is designed to simulate the experience of gambling at one of the premier casinos in Las Vegas, and contains a mixture of actual photographs of Caesar's Palace, together with computer animations of roulette, craps, blackjack and five different slot machines. The game rules and betting are identical to casino practice and the overall aim is to repro-duce the actual experience of gambling.

Visual appearance is assumed to be crucial to the success of the disc, and much of the work was done by doctoral students in graphic design at the University of California. Photographic colour slides were scanned, and then enhanced by computer manipulation in order to sharpen or soften edges, create textures and so on. One of the major limitations is the small size of the television screen: to make text readable at 10 feet takes up a considerable portion of the screen, which reduces the area available for visual effects. The interior of the casino cannot be shown in full, neither can the screen accommodate at one time all of the details of a particular game. The design solution was to make the screen a window on a larger visual plane, so that users can scroll as if they were using a camera to photograph the scene. The eventual solution was the product of successive trials.

The age range of expected users was 8 to 80, which meant accomm-odating poor reading skills as well as older players with limited experience of interactive video games. To overcome the former problem 'the disc literally talks to the player.'[49] The user forces a response by positioning a cursor over a 'hot spot' and clicking the action button. If unsure, the user can click another button, and an oral description is given of what would happen if the action button were pressed. Ease of use is maximised if the hot spots are large, but accuracy of the visual representation is maximised if the hot spots are small. To emphasise once more the distancing of CD-i from computer conventions, there is to be no printed documentation; instead the disc contains a tutorial mode, but thereafter

help messages have to be requested by the player.

Such design rules and conventions have been produced through a lengthy trial and error process, as have the specific technical skills to implement them. As the producer of the project emphasises:

> At this time in the development of CD-i the production of a title is an extremely complex technical and artistic project. The most important task for a producer is to create and nourish a team of talented people. Art direction, interactive design, title engineering and subject specialists must work together throughout the title production.[50]

To enable CD-i to develop as a mass market product, the technical aspect of these skills has to be routinised and made accessible to as wide a community as possible. The Philips IMS Authoring Group based in Los Angeles was given the task of designing programming tools to accomplish this. It announced three levels of production software. *CDiAuthor* consisted of conversion routines which enables skilled 'C' programmers on different hardware platforms easily to transfer video and audio files to the CD-i format. *CDiNavigator* was designed for non-technical title producers, and helps them to organise the planning of projects and the integration of different skills. Finally, *CDiDesigner* was a tool for building applications which automates some aspects of the production process, containing, for example, standardised templates which designers can use as ready-made solutions to common problems.

Philips's role has thus evolved into a first mover in hardware, in software and in the production of software tools for the development of software. It has played the major part in the construction of the infrastructure of the emergent industry. But the recruitment of producers and the technical process of design are only part of the process; an important part — perhaps *the* important part — is the content of the software, i.e. what kinds of applications are likely to prove commercially successful. Here the consensus of the industry seems to be that market research is of limited use, and market experience with precursors to the technology is a better guide.

Marketing strategy for CD-i

The linchpins of the marketing strategy for CD-i have evolved from the bitter experience of the VCR format battles of the 1980s, and the success of the strategy for CD-Audio. The prime lesson was the need to establish, before any product launch, a world standard for the technology backed by the major consumer electronics producers in Japan in order to pre-empt alternative multimedia formats. As we have seen, delays in finalising the technology, and in particular the agreement of standards for the incorporation of FMV,

have opened up opportunities for competitive challenges which are discussed below. The second requirement, which has also contributed to delays, was for an extensive launch catalogue of software. Finally falling hardware prices are expected to take the product well beyond the early adopters into the mass consumer market with a target of at least 20 per cent of homes possessing CD-i.

Yet as a radically innovative technology, CD-i poses very different kinds of marketing problems to earlier audio-visual technologies. The unique feature — *interactivity* — has to be explained to the consumer in an easily understandable way in terms of familiar concepts, yet the extra benefits which for the consumer will comprise the incentive to purchase have to be stressed.[51] In the pre-marketing phase this led to some clear divergences of approach. For example, the Japanese approach focused on simplicity:

> Difficult explanations do not have a place in consumer electronics. The multimedia we envision is simple: 'A picture book with sound' or 'Sound with pictures'.[52]

AIM's own attempt at encapsulating the concept of CD-i stressed the blend of entertainment and instruction, but the result was something of a 'difficult explanation':

> A superior form of self enhancement in an entertaining manner for the entire family.[53]

Neither concept embraces the notion of interactivity, that is, the possibility that the technology offers for the user to determine how the material is 'read', although the first attempt at an advertising slogan for CD-i does: 'Television with a mind of its own — yours.' This emphasis on television as the reference technology, rather than computers or enhanced CD-Audio, reflects the central position of television as a leisure activity. But positioning CD-i in the minds of consumers is only the last stage in marketing CD-i; before that it has to be sold to hardware and software producers and to retailers.

Creating a professional community for CD-i proved to be a lengthy and difficult process. AIM's strategy was to interest large publishing and media corporations in the US through the joint venture approach in the expectation that smaller producers would be willing to risk their own capital when they saw that the industry majors were committed to CD-i. In the United States early participants included Time-Life, Rand McNally, Grolier, the Smith-sonian Institution, ABC Television and Children's Television Workshop (producers of Sesame Street). In Europe Philips had lengthy negotiations with Maxwell Communications, Bertelsmann, Hachette, Virgin, amongst others, but had some difficulties initially in securing publicised commitments.[54] A year before the Maxwell empire crashed, Ian Maxwell cited a number of factors as inhibiting the participation of publishers:

> ... the costs of authoring systems and designing and developing CD-i products remain high today. These factors, together with the still unresolved CD-i/DVI standards debate, are perhaps the major inhibitors to the rapid development and take-off of the CD-i market from the publishers' point of view. These difficulties will have to be overcome before large numbers of software producers emerge across all publishing fields. Whilst global communications groups like ours are in a position to invest in developing multimedia products, smaller more traditional publishers are not.[55]

It is difficult to find reliable estimates of the cost of software production, and hence of the barriers to participation by small firms.[56] Early involvement by small producers in the US and UK was largely funded by Philips. Estimates made in 1990 of the cost of producing one PolyGram title, *Bodyworks*, were for £220,000 made up of £60,000 for design, £30,000 for production and £130,000 for authoring.[57] Even the conversion of an existing US title for the European market cost around £80,000. The total investment of Philips/PolyGram in producing software specifically for the UK launch was estimated at over £3 million.[58]

The issue is not only one of resources, however; it is also access to *content*, where major publishers and media corporations own material which is capable of being re-presented in CD-i format as interactive entertainment, interactive movies, interactive encyclopaedias and so on. For smaller companies the question of copyright looms large, since established legal notions of 'film', 'book', 'play' and so on will inevitably be subject to expensive challenge until new legal definitions are agreed which match the new technology.

What potential participants do seem to agree on is the importance of 'trigger' applications; that is, ones which successfully exploit both the technology and a market niche in a way which triggers hardware sales and breaks the perennial 'chicken and egg' problem of software-dependent technologies. Much-cited examples of this include the Visicalc spreadsheet (and its imitators) which helped to establish the concept of personal computing, and desk-top publishing which was responsible for the popularity of Apple's Macintosh computer. In the early days at Philips the interactive encyclopaedia was seen as a potential trigger product, probably because it fitted well with Philips's 'high-minded' view of the technology, and the fact that the total hardware and software costs of supplying an encyclopaedia in electronic form should be less than the cost of buying a multi-volume encyclopaedia in printed form. But experience suggests that trigger products are unpredictable, and the advice to Philips from its consultants was that it is unlikely that there will be a single trigger.[59] Both the 'triggers' cited above come from the professional context where the software solution met a specific business problem,

and it is difficult to think of a comparable case in the domestic market unless parallels can be drawn with the stimulus to the growth of the television industry in Britain in 1953 given by the Coronation, and to the VCR industry by the Royal Wedding in 1981. We should perhaps expect an interactive encyclopaedia of the royal family, which after recent marital scandals could include phone calls and *paparazzi* photos!

Producers recognise that the interactive element of CD-i is what differentiates it from existing audio-visual technology, but that in order to be understood by consumers it has to be *experienced*. The evidence that consumers will demand new interactive products such as CD-i, when the opportunity to experience it becomes available to them, came initially from a reading of past experience, especially with the remote control of television and CD-Audio. Later experience with prototypes and demonstration machines was claimed by Philips to have confirmed these expectations. Younger consumers were argued to have cut their teeth on interactive technologies such as computer games, but with a $1,000 product the marketing effort has at least initially to be directed towards their parents. Such factors account for the stress on *demonstration* in order to put across the specific characteristics of the technology. In Japan nine of the principal consumer electronics manufacturers collaborated in mounting a demonstration of CD-i at the International Garden and Greenery exhibition which opened on 1st April 1990 and attracted 8.5 million visitors in its first ten weeks.[60] AIM and North American Philips announced plans for extensive consumer demonstrations of CD-i at shopping malls, where separate areas for children and their parents would afford hands-on experience for consumers. Philips IMS in the UK has similar plans for exhibitions of CD-i in shopping centres and other public places.

The current thinking about marketing CD-i and the identification of critical marketing issues can be seen in the marketing plans of Philips IMS (UK) and AIM.[61]

Philips IMS

The core of the UK approach was to prepare the ground for the mass market launch by concentrating initially on specialist interest groups and developing professional applications which could act as demonstration projects for con-sumers. The assumption was that the early adopters of CD-i would be middle class and middle-aged, but PIMS accept that market research will be necessary to identify target groups more closely.[62] According to PIMS ‘The theme that characterises CD-i’s main properties is one of "SELF-ENHANCEMENT".’ This implies individual motivation to improve in a variety of fields.’ The tie-up between self-enhancement and the presumed middle class profile of the early adopter is common to the US and UK, but was not then backed up by market research.

Mail shots were planned to high-earning credit card holders (e.g. Gold Card and

American Express holders) and to the members of wine societies, golf clubs, and music societies. For demonstration applications PIMS was seeking to introduce CD-i into what they call ‘Browsing/Captive Audience Environments’ such as airport lounges or stately homes. PIMS recognised that to some extent they were constrained by the software catalogue available, which comprised mainly American titles re-worked to suit European tastes.[63] One of the titles developed by PolyGram was *Wines of France*, which could be targeted to wine societies; another was *Rules of Golf* in conjunction with the Royal and Ancient at St. Andrews, which together with *Palm Springs Open* developed by AIM/ABC Sports, was publicised to golf clubs. The possibilities for extending the effort towards other groups such as gardening clubs, anglers and so on was seen to depend on suitable software being developed.

PIMS identified CD-i as a ‘slow burn’ market, in which achieving early return on investment in software would be extremely difficult.[64] Underlying this belief was the view that educating the ordinary consumer about the benefits of CD-i would take time, which meant that filling the shelves of multiple electrical retailers such as Dixons and Comet with CD-i players and advertising its existence on television would not be enough. Innovative products were argued to require innovative marketing strategies, which in an interesting throwback to the encyclopaedia salesman, might involve teams of door-to-door representatives demonstrating CD-i in the home. The PIMS UK marketing plan proposed that at first the distribution of CD-i should be confined to 100 or so specialist retailers who would be required to stock CD-i software as well as hardware, and offer adequate facilities for hands-on demonstrations. Only at a later stage would distribution be widened to the multiple retailers and television advertising be launched. The actual launch followed this plan quite closely.

PIMS was insistent that the marketing strategy could only be fine-tuned on the basis of market research in order to identify how the product should be ‘positioned’ in the home. This meant physical position (living room, bedroom etc.) as well as conceptual position (extension of the television, source of entertainment etc.). The research brief covered both hardware and software, including behavioural research on interactivity as well as more conventional marketing questions, including the social class and age profile of early adopters, use of other consumer electronics products, and pricing strategies.

This long-term market building approach was, however, based on the assumption that, at least in the early days, CD-i will have the field largely to itself. The announcement by Commodore in May 1990 that it was to launch a rival multimedia product for the home, CDTV, in September 1990 seems to have caught Philips by surprise, and was the first sign of a coming format battle along the lines of that fought out between Sony, JVC and Philips in the early 1980s. The advent of competition forced Philips to take its product into the High Street multiples earlier than it had hoped, and although it had seen off CDTV by 1993, a clutch of other competitors were in the market-place — including VIS

and CD-ROM peripherals for home PCs — and others — such as 3DO's *Opera* — were in the pipeline.

American interactive media

AIM was at least a year ahead of Philips IMS in defining its marketing strategy for CD-i, and by 1990 had already conducted an extensive programme of consumer focus group trials and retailer presentations. From this research AIM became convinced that changes in consumer habits and accompanying social trends have prepared a fertile ground for CD-i. The loss of audience of the major TV network channels in the US, and particularly the rapid growth within the video market of special interest videos (such as those featuring fitness, gardening and sports) was seen as part of a trend towards more variegated markets. In turn these were seen to reflect changes in family life, where there is less emphasis on the collective viewing of television programmes, and more on individual-centred activities, or what is known in US marketing jargon as 'cocooning'. Furthermore, a growing concern with educational standards and self-improvement was judged to fuel the acceptance of appropriate technological solutions. Marketers cited parental reactions to 'mindless' computer games, or the resistance to 'Nintendomania', as an indication that the time was ripe for more serious applications of computer technology in the home.

Focus group research amongst early adopters of new consumer tech-nologies was claimed to be strongly positive, with few put off by the $1,000 selling price or the $20 - $40 range for CD-i titles. AIM insisted that in their tests consumers enthusiastically embraced interactivity, and found the tech-nology easy to use. The theoretical notion of 'edutainment' — that is, the blending of educational objectives and entertainment within the same programme which was among the very first conceptions of CD-i — was claimed to have produced a positive response in the trials.[65] The research did confirm the importance of involving major publishers as co-producers: consumers were impressed by the involvement of major 'brands' such as Time-Life and ABC.

These and other findings were built into AIM's basic marketing assumptions. The role of traditional advertising was seen as limited to supporting the primary strategy of generating credibility through public relations and demonstration events in high profile venues such as Disney's EPCOT Center, hotels, museums and golf clubs. Crucial to this is again the notion of hands-on experience which cannot be communicated by advertising. Much was argued to depend on the initial positioning of CD-i as a consumer product and the need to avoid creating its image as an advanced form of video game.[66] This could be done by giving it a family orientation, stressing that the diversity of available applications means that the various family members can pursue their individual interests through the same technology. The strategy also involved stressing that CD-i is an evolutionary and not a revolutionary technology, i.e. a logical step forward from the

well known technologies of television and CD-Audio. Consistent with the earliest design principles, there was no place in this strategy for selling CD-i as a home computer, or for stressing the futuristic elements of the technology.

Advertising enters the marketing picture only ‘at one minute to midnight,’[67] although an advertising agency was involved in discussions leading up to the decision to place CD-i as an enhanced form of television. Ironically one of the ideas considered and then discarded was to rename CD-i as CDTV — the initials chosen by Commodore for their competing product. A Philips marketing manager described the role of the agency in the following way:

> There’s the over-the-beer chat with the agency director, when you say ‘look, this is happening and we’d appreciate some ideas’ and he goes away and he puts somebody on it and they come back with a few storyboards, and say ‘is this what you want, is this the image you want to portray?’ And then it stops, we don’t go any further, and the internal team carry on talking between themselves, and come up with mission statements, messages that we want to leave with the target group. Who are they, what do they do, what do we at Philips want to say to them, and how can we do that? There are simple AIDA rules — awareness, interest, desire, action — and then we go back to the agency and say this is what we’ve done, this is what our research shows ... and now come up with a more defined idea. That might be the first time at which it becomes formal, and they charge us for it.[68]

AIM contracted its US agency to carry out the programme of developing awareness with key groups such as retailers and the media, from which ideas for the launch advertising programme were generated. By the time CD-i was launched in Europe the experience of the US advertising programme was available for evaluation, which confirmed the central theme of CD-i as an extension of the television and portrayed television owners *without* CD-i as disadvantaged — using only half of the potential of their televisions.

Timing

One of the most difficult decisions in preparing a new product for market introduction is how to time announcements to different groups. In the computer and consumer electronics industries, products are often announced during the development stage when it is known that rival products are being developed so as to pre-empt competition and persuade software developers and retailers, and sometimes consumers, to delay making any commitment to the rival. But this strategy runs the risk of premature disclosures leading to continual delays — and the sobriquet ‘vapourware’ — which makes

acceptance of the technology more difficult when it does arise. Philips's record in this respect is not a good one: CD-Video was announced before the product engineering phase was complete, which led to the postponement of the launch by a year and much adverse comment in the press. Philips's announcement of CD-i at the first Microsoft CD-ROM conference in 1986, with a market launch predicted for 1987 led to accusations of 'spoiling' the emergent CD-ROM industry. Some commentators saw RCA's demonstration of DVI at the following year's CD-ROM conference as 'Microsoft's revenge'. The effect of these tactics was to dissuade many software developers from making investments in either technology until a clearer picture of the likely success of each was available. Instead of preparing the market through the steady development of a community of interest, successive postponements in the timetable bred cynicism. Philips's stance was in sharp contrast to that of its partner Sony, which even long after the Philips launch had disclosed almost nothing about its own plans for CD-i.

By 1988 the seriousness of the mismanagement of the development process was recognised by senior management within Philips. Soon after his appointment in 1987 as head of Philips's Consumer Electronics division, Jan Timmer ordered a thorough review of return on investment of all Philips's consumer electronics activities. The HIS (Home Interactive Systems) group, apart from its responsibilities for CD-i, had a general brief to adapt products from the professional sector for the domestic market. It had chosen the ill-fated MSX standard for its home computer, and developed a personal word processor which failed to make any impact against Amstrad's highly success-ful PCW machines. At this stage Philips considered abandoning CD-i, and it seems likely that this might have happened had not Philips's Japanese partners continued to express confidence in the product. Instead Timmer chose to reorganise HIS completely, renaming it Philips IMS and completely changing its personnel. By March 1990 not one member of the original CD-i managerial team had survived the reorganisation. Timmer succeeded in persuading Philips's main board to step up its investment in CD-i at a time when the company as a whole was looking for areas of retrenchment.

The most significant appointment was that of Gaston Bastiaens, who moved from his post as Plant Manager of the Philips CD factory at Hasselt, Belgium, to become Director of Philips IMS. One of his first decisions was to stop making any further announcements about CD-i until a firm timetable for product development could be drawn up,[69] and this embargo lasted almost two years until the new range of professional hardware and development software tools was announced at the Microsoft CD-ROM conference in San Francisco in February 1990. A major conference attracting 450 fee-paying delegates was held in London in June 1990, which confirmed the extent of interest in the new technology amongst the audio-visual and computer software industries. Equally significantly Bastiaens reversed the earlier policy of spurning potential professional markets for CD-i, and signed a major contract with Renault to develop a CD-i system for staff training in Renault dealers around the world.

The launch catalogue

The initial impact of CD-i on the market owed much to the range and quality of available software. Table 5.2 classifies the range of CD-i software intended to be available at the launch[70] according to four categories: children's, games, education and special interest, and entertainment.

From this table we can see that despite the desire to distance CD-i from the image of a computer games machine, games software would comprise a significant part of the launch catalogue. Some of these titles, such as *Dark Castle*, were conversions from existing computer games, and in such cases promotional material would stress the enhancements that CD-i affords, especially hi-fi sound and later full-screen moving video. What is particularly interesting was the relatively small number of general entertainment titles, given Philips's intention to stress the commonality between CD-i and existing consumer electronics entertainment products. None of the titles announced at the launch was specifically aimed at women, although children and men are clearly targeted, reflecting the marketers' views about the likely characteristics of early adopters. At launch there was no sign of the interactive movie in which the producer offers a choice of storylines according to the user's preference, but several such titles are under development, including some by a Philips subsidiary in collaboration with *Twin Peaks* director David Lynch. This comparative sloth may be due to the relatively late inclusion of full-motion video into CD-i, but even granted this, the movie industry was conspicuous by its absence among those reported in 1990 to be doing development work on CD-i.[71]

PIMS UK recognised the absence of movie software, especially given the pivotal role that movies have played in the expansion of markets for VCR and satellite television. UK managers argued for the inclusion of linear digital movies (i.e. non-interactive films) which could be available on CD-i discs and playable through CD-i players as an alternative to viewing such films on VCR or LaserDisc.[72] There was, however, resistance to this idea in Eindhoven, on the grounds that it would undermine the aim of identifying CD-i as *enhanced* television in which interactivity is the principal means of enhancement. Philips's product development team did, however, design a prototype carousel CD-i player which would seamlessly join two or three 72-minute CD-i discs to accommodate cinema films.

Alongside the launch of CD-i titles, consumers would begin to see CD-Audio discs appearing in record shops with the label 'CD-i Ready' on them. Philips's subsidiary PolyGram began to develop a range of music software which contains text and graphics on the disc inaccessible until played on a CD-i player. The sleeve notes would include an explanation of what CD-i is, and how such information as the song lyrics, a discography

of the group, biographies of the musicians and so on can be explored through CD-i.

Standards

In consumer electronics technologies, standards have tended to emerge after a process of competition in the marketplace between rival products, with the market leader emerging as the *de facto* standards setter. Philips was very successful in the 1960s in promoting its 'Compact Cassette' technology for domestic tape recorders against the challenge of the American 8-track cartridge, but despite an early lead in VCR technology its attempt to promote its V2000 system as a standard was an expensive failure, almost leading to the withdrawal of Philips from consumer electronics in 1983. Its decision to co-operate with Sony to finalise the development of the Compact Disc was a direct result of this failure, and the alliance between the two firms successfully prevented any rival optical disc recording technology from finding an application in the home. Instead of trying to monopolise CD production, Philips and Sony followed the route that JVC had followed with its VHS videocassette technology by making licences freely available (at a price) and encouraging smaller manufacturers to market their own-label CD players bought in from other firms. It was *not* the route that Sony chose with its Betamax VCR system, and Sony, like Philips, were losers in that battle.

The mechanism by which Philips and Sony have 'policed' the standard has been to insist that licensees stick to the letter of the technical specifications of the system, as laid down for CD-Audio in the 'Red Book', CD-ROM in the 'Yellow Book' and CD-i in the 'Green Book.'[73] For CD-Audio and CD-i the essential principle is that every disc should be playable on every player everywhere in the world.[74] CD-ROM was seen by Philips as peripheral to its main business of consumer electronics, and its Yellow Book specification did not extend to file structures and file handling, which means that CD-ROM discs will not play on any CD-ROM player, although two incompatible *de facto* standards have emerged around the Multimedia PC (MPC) and Macintosh computers.[75]

The International Standards Organisation's (ISO) Motion Pictures Experts Group (MPEG) was expected to rule on standards in late 1990,[76] with both DVI and CD-i under consideration, but in the end standards were not finalised until November 1992 — after the US and UK launches of CD-i. Broadband telecommunications also offers the potential for multimedia applications, and the CCITT are also expected to adopt standards in this area. The MPEG-1 standard adopted in the CD-i FMV chipset is broadly similar to the approach adopted by Philips, and is less costly to implement in silicon than DVI, which could spell the end for DVI.

The CD-i licence binds licensees to observe the Green Book standards, which ensure

compatibility by laying down exactly how data is handled on the disc. Extra refinements can be added by software developers as long as they observe ‘base case’ rules. One important condition of the CD-i licence is the stipulation that developers must not mix DVI and CD-i on the same disc. Apart from legal action for breach of contract, Philips owns the patents on Adaptive Delta Pulse Code Modulation (ADPCM) — the technique used to record digital sound on Compact Discs. This proprietary control prevented Sony from realising its plan to market long-playing 3 inch CDs for its Walkman range which would have departed from the Red Book specifications. Another means of enforcing the CD-i Green Book standard lies in the proprietary ICs for full-motion video being developed by Philips, Matsushita and Motorola. At least initially Motorola will be the sole source of supply for FMV chips, and any intended departure from the rules could be pre-empted by the withholding of these chips — a far quicker and cheaper means of enforcement than legal action.

The major difficulty for CD-i standards lies not in the hardware, but in the software. Here the issue is not technical standards but quality control, and the potential damage that could be done to the market launch by inferior quality software.[77] Philips and its partners lack any means for policing software standards, or for conveying ‘best practice’ in software develop-ment:

> The difficult thing is once you’ve got that knowledge [of good software design] is actually to impart it to the designers of CD-i software, and say actually red buttons that click on and off don’t work, or saying ‘click on a button’ after everything that you’ve done drives people mad eventually. The mechanism for feeding that out is something we’ve got to do. That’s the real difficulty, getting the knowledge that has been put together in one group and disseminating it out to all the other groups. That’s one of the disadvantages of having a pluralist authoring policy — you can’t guarantee to get it to everybody.[78]

One of these mechanisms is the provision of training courses to CD-i developers, and in the UK these began in mid-1990 at the new Philips IMS centre in Dorking. But such courses would only reach a fraction of software developers, and ultimately Philips were forced to rely on the development of a collective interest in standards through, for example, the promotion of a CD-i Developers’ Association, which was mooted by Philips IMS Director Gaston Bastiaens at the first CD-i conference.[79] From the point of view of the user, acceptance of CD-i may be speeded by the development of a consistent interface such as that successfully pioneered by Apple for Macintosh personal computers, which has been followed by Microsoft for the PC market with Windows. From the point of view of the software producer, however, wanting to differentiate his or her product from rival offerings, the user interface may be an important focus for competition.

Inter-firm collaboration

As we have seen, collaboration between consumer electronics manufacturers was a crucial part of the development of CD-i technology. In addition to the pivotal agreement between Philips and Sony on hardware standards, Philips had entered into a string of joint ventures in Europe, the United States and Japan (see Figure 5.3) in order to develop hardware and software tools and facilitate software production.

The scale of these joint ventures illustrates the extent to which CD-i as a multimedia technology involves areas of technical expertise (or in David Teece's terminology discussed in Chapter 1, 'complementary assets') which even a major multinational electronics company does not possess in-house. In both Japan and the United States Philips teamed up with major print and electronic data publishers, Toppan and R.R. Donnelly respectively. The development of the prototype professional player was carried out by the joint venture with Kyocera, and the participation of Yamaha and the major record company Pony-Canyon (which has since forged an alliance with Virgin) in Japan Interactive Media was intended to compensate for the relative weakness of PolyGram in Japan compared to its position in Europe and the US. Studer AG is a major supplier of professional studio equipment — including CD-Audio players for broadcasting companies — and the joint venture was formed to produce hardware for CD-i studios. Sun Microsystems were chosen as a partner for the development of multimedia workstations because of their technological strength in high-speed microprocessor applications. Philips-Dupont Optical took over from Philips the management of its CD pressing facilities in Europe and the US. Finally the joint venture with Control Data Corporation gave Philips access to expertise in systems software.

The issue of inter-firm collaboration has become even more critical as delays occurred in the development timetable, and Philips needed to establish a credible programme for introducing the technology in the face of the competitive threat from DVI. After Intel acquired the rights to DVI from RCA's parent company, General Electric, the prospect of collaboration between Intel, Microsoft and IBM became a major threat, especially after Intel announced its intention to enter the consumer market. It became important to extend the development coalition beyond the Philips/Sony axis, since the recruitment of additional Green Book licensees, whilst welcome, did not represent a major commitment of resources. In 1989 Matsushita announced its participation in with Philips in developing FMV for CD-i, and Motorola — the manufacturer of the 68000 microprocessor at the heart of the CD-i system — was chosen to make the VLSI chips for FMV. The addition of these major partners, especially Matsushita — the world's largest consumer electronics manufacturer — was claimed by Philips as a major strategic advantage in its competition with rival technologies. Apart from NEC and

Hitachi, all the other major Japanese consumer electronics companies were known to have developed CD-i players. At one time it seemed that the two outsiders to the CD-i 'family' would be persuaded to join the rival Intel-IBM-Microsoft grouping, but the latter never materialised, and Microsoft joined Tandy in developing VIS as a rival home interactive multimedia technology. As discussed below, by 1993 it was clear that the major competition for Philips would come from the cable TV and telecoms industries, who have quickly grasped the potential of MPEG-1 compression for interactive entertainment.

Thus we can see in the case of CD-i a good example of the tendency for competition in new technology products to take the form of a struggle between inter-firm groups, rather than between single companies, as was the case with colour television and VCR. Coalition building of this kind is partly dictated by market considerations (i.e. market power is critical in persuading retail chains to accept the product), but is also reinforced by the inability of major companies to put together the technological resources by themselves. This of course varies from company to company: Philips feared NEC and Hitachi in particular because of their strength in related technologies. NEC is the major player in the personal computer market in Japan, and is also well-placed in semiconductors, telecommunications and office systems. Hitachi has formidable expertise in VLSI design and semiconductor manufacture in addition to its market strength in consumer electronics. Neither company would need quite as extensive coalition of joint ventures and alliances as Philips has forged in order to mount a strong challenge to CD-i in the marketplace. Moreover as has been shown in recent years by the phenomenal growth (and sudden shrinkage) of Amstrad, major companies can be out-flanked by smaller competitors who can respond more quickly to changes in the market and, by Philips's standards, achieve astonishingly short lead-times between new product ideas and their launch.[80]

Joint ventures in software production fostered by AIM have, for the most part, been limited to the production of a single title. In the UK, however, a joint venture, SPIN UK Ltd, was formed between Philips and Shell UK to develop CD-i software specifically for the educational and training markets. Shell has had considerable experience of producing videocassettes for use in schools and LaserDisc-based software for in-house applications. Initially SPIN's major task was to try to persuade the Department of Education and Science to fund a programme to equip secondary schools with CD-i players, and to this end have produced demonstration software for National Curriculum syllabuses in Science and Maths — the two subjects where teacher shortages were having the greatest impact. If successful SPIN had plans to market versions of the software to parents for use at home.[81]

Looser forms of inter-firm collaboration have been employed to try to establish CD-i authoring studios in Europe. New Media is a small company which had been involved in

Interactive Videodisc production, mainly for training applications. In 1986 when CD-i was first announced New Media had been working with Grolier on a version of its encyclopaedia as a follow-up to the Philips/BBC Domesday project. New Media produced the first demonstration CD-i disc in Europe, based on its work with Grolier, and the National Curriculum disc for SPIN UK. Despite its pioneering collaborative efforts as the only CD-i studio in the UK outside of Philips IMS, however, the relationship with Philips proved difficult and the company complained (in private) of a lack of consultation by Philips over the latter's intentions for CD-i.[82] Perhaps such problems are inevitable in the clash of cultures between small pioneering ventures such as New Media and large corporate bureaucracies like Philips.

But distrust is not confined to small companies. Despite the division of labour within the CD-i coalition which gave Philips responsibility for the refinement of the compression technology for full-motion video, Gaston Bastiaens was surprised to discover on a visit to Japan that Matsushita had been working on FMV compression in parallel to Philips' efforts. When asked why this work was taking place, the Japanese replied 'Insurance, Mr Bastiaens, insurance.'[83] In a striking example of intra-firm technology competition in parallel even to this parallel effort, the Matsushita subsidiary JVC has developed independently its own compression algorithm for FMV, which is a re-run of the VHS story when both JVC and Matsushita developed independently different video technologies from which the most promising version (JVC's VHS system) was selected for commercialisation. For the Japanese firms collaboration seems to be not a substitute for market competition; rather, calculations of competitive advantage are constantly used to evaluate the benefits of collaboration.

Collaboration with Kodak: PhotoCD

Philips joined with Kodak in the final stages of the development of a standard for recording and retrieving very high quality photographic images on compact disc — aimed at both the professional and consumer markets. PhotoCD uses digital compression to store an image in 6 Mbytes, which gives approximately 100 images on a 12 cm disc. The images need not be recorded on the disc in a single session; the consumer can pay the retail photo store to add additional pictures over several sessions until the disc is full. The discs can then be played back on dedicated PhotoCD players (manufactured for Kodak by Philips) or on CD-i players, or on a PC attached to a CD-ROM drive using specific PhotoCD retrieval software.[84] For professional markets — including publishing, medical and photofinishers — different software products are available for use on high speed computer workstations.

Some software developers have announced plans for commercial products which mix Photo-CD images together with text and sound, thus bringing PhotoCD software very close to some CD-i applications. For some educat-ional and reference material Photo-

CD offers a very cheap means of develop-ing software, and the agreement between Philips and Kodak to keep the standards compatible means that such products can be sold to the owners of the growing number of CD-i players. Whether large numbers of consumers will buy dedicated Photo-CD players, which although they can play CD-Audio discs, cannot handle CD-i discs, remains to be seen.

The standardisation of the two systems is likely to be of considerable benefit to both Kodak and Philips in establishing CD-i/PhotoCD amongst the raft of competing products and technologies described in a later section of this chapter. The Philips/Kodak collaboration contrasts strongly with the awkward relationship between Philips and Sony, where Sony has gone its own way in sponsoring a rival multimedia format, MMCD (see below), which will not work with CD-i.

Philips in a quasi-governmental role as infrastructure provider

The theory of public goods ascribes to government the task of creating conditions which allows markets to flourish which no single market participant will provide. Whether it is constructing physical shelter for commodity markets, infrastructure such as roads and communications, or the legal basis for market exchange, the role of governments has historically been intertwined with the extension of markets. In many cases governments are involved directly in creating public markets for new technologies, especially in the defence sector. In consumer technologies governments have tended to reject any claims of strategic importance made by producers, and for the most part have declined to undertake either a defensive role when industries have been threatened, or a promotional role to reduce the cost or the risk of investment in new technology. Not all governments have followed this path; in France the state owns the biggest consumer electronics manufacturer Thomson, in Europe second only to Philips in size. Moreover, strategic arguments have recently been accepted by the EC and European govern-ments in the case of High Definition Television, where large amounts of governments' money were used to develop the HD-MAC technology.[85]

In the case of CD-i, Philips has acted as a quasi-governmental actor in terms of creating the infrastructural preconditions for the development of the market. It has subsidised firms to develop software, and created quasi-public resources in the form of studio facilities for smaller firms. The motive for such action has been essentially the same as the justification for governments to provide public goods, i.e. actual or potential market failure. Governments have not perceived CD-i as a strategic technology, despite the recognition that it offers some potential for training applications within the public sector.

Government support is, however, identified as a crucial precondition of the penetration of CD-i into the most significant public sector market, education. In Britain the DES

played an important part in the diffusion of microcomputer technology into schools, and for a time offered subsidies to schools wanting to acquire the BBC's interactive LaserVision Domesday package. Its experience with the latter, however, seems to account for the cautious reception given to suggestions from Philips that it launch a support programme for CD-i. Despite promises that the Domesday disc would be only the first of a range of educational software for the LaserVision system, only one other title appeared, and at £3,000 the hardware costs were too high for schools to afford. Although CD-i promises to be considerably less expensive, the DES has continued to fund development work for a Mathematics project using LaserVision rather than CD-i technology. It has, however made the concession to the CD-i lobby that the mastering of the discs will be done in such a way as to minimise the cost of later conversion to CD-i.

At the European level there has been interest but no firm commitment to CD-i. EC officials have endorsed the potential of interactive multimedia for educational and training purposes, and have recognised that its multi-language capacity could help in the very long term process of harmonising educational and training qualifications. But up to 1993 the work being done under the Communities educational programmes like DELTA has been preparatory, and the EC had not added a public dimension to Philips's quasi-governmental programme of infrastructure building, although it did fund some CD-i projects under the ESPRIT programme. A PolyGram senior vice president expressed the hopes of the CD-i coalition in the following terms:

> ...we want to encourage a lot of independent companies to make titles at various levels of investment, from low-level low entry cost to high-level high entry cost investment across a wide range. The method of doing so I think will partly be financed from PolyGram, partly be financed from Philips, and I hope, especially on this side of the Atlantic, with a large measure of support from the various EEC bodies to whom all of us pay a large part of our taxes, and who gather the money together in some funds in Brussels, and we want our share to help support what is after all one would have thought the most suitable programming and technology initiatives for bringing together Europe in the 1990s.[86]

In addition to development subsidies, Philips also continued to press the EC Commission for protection of its hardware manufacturing against competition from lower-cost producing countries in the Far East. In 1983 Philips successfully persuaded the EC to levy a special tariff of 19 per cent on CD-Audio players, reducing to the 'standard' rate (of 14 per cent) for consumer electronics products over three years. Such a tariff might also encourage the Japanese CD-i producers to manufacture their players at their European plants, but as with CD-Audio they are likely to do this in any case if and when the mass market for CD-i emerges.

Linking institutional and consumer markets

Although targeted principally at consumer markets, there are important linkages between these and institutional markets which could help to diffuse the technology. In theory there may be a symbiotic relationship between the two, where penetration in the professional sector diffuses knowledge and skills which in turn help provide the preconditions for consumer acceptance, as happened especially in the United States with the PC. In the case of a product from a single supplier, the co-ordination of diffusion in the two markets is a problem for the firm's management, and much depends on the internal organisation of the firm. The case study of CD-i reveals how organisational politics within the firm can make such links difficult to forge.

Within Philips CD-i was seen as the 'property' of the consumer elec-tronics division which invented it, and HIS management resisted sharing it with the Telecommunications and Data Services (TDS) division. The experience with another technology which crossed the professional/consumer boundary — LaserVision — also revealed divisions within the organisation:

> In the UK there was this perennial battle between PBS [Philips Business Systems, which is how TDS is known in the UK] and Consumer Electronics. You had ridiculous situations of two account managers visiting the same customer and saying 'I am Philips' and the other person will come in ten minutes later and say 'I am Philips' often with the same products.[87]

Organisational changes in Britain and Eindhoven have altered that situation: the new team under Bastiaens started actively to pursue professional applications for CD-i, and the IMS structure brought professional and consumer optical disc products under the same umbrella. Marketing plans for CD-i were drawn up which sought to realise the theoretical synergy between the two market segments. Important links were identified as follows:

> 1 Point-of-sale and point-of-information applications[88] can help to familiarise consumers with the technology at the same time as they provide useful revenue before returns are available from the mass consumer market.
>
> 2 Some professional software may be readily adaptable for the consumer market. A prime example is educational material which can be sold to parents, but also significant is training material which can be marketed as tools for personal self-improvement. The prospect of eventual consumer sales may help to persuade institutions to invest in the technology.

Companies which invest in CD-i for in-company training may be able to encourage their managers to undertake training in their own time at home. Some of the key early adopters may be professionals who see the possibility of using the technology to improve their career prospects.

3 Given the shortage of programme-making skills and relatively high entry costs, higher margins in the professional sector may be useful in attracting entrants to the industry and diffusing skills more widely.

There is a chicken-and-egg problem which means that the expansion of the market is unlikely to proceed smoothly from the institutional to the mass market. For large companies the decision to adopt new technologies for training represents a major investment. For many applications the advantage that CD-i has over Interactive Videodisc is cost, but here assumptions of low cost are predicated on mass production for a mass market, since initial software development costs may be higher for CD-i. Thus the penetration of the institutional sector may depend on judgements about the likely success of the technology in the mass market. There may well be an acceptable time lag between the two, but business purchasers need to be convinced that their investments will be 'foreseeable future-proofed'.

Competing products and technologies [89]

It is clear that there will be a variety of competitors for CD-i in professional and consumer markets, although in the former each may find a niche in a way that is unlikely in the consumer market, where format battles will eventually produce a *de facto* standard. The players in each market segment will be different, with competition in the professional sector coming from multimedia PCs and PC add-ons, and in the consumer sector from the computer games and audio-visual industries. The following section reviews the competition according to the different multimedia technologies and the companies which support them.[90] In addition to the products discussed below, which were on the market as of mid-1993, Apple and Toshiba announced in 1992 the co-development of 'Sweetpea' — a CD-ROM-based multimedia player which they hoped to market in the US for $750 by mid-1993, and 3DO demonstrated a prototype version of its 'Opera' multimedia player which was launched on the US market in late 1993.[91]

Commodore's CDTV

Commodore's rival to CD-i was a fully-fledged consumer product rather than a PC add-on, and was launched ahead of CD-i in 1991. It consisted of the innards of an *Amiga* computer together with CD-ROM player and interface presented in a black box with an infra-red remote controller. *CDTV* does not stand for Compact Disc Television, but

Commodore Dynamic Total Vision, and it was described on the casing of the first machines as an 'interactive graphics player.' The player operates on a slightly amended form of the ISO 9660 standard for CD-ROM, which means *CDTV* discs cannot be played on other machines. The launch price shadowed CD-i plans closely at £699, later cut to a final selling price of £399. Less than six months after the product was launched in 'black box' guise as a television add-on, Commodore changed its strategy completely and re-positioned CDTV as a computer peripheral. The product was re-named *Amiga CDTV*, and was also made available as a (grey coloured) CD-ROM drive at £350 to plug into the *Amiga*. In June 1992 Commodore launched a 'Multimedia Home Computer Pack' which comprised a *CDTV* player, a keyboard, mouse and floppy disk drive at £499.

Software was a major factor in determining *CDTV's* fate in the marketplace. Full-screen, full-motion video (FMV) was claimed to be available later as an add-on (but without much credibility, since unlike CD-i players, *CDTV* machines did not carry sockets for FMV chips). Much of the early software comprised converted computer games, which were already available to *Amiga* owners (at a lower price). Commodore, like Philips, was keen at first to emphasise the 'serious' potential of the system and even borrowed from Philips the ugly term 'Edutainment'. The bundled 'Welcome' disc gave a sample of six programmes, which comprise material on the rain forests, sport, space flight, a trip round the Victoria and Albert Museum, a tour of an Egyptian pyramid and a biography of J.S. Bach. Commodore promised 100 titles by Christmas 1991, but in fact there were fewer than this on the market by the end of 1992. The promised range paralleled CD-i titles quite closely, with an encyclopaedia, a world atlas, interactive games and a variety of special interest programs on subjects like cookery. Although titles could be developed more quickly and cheaply for *CDTV* than CD-i, because of the availability of authoring tools for the *Amiga*, and the existence of software houses with *Amiga* experience, this tended to work against Commodore when relatively few high quality titles appeared amongst the offering.

The fate of *CDTV*, which was discontinued in the summer of 1993, supports the proposition that it is the appeal of the software which determines the fate of the format. The demise of *CDTV* reduced the number of competitors to CD-i, but news of yet another failed consumer electronics format may deter customers from buying CD-i unless they are reassured by Philips's image as a blue chip supplier.

CD-ROM and the Multimedia PC

The *Multimedia PC* is a sub-set of the PC family agreed in 1990 by some of the major hardware and software firms in the computer industry (including Philips and Microsoft, but not IBM which brought out a higher-specification *Ultimedia* machine). The standard is based on a minimum level of PC (with at least a 386SX processor) equipped with a sound card, and linked to a CD-ROM drive with associated retrieval software. Sales of

multimedia upgrade kits began to take off late in 1992, as did CD-ROM discs especially in the *MPC* format. CD-ROM has some limitations as an interactive multimedia technology, in that in cannot interleave (i.e. retrieve simultaneously from the disc) audio, text and images in the way that CD-i was designed to do. Clever software and software design, or adoption of the CD-ROM XA standard, can partially overcome this to enable CD-ROM and CD-i versions of the same software to be marketed. Compressed digital video can be added to CD-ROM discs, and decompressed through software (as in *QuickTime* and *Indeo* (see below) or through hardware chips (as in *DVI* and CD-i). The very large number of PCs in homes in the United States offers a large market for *MPC* upgrades, which have reduced in price to around $500 as cheaper CD-ROM drives became available. This solution also offers access to the Kodak/Philips *PhotoCD* system (see below). The expansion of the range of CD-ROM titles, and the reduction in price of multimedia peripherals for the PC, suggest that the *MPC* is beginning to become a competitor to CD-i for the home market as well as institutional markets. In 1993 negotiations were underway to upgrade the standard to accommodate faster processors and CD drives. The *MPC-2* standard has as a minimum a 486 series processor, and includes provision for dual speed CD-ROM drives which allow for the much faster data rates needed for speedy image handling.

DVI - Intel, IBM and Microsoft

Intel has disclosed its intention of seeking both institutional and consumer markets for products based on its *DVI* chips, although by mid-1990 only one Canadian company had announced development work on a *DVI*-based game. The first version of the technology comprised two boards to be used with IBM AT or PS/2 machines or compatibles, for video capture and compress-ion, and for decompression and playback respectively. Moving video compressed in this way can then be used with CD-ROM sound, text and graphics to create the functional equivalent of CD-i. When first demonstrated in 1987 *DVI* comprised seven boards costing $25,000; by 1990 the cost for the two boards had been reduced to $5,000. The intention was to integrate the *DVI* chips and the CD-ROM interface onto the motherboard of a PC to offer a true multimedia computer for an additional cost of $500 by 1992, but so far DVI has appeared only on IBM's high-end *Ultimedia* PCs. Video compression achieved by the capture board ('Real Time Video') gives a relatively poor quality picture; for final products 'Presentation Level Video' (PLV) is required which could only be done by Intel at a cost of $250 per minute of video.[92] In fact *DVI* uses two different compression algorithms for the two levels of video; PLV uses a similar algorithm to CD-i. Alongside the chip sets Intel offer three sets of authoring tools, broadly similar to the different levels of the CD-i tools discussed above.

The chief advantage of *DVI* is that it can easily (but still relatively expensively) be incorporated into PC-based products, and thus take advantage of the installed base of PCs which might be upgraded. The extra hardware cost of the chipset remains a

substantial deterrent, however, and Intel has countered this with a *DVI*-compatible software solution — *Indeo* — which works in conjunction with Microsoft's *Video for Windows* in exactly the same way as Apple's *QuickTime*, giving scaleable video in a window on the monitor screen.

Apple's Macintosh

Every *Macintosh* computer now comes with sound and system software for video compression (*QuickTime*), but despite price cutting, Macs remain relatively expensive for the mass consumer market. The high end *Quadras* became the preferred development platforms for multimedia producers, and the quality of the multimedia software tools from third party suppliers such as Macromedia remains ahead of Philips's own tools for CD-i. Apple seems to be devising its multimedia strategy with institutional markets in mind, and is pinning much of its hopes on hand-held devices, beginning with the *Newton* which was introduced in 1993. That it had some designs on the home market for multimedia is evident in the luring of Gaston Bastiaens from Philips IMS in 1992 to head the consumer products division at Apple Headquarters, but internal problems led to his departure in 1994.

Fujitsu's FM Towns and Marty

Fujitsu has had an unexpected success with a multimedia games machine in Japan — unexpected because it is primarily a mainframe computer and telecommunications equipment supplier with little previous experience of consumer markets. The *FM Towns* product consists of a 32-bit PC with integral CD-ROM drive and FM radio retailing (so far only in Japan) at £1,500. It spent $24 million on promoting *FM Towns*, primarily to high income families, and commissioned a range of software to include entertainment and instructional titles as well as games, much like CD-i and CDTV. By the end of 1991 sales were reported to have reached 160,000, when the machine was redesigned around the *MPC* standard including, in addition to its own operating system, MS-DOS and Windows. In early 1993 Fujitsu aimed squarely at the mass consumer market with an *FM Towns*-compatible derivative, the *Marty*, a £600 CD-ROM player which plugs directly into the TV set like CD-i and CDTV, and is capable of handling Sony's *Electronic Book* format as well as CD-ROM discs. In Japan the launch was accompanied by a high profile television advertising campaign featuring a cartoon frog (Marty) which Fujitsu hoped would catch the public imagination.

NEC's PC engine

NEC's proprietary multimedia technology (the *PC-Engine* console launched in 1987, and the optional extra CD-ROM player introduced in 1988) was the first to use CD-ROM discs for software instead of integrated circuit cartridges. NEC was followed by

Sega and, eventually, the market leader Nintendo. and had sold over 3.5 million consoles and 1 million CD-ROM drives in Japan by the end of 1992. The CD-ROM player cost $700, with software titles $20-$25 each. NEC has encouraged software development by marketing a set of authoring tools. NEC at one time controlled 80 per cent of the PC market in Japan, but has lost market share to American companies such as Apple, Compaq and Dell. NEC introduced a version of the *PC Engine*, called the *Duo* — known in the US as *TurboGrafx* — with built-in CD-ROM drive in late 1991.

JVC/Sega's Mega Drive and Nintendo's Super NES

Sega, based in Japan, is the main supplier of arcade video games. Following the success of the *PC-Engine* and *FM Towns* games players Sega introduced its own home video games player, the *Mega Drive* or *Genesis*, jointly developed with JVC, in December 1991. This was an add-on to its games console, and was marketed alongside a range of attachments, including alphanumeric and musical keyboards and a modem. The latter was used to offer a home banking service. JVC introduced its Sega-compatible *Wonder-Mega* player to the Japanese market, and also developed (with Philips) an interactive karaoke player, *Digital Vision*, with full-motion video, compatible with CD-i. The market leader in games consoles, Nintendo, was slow to follow suit into CD-ROM-based technology, but eventually launched its *Super NES* player in mid-1993.

Tandy's Video Information System (VIS)

Tandy was a pioneer of the home computer in the United States, and is the largest retailer of consumer electronics in the US, under the Radio Shack name. The *VIS* system was announced in mid 1992 as a direct competitor to CD-i for the home interactive multimedia market. Tandy's approach to product development, and its strategy for introducing the product to the market differs from Philips's in several significant ways. Most importantly, while Philips had taken a 'brown goods' approach, seeing CD-i as value added television, Tandy has designed its product around existing personal computer technology (much as Commodore did with *CDTV*). The difference was that Tandy chose as its platform the IBM-standard PC, and worked with Microsoft to adapt the latter's *Windows* operating system for *VIS*. The advantage of this was that software development costs were much lower than those for CD-i, and developers familiar with *Windows* products could quickly bring out *VIS* software using the same development tools they use for CD-ROM titles. Conversion to *VIS* from standard *MPC* CD-ROM software was inexpensive, and discs could be designed in such a way that they are playable on both *MPC* and *VIS* systems. By the end of 1992 around 100 titles, almost all conversions of existing software, were available on the US market. Tandy promised, but did not disclose how and when full-motion video and *PhotoCD* would be incorporated into the *VIS* format.

One design feature which differentiated *VIS* from CD-i was the incorporation in the former of a cartridge system which allowed users to record their responses, or positions within a game so that they could resume in the same place at the next session. Also unlike the CD-i consumer player, *VIS* embodied an 'open architecture' which was designed to permit *VIS* players to be connected to telephone lines or cable TV circuits. Philips considered, and rejected, such design features for consumer CD-i, but they were embodied in the CDI-602 professional player (but using a 3.5" floppy disk rather than a cartridge) and could feature in a future domestic CD-i player.

In conception and execution *VIS* was similar to the revised *CDTV* strategy, but with the advantage of being based on the dominant *PC/Windows* standard rather than the *Amiga*. It is too early to say whether the cheapness of producing *VIS* titles will lead to a flood of low quality titles, as happened with *CDTV*. The experience of Nintendo suggests that software quality control was critical to its success, and the same may be true for CD-i in that the investment required to produce a CD-i title tends to mean that the production values and standards are higher.

Sony's electronic book concept: the Data Discman and the Bookman

Despite being a co-developer, and royalty recipient, of CD-i, Sony has done nothing to assist Philips in the development of an infrastructure for software development, nor — apparently — has it developed any CD-i software in-house. Sony's strategy appears to be to wait for others to make the running on CD-i, and open up a market in Japan for its own *Data Discman* CD-ROM format — now re-named the *Electronic Book*. The standard for the *EB* was set in January 1990, with text and graphics displayed on a hand-held 8 cm CD-ROM player, and the product began to be sold in June 1990. In addition to Sony, Sanyo and Matsushita (Panasonic) have introduced EB players. Support of key Japanese print publishers has been obtained through the establishment of an *Electronic Book* Committee, and by the end of 1992 there were over 120 titles available in Japan. The original specifications were modified in 1992 to permit sound to accompany text and graphics; the *EB-XA* players use part of the CD-ROM XA standard with the same 8 cm discs as the original *EB*.

Despite an outline agreement between Philips and Sony to make the *EB* system compatible with CD-i, in the same way that Kodak and Philips did with *Photo-CD*, Sony has not introduced the promised hand-held full-specification CD-ROM XA player, instead launching a non-standard 12 cm disc *Bookman*, which will not play CD-i or CD-ROM XA discs. The machine uses a different graphics standard for its display from CD-ROM XA. The player is now called the *Multimedia CD (MMCD)*, and has limited compatibility with the *MPC* standard, in that a modified operating system is available from Microsoft which will enable developers to make discs which will play on *MMCD* players and standard CD-ROM XA players attached to PCs. As so often, Sony has chosen an independent path.

Conclusion: the multimedia maze

This chapter has concentrated on CD-i — the most significant of the new interactive multimedia compact disc-based technologies aimed at the home market. In the early days, Philips assumed that the successful pre-market standardisation of CD-Audio, and the partnership forged with the major Japanese firms Sony and Matsushita, would ensure that, like CD-Audio, CD-i would have no competing format to inhibit its diffusion to the mass market. Contrary to expectations, however, the partnerships have proved disappointing, and Philips found itself with a format battle which opened up on many fronts. Not only was there direct competition for CD-i as a consumer electronics product — first CDTV and then VIS — there was competition in packaged media from CD games consoles and the multimedia home computer, and very soon there will be formidable competition from cable TV and telecommunications companies. The original idea of a single standard for multimedia CDs, so that as with CD-Audio, cassette tapes, and LPs, any disc or tape will play on any player anywhere in the world, has long disappeared. Instead, consumers looking at a rack of 'multimedia CDs' will face a confusing variety of formats and standards which will require some technical knowledge — at least on the part of the salesman — to ensure that the disc will actually play on the consumer's equipment.

Philips launched CD-i in the United States in October 1992, and in the UK the following Spring. One year after launch, and despite the appearance of further competition, Philips were claiming encouraging early sales of CD-i — at least as good as CD-Audio in the early years — which would mean a combined sale of around 70,000 players in the US and UK. In addition Philips have disclosed that each purchaser of hardware has also bought six discs in the first year, which compares favourably with an average of four in the first year of CD-Audio.[93] Over the same year the availability and sales of CD-ROM titles has expanded dramatically, from 48 in 1987 to 817 in 1990. According to the publishers of the *CD-ROM Directory*, there were 2,212 titles available in 1992. By the time of the mid-1993 edition, the number had increased to 4,731.[94] The distribution of discs by format was as follows:

Format	**Number of Titles**
PC	3,274
Apple Macintosh	1,069
CD-i	204
CDTV	127

For Philips this would seem to be an encouraging beginning for CD-i, but it must be remembered that CD-Audio had no direct competitor, and for consumers the purchasing decision was relatively simple, since they did not need to learn about what recorded music has to offer, and the benefit obtained from eliminating hiss and scratches was evident. In the case of interactive multimedia none of these factors applies. Even if the product space survives the exaggerated claims made for it, the position facing the consumer will be more complex than for any other past consumer electronics product. The range of products competing within the multimedia product space will be considerable, and the number of products which will join CDTV in the category ‘obsolete’ will steadily grow.

Table 5.3 illustrates the range of competing formats and systems, and shows the (limited) extent of compatibility between them.

The experience of home consumer electronics products suggests that this format battle will create by attrition a single de facto standard for the home player, but it does not mean the convergence of all consumer interactive multimedia around a single format. Just as the consumer now has a choice of watching a film on broadcast television, on cable television, on video, and now on CD, so will the consumer have a choice of formats for the same interactive multimedia software. There will most likely be a single ‘packaged’ format — and at the time of writing CD-i is the front runner in this race — and software ‘on demand’ via broadband fibre optic cable, whether operated by cable television companies of telecommunications service providers.

Digital compression technology, which made possible the introduction of full-screen full motion video to CD-based multimedia, has opened up a range of new opportunities for broadcasters, cable TV companies and telecoms network operators. The Hughes Corporation launched DirecTV in 1994 eventually to offer 150 channels of television on a DBS satellite. Somewhat later — perhaps two years later — cable TV operator Time Warner, and in competition an alliance of cable TV company TCI and US West (one of the former regional operating companies of the Bell/AT&T system) may launch rival multi-channel services which would have interactive capability. Not only will this mean that viewers can use a keypad to send back messages through the cable to take part in a live programme, it might open up interactive multimedia on demand in direct competition to packaged media such as CD-i and VIS. Time Warner, TCI and Sega are about to launch the Sega Channel, which will offer cable subscribers a range of over 100 Sega computer games if they already own a Sega Mega Drive games console and rent a decoder unit.

Over the past two years there has been a rush by computer companies, consumer electronics manufacturers, cable TV and telecoms companies and audio-visual entertainment companies to form alliances and joint ventures to position themselves for what they see as the inevitable arrival of multimedia in the home. The range of products and services promised adds up to a bewildering maze, and has added a new dimension of complexity to the innovation process described in this chapter. Figure 5.4 represents the range of products and links between companies as of July 1993. Many of these products and services will fail; some at least may succeed in opening up a market for interactive multimedia hardware and software. The time it will take before such a market emerges, and perhaps a *de facto* standard is set for CD-based media, is likely to be lengthy as the new multimedia software industry learns to master the new technology. It took the motion picture industry several decades to do just that; we would be foolish to believe that a much more complex medium will arrive more quickly.

The experience of innovation in consumer electronics products would seem to confirm the emphasis that Philips has put on developing the infrastructure for software development in its strategy for the diffusion of CD-i. Initially Philips's managers were naïve enough to think the product could be rushed into the market within months of finalising the technical specifications. When the complexity of the process was eventually grasped, and the necessary organisational changes made within the company, the effort shifted to putting in place what was required to bring into existence a CD-i software development community. The multi-disciplinary nature of multimedia meant that this community would have to combine people (and companies) from different backgrounds, and new skills would have to be developed. This is true of multimedia in general and not just CD-i, and even if the technology of CD-i is overtaken by further developments, and even if CD-i as a consumer product fails to win a mass market, the development of successive products within the interactive multimedia product space will bring with it a new multimedia publishing industry. As a medium of communication, interactive multimedia is so revolutionary that the relevant historical precedents are technologies such as cinema, radio and television, which created entirely new industries. The early moves towards developing multimedia reported in this chapter are like the first hesitant steps of the pioneers of those earlier industries. Unlike Hollywood at the turn of the last century, the multimedia industry at the turn of the next century will be dominated by global alliances forged between multinational electronics companies like Philips, Sony, Toshiba and Matsushita, and other IT and audio-visual producers. The 'winner' will have found a successful pathway through the multimedia maze.

Notes

1 From an unpublished draft MS on innovation in audio-visual technologies by Ben Keen, kindly made available by the author.

2 *Ibid*., p. 305.

3 Not least because Philips was suffering financially from the failure of its V2000 video recorder format against its Japanese rival VHS. The CD-Audio alliance brought together Sony and Philips, the two losers in the video wars.

4 Akio Morita, Sony's chairman, claims that Philips's original specification for CD-Audio was for 60 minutes' playing time, but Morita persuaded Philips to extend the playing time to 72 minutes so that his wife's favourite Beethoven symphony could be contained on a single disc. See A. Morita, *Made in Japan*, London: Collins, 1987.

5 *Keen MS*, p. 307.

6 *Ibid*., p. 300.

7 For a discussion of the VCR format battle between Philips, Sony and JVC, see A. Cawson et al (1990), *Hostile Brothers: Competition and Closure in the European Electronics Industry*, Clarendon Press, Oxford, Chapter 13.

8 This is based on the 'normal' data rate of 150 Kbits/s, but Toshiba has improved on this by varying the speed at which the disc spins so that 'burst rates' of up to 300 Kbits/s can be achieved, bringing down to less than half a second the median access time, and making CD-ROMs nearly as fast as hard discs. Further innovation has now produced CD-ROM drives which can achieve data rates of up to 600 Kbit/s.

9 Later Motorola joined the inner group of the CD-i family, specifically to develop full-motion video chips and to help integrate all CD-i functions onto a single chip.

10 In the same way that the designers of Apple's QuickTime did. Improvements on the original algorithms allow bigger windows of full-motion video.

11 CD-i players can read CD-ROM XA discs but not vice versa. Discs, however, can be mastered in such a way as to be readable by both CD-i and CD-ROM XA players.

12 One early estimate was that 'it will probably take at least ten years just to produce one really good application.' M. Canter, E. Neumann and J. Fenton, 'Controlling CD-i: Languages and Authoring Systems', in S. Lambert and J. Sallis, eds. (1987), *CD-i and Interactive Videodisc Technology*, Sams, Indianapolis, p. 141.

13 The drive to create revenue from software development must have been reinforced by an internal review of return on investment in the consumer electronics division conducted by Philips in 1988 which showed a negative return on CD-Audio hardware

despite the astonishing success of the compact disc. (Interview, Philips UK, October 1988). In 1990 the expectation in Philips was that the same would happen with CD-i players, but that unless Philips was committed to hardware development the whole technology would lose credibility in the eyes of third parties. (Interview, Philips Eindhoven, March 1990). Thus Philip surmised very early on that CD-i would be a 'razor blades' business, where profits would come from the blades (software) and not the razors (CD-i players), but you still had to make the razors.

14 This can be compared to the difference between the IBM and the Apple strategies in personal computing hardware. IBM deliberately adopted an open architecture to encourage others to manufacture to the standard (the so-called clones), whereas Apple sought (at least until 1993) to prosecute any infringement of its patents.

15 As we discussed in Chapter 2, there are signs of convergence between institutional and consumer markets for IT, and some products sell in large numbers into both markets, as in the case of PCs and PC-based multimedia CD-ROM systems. This market has been labelled the SoHo (Small Office/Home) market.

16 Although the decision was made early on that the 'computer' dimension of CD-i should be disguised, and that it should be positioned as an enhancement to the family television set.

17 Address by M. Higashi to the CD-i Conference, London, June 1990, p. 5.

18 See Chapter 3 where Philips's conception of home automation is described. Later on Philips managers decided that CD-i was most likely to succeed independently of home systems, and indeed the whole home automation concept has been demoted within Philips corporate strategy.

19 J.J. Tuyt in *HIS Today*, November 1985, p. 1.

20 This building-block approach is still evident in Philips' approach to home automation (see Chapter 3), but organisationally CD products are no longer included within HA.

21 L. de Waal, (Application Research Manager of HIS), in *HIS Today,* November 1985, p. 14.

22 L. Arpino in *HIS Today*, November 1985, p. 9. The research also gave rise to the one product launched before HIS was reorganised and home automation separated from it. That product was the Videowriter, a dedicated word processor which had its origins in the research finding that 50 per cent of home computer purchasers bought them for word processing, and a year later half of those were using their computers exclusively for

word processing. This was essentially the same logic that underlay the launch of the Amstrad PCW computers.

23 Interview with the Consumer Product Manager for CD-i, Eindhoven, 7 March 1990.

24 But only for playback; compression of maximum quality images had to be done by RCA using mainframe computers.

25 A.D. Little were commissioned by Philips UK to prepare a study of the potential market for CD-i in 1988. Their report, Interactive Multimedia for Philips UK, was completed in June 1989, when they reported that the idea of a full CD-i plug-in board 'is (still) taboo' although it was under discussion (Vol. II, p. 28). Philips finally marketed a CD-i board for PC, Macintosh and Sun platforms in 1990.

26 The 180 series machines were replaced in late 1990 by the CDI 602, which combined all the functions of the 180 series in a single box.

27 Interview with Marketing Manager for CD-i, Eindhoven, 6 March 1990.

28 To be fully accurate, the first software development products were based entirely on Philips's proprietary technology, and assumed that developers would forsake existing technology to author entirely on Philips CD-i equipment. An interview with an early software developer in Florida in February 1991 elicited the remark that 'We had serial number 001, but it never worked.' He pointed to a piece of equipment gathering dust in a corner, and said that they had quickly reverted to the Macintosh for software development.

29 Interview with Product Manager for CD-i (Institutional Markets), Eindhoven, 6 March 1990.

30 Interview with Marketing Manager for CD-i, Eindhoven, 6 March 1990.

31 CD-i was originally scheduled for launch onto the consumer market in Autumn 1987. The timetable set in 1990 was for CD-i to be launched in the United States in Spring 1991, in Japan late in 1991, and in Europe in 1992.

32 *Interactive Media for Philips UK*, Vol. II, p. 35.

33 Critics in the trade and technical press accused Philips of muddying the CD concept by incorporating analogue video into what had hitherto been an all-digital medium, and for including larger size discs under the term 'compact disc' (CD). The move had reportedly been strongly opposed by Sony.

34 *Interactive Media for Philips UK*, Vol. II, p. 20.

35 Interview with the Consumer Product Manager for CD-i, Eindhoven, 7 March 1990. This intention was confirmed by the Philips manager in overall charge of CD-i, Gaston Bastiaens, at the CD-i conference in London in June 1990. No such product has yet appeared.

36 The issue is not so pressing in other European countries, especially France, where SCART-equipped sets are more common. The US model will have RF output since almost no sets in the US have any other form of connector. US software developers have to work within these constraints - even more since the NTSC picture quality is inferior to PAL and SECAM.

37 The same stance was initially taken by Commodore with CDTV, but later Amiga was prefixed to CDTV, and the functionality of CDTV as a computer peripheral was stressed in an attempt to market the product to existing Amiga owners (of which there were about 1.4 million in the UK.

38 L.G. Haddon (1990), *The Roots and Early History of the British Home Computer Market: Origins of the Masculine Micro*, Unpublished PhD thesis, Imperial College, University of London.

39 Interview at Philips Research Laboratories, Redhill.

40 As reported in interview with one of his colleagues, the suggestion was made by Dick Fletcher, head of New Media, which produced early prototype CD-i software for Philips. In fact CD-i soft porn quickly appeared in the US, and there is now a proliferation of CD-ROM 'pin-up' discs. Philips responded by commissioning *The Joy of Sex* as a launch title for the FMV cartridge, and signed a deal with Playboy.

41 CDTV used a proprietary caddy system, which added significantly to the cost of a disc. Many consumers would buy fewer caddies than discs, which then involved a fiddly process of swapping discs between caddies.

42 Philips introduced a hand-held model with liquid crystal display in 1992, principally for professional users such as sales representatives. Sony's only model (as of mid-1993) was a similar handheld machine (the 'Intelligent Discman') aimed at professional users. Philips introduced a laptop CD-i player in early 1993 aimed at professional markets.

43 This of course need not be the strategy followed by subsequent entrants into hardware production, who could wait for the market to develop through software sales before

competing against the first movers for the hardware market. This is thought (e.g. by *Screen Digest*, November 1992, p. 252) to be the strategy of Korean manufacturers.

44 As reported by speakers from Sony and Matsushita at the London CD-i conference in June 1990.

45 Speech by Garry Hare, President of Fathom Pictures of Sausalito, Ca. at the CD-i conference, London, 19 June 1990. Hare was later recruited by Philips to lead the software development strategy for Europe.

46 *CD-i News*, 1,1 (1986), p. 8.

47 According to Philips managers it was always expected that the bulk of early activity would be in the US, which reflects the greater interest and willingness to take risks of the American publishing and media industry.

48 Interview with the president of CD-i Systems Inc., London, 19 June 1990.

49 Presentation by Philip Mittelmann at CD-i conference, London, 19 June 1990, xerox notes, p. 1.

50 *Ibid*., p. 3.

51 *Screen Digest* estimates that it takes an average of 18 minutes to demonstrate CD-i to a potential customer, which creates some difficulties for retailers of fast-moving consumer electronics goods in stores such as Comet and Dixons. Philips claims that by September 1992, 100,000 people in the UK had witnessed CD-i demonstrations. *Screen Digest*, November 1992, p. 253.

52 Nobuyuki Idei of Sony at the CD-i conference, London, 19 June 1990.

53 Richard Arroyo, Senior Vice President, Marketing, of AIM at the CD-i conference, London, 19 June 1990.

54 By March 1990, Philips claimed that agreements have been reached with a number of 'major publishing concerns who like to keep things to themselves'. Interview, 6 March 1990. In June 1990 the only projects publicly announced were by Bertelsmann and Berlitz (part of the Maxwell group).

55 Ian Maxwell, Joint Managing Director of Maxwell Communication Corporation plc at CD-i conference, London, 19 June 1990. MCC subsequently secured backing from Philips for a joint venture, Maxwell Multimedia Corporation, which sunk with the

Maxwell ship before any titles had been completed.

56 By the end of 1992 there were 63 studios or developers working on CD-i projects in the UK. *Screen Digest*, December 1992, p. 280.

57 Interview. *Screen Digest* (December 1992, p. 279) quotes £150,000 to £200,000 as the average cost of producing a CD-i title, which is significantly higher than the average for PC or console games (£100,000), CDTV titles (£30,000-£40,000) and interactive videodisc software (£75,000). The 'typical' cost structure quoted by Philips IMS (UK) is as follows: design: 10-20 per cent; rights acquisition: 0-10 per cent; content creation: 10-60 per cent; content capture: 10-20 per cent; software engineering: 20-60 per cent; and testing: 5-10 per cent.

58 This estimate is based on interviews conducted in 1990. By the time of the delayed launch in 1991 the figure was much higher. *Screen Digest* (November 1992, p. 251) estimates a total worldwide spend by Philips/PolyGram on title development at $200 million.

59 *Interactive Media for Philips UK*, Vol. I, p. 64 suggested that encyclopaedia sales will follow hardware sales, and recommended a 'multi-hook' strategy (i.e. different approaches to different segments of the market) for boosting software sales.

60 Yet after an initial flurry of interest, Japanese electronics firms are playing a waiting game, with hardware ready to be released at speed if Philips succeeds in opening up a market. Philips alone launched CD-i in the Japanese market in 1992, and a year later its machines remained the only ones on sale in Japan, apart from Sony's miniature model. Sony seems to be putting its multimedia efforts into its Electronic Books, and perhaps in time its new magneto-optical digital audio technology - MiniDisc - will emerge in interactive multimedia form.

61 The information in the following section comes from the August 1989 draft marketing plan which was generously made available to us by Philips UK. AIM's strategy is based on the presentation by Richard Arroyo at the CD-i Conference, London, 19 June 1990.

62 In fact early purchasers included many more low-income households than Philips expected, thus following the diffusion of VCR more closely than CD-Audio. In retrospect, given the positioning of CD-i as a television add-on, this might have been predicted. Interview with Philips IMS marketing manager, November 1992.

63 Of the first batch of titles, 19 were reworked AIM titles and only 4 were original material developed by PolyGram.

64 In the first year consumers who bought players also bought an average of 6 titles; this compares favourably with the average of four CD-Audio discs bought in the first year by CD player purchasers. *Screen Digest*, November 1992, p. 253.

65 These claims must be treated with some caution since they were made in a presentation intended to boost acceptance of CD-i. They are presented here in order to show the assumptions underlying the CD-i marketing strategy.

66 Despite this, given the success of Nintendo games consoles in the US market, Philips felt it expedient to sign a deal with Nintendo to permit the conversion of Nintendo software to the CD-i format.

67 Interview, CD-i marketing manager, Eindhoven, 6 March 1990.

68 Interview, CD-i marketing manager, Eindhoven, 7 March 1990.

69 The publication of a free newsletter, *CD-i News*, was also halted.

70 This list has been compiled from *CD-i News*, A.D. Little and AIM. It is not a definitive list of the titles available at the consumer launch, but is intended to show the spread of software in the different categories.

71 More recently there has been some evidence of links being forged between Hollywood and the interactive multimedia development community. Sony Entertainment - the parent company of Columbia Studios - has set up Sony Electronic Publishing, which includes an offshoot, Sony Imagesoft, specifically intended to produce multimedia software from Sony Entertainment films. Sega produced an interactive game version of Steven Spielberg's Jurassic Park, and Total Vision Inc. has acquired multimedia rights to JVC/Largo Entertainment's films. *Screen Digest*, December 1992, p. 276.

72 PIMS, *Draft UK Marketing Plan for CD-i*, August 1989.

73 There is also an 'Orange Book' for writeable CDs, as used by Kodak/Philips in PhotoCD (see below), and a 'White Book' for VideoCD.

74 This principle was breached by Sony when they introduced the 3 inch CD single, and a range of Walkman-type CD portables which could only play 3 inch discs. Philips opposed the CD-single concept, and reportedly a compromise was reached when Sony dropped their objections to Philips plans for CD-Video, to which Sony had objected because it was not an all-digital format.

75 Discs can be designed to carry both standards, and so be playable either on PCs or Macs.

76 *New Scientist*, 9 June 1990.

77 Many commentators attribute the success of Nintendo in computer games consoles (in taking off where Atari and others failed) to their strict quality control and insistence on manufacturing all games cartridges themselves. The demise of Commodore's rival CDTV system may have been, at least in part, due to the inferior software - often simple conversions of poor computer games software - sold for the machines.

78 Interview, CD-i marketing manager, Eindhoven, 6 March 1990

79 A CD-i association was formed by Philips in 1991.

80 See D. Thomas, *Alan Sugar: The Amstrad Story*, London: Random Century, 1990 for an account of Amstrad's growth. In their report to Philips IMS the consultants A.D. Little pointed out that the competitive position of CD-i would alter greatly if Intel were to join up with Amstrad to produce consumer DVI machines. *Interactive Media for Philips UK*, Vol. I, p. 94.

81 Interview with SPIN UK, 25 January 1990. The DES failed to adopt CD-i, and Shell lost interest and sold their share of the venture back to Philips, when it was re-named Philips Professional Products International (PPPI).

82 Interview with New Media, 23 January 1990.

83 Interview at Eindhoven, 6 March 1990.

84 Older CD-ROM drives can only read the index recorded at the first session, but 'multi-session' drives have been introduced and quickly became the standard for new CD-ROM drives. By early 1993 inexpensive multi-session CD-ROM drives were available for less that £200, or slightly more when bundled with Kodak Photo-CD Access software.

85 See Alan Cawson, 'Managing consumer electronics', in R. Maidment and G. Thompson, eds. (1993), *Managing Britain*, Sage Publications, London.

86 Michael Kuhn at CD-i conference round table discussion, London, June 87 1990.

87 Interview, Eindhoven, 7 March 1990.

88 One of the difficulties of creating consumer awareness of the technology through retail point-of-information applications has been the insistence of the major multiples on making the technology 'transparent'. In the United States there is more competition in the retail sector, and Philips has been able to insist that opening screens announce that 'this is CD-i'.

89 The principal sources for this section are *Personal Computer World*, August 1990, and *Screen Digest*, November 1992 and December 1992.

90 One contender never reached the market at all. Mattel, a major player in the US toy industry, bought a licence to develop Compact VideoDisc (CVD) technology from its developer, SOCS Research Inc. of California. Its intention was to launch a $500 games machine on the US market in 1989, but failed to achieve this and the company abandoned work on CVD technology. Licences for CVD were also taken out by Hewlett Packard and Lockheed, but neither company divulged any product plans, and the technology has disappeared from view.

91 3DO is part-owned by Matsushita, one of the 'core' CD-i firms, and is yet another example of Matsushita hedging its bets on what format will succeed in the future. Matsushita also produces players to Sony's Electronic Book format.

92 This was the figure given by Intel at a DVI Developers Workshop, London, 21 May 1990.

93 *Screen Digest*, November 1992, p. 253. CDTV sales in the UK took 17 months to reach 20,000.

94 TFPL data quoted in *The Guardian*, 19 August 1993.

Back to Chapter 4
Forward to Chapter 6

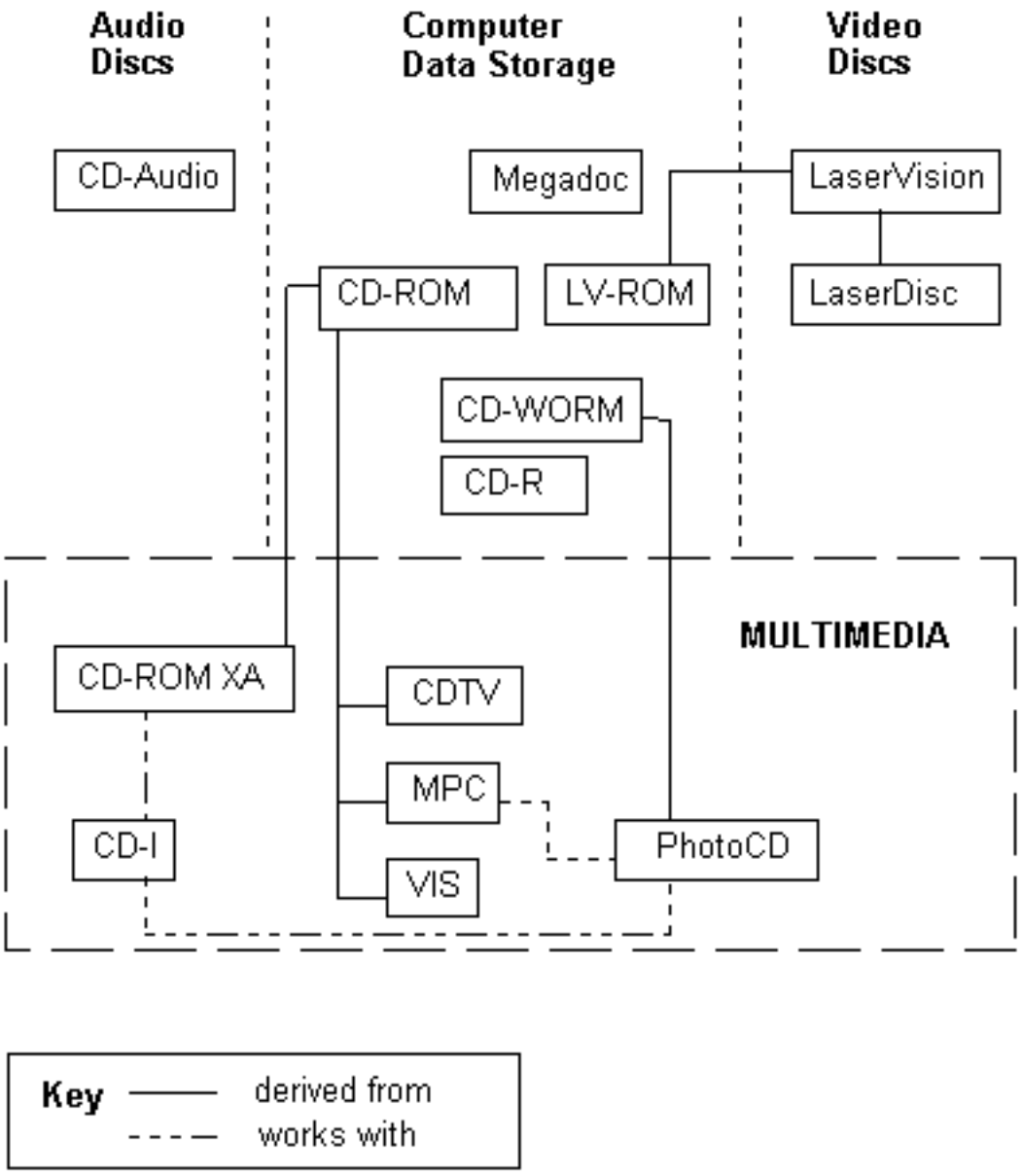
Audio Discs
Computer Data Storage
Video Discs
CD-Audio
Megadoc
LaserVision
CD-ROM
LV-ROM
LaserDisc
CD-WORM
CD-R
MULTIMEDIA
CD-ROM XA
CDTV
MPC
CD-I
PhotoCD
VIS
Key
derived from
works with

Table 5.1

Storage capacity of CD-i disc

One CD-i disc can contain combinations of		
Sound	**Pictures**	**Text**
72’ of CD-A stereo **or** 144’ of hi-fi stereo (LP record quality **or** 5 hours of hi-fi mono **or** 5 hours of mid-fi stereo (FM broadcast quality)	72’ of full-screen full motion video **or** 5,500 frames of natural pictures (photographic quality) **or**	100,000 pages of A4 text **or** 50,000 A4 pages of enhanced text

or 10 hours of mid-fi mono **or** 10 hours of stereo speech (AM broadcast quality) **or** 20 hours of mono speech	5,500 frames of user-manipulable graphics **or** 60,000 frames of graphics	**or** 20,000 A4 pages of bit-mapped text

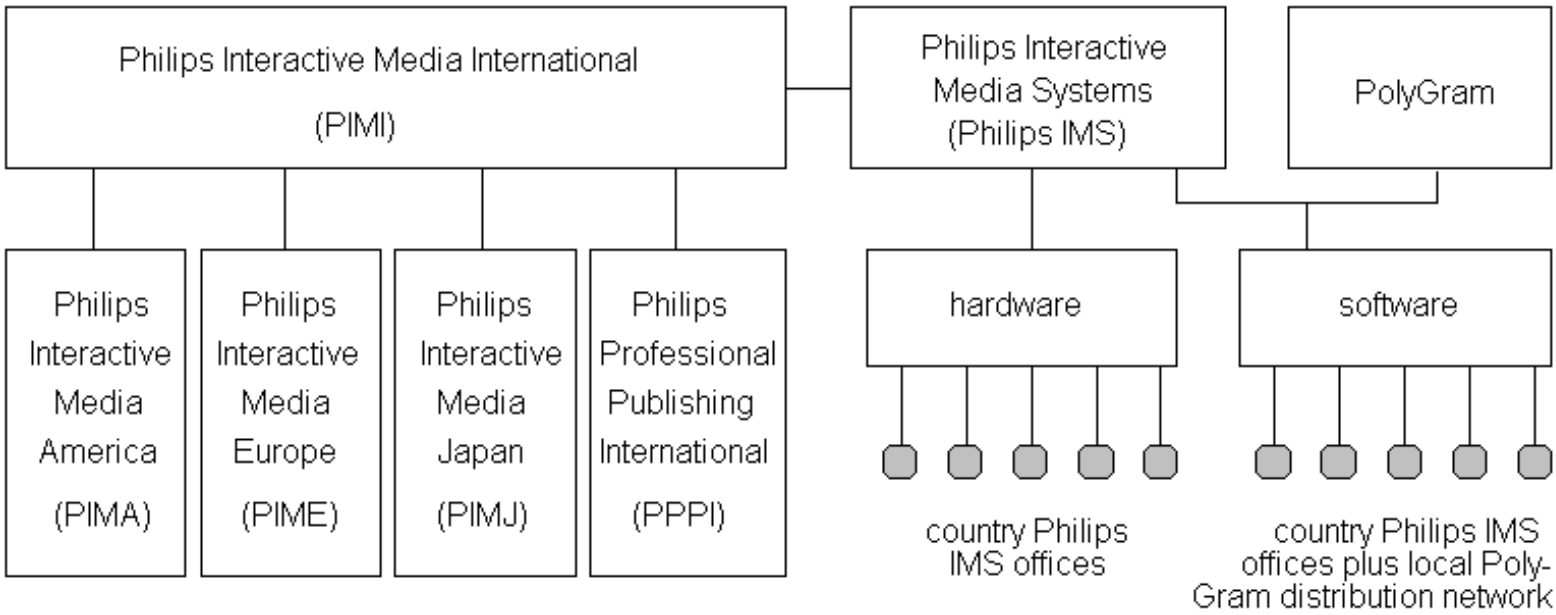
Philips Interactive Media International
(PIMI)
Philips Interactive Media Systems (Philips IMS)
PolyGram
Philips Interactive Media America (PIMA)
Philips Interactive Media Europe (PIME)
Philips Interactive Media Japan (PIMJ)
Philips Professional Publishing International (PPPI)
hardware
software
country Philips IMS offices
country Philips IMS offices plus local Poly-Gram distribution network

Table 5.2

CD-i launch software titles by category

Title	Developer
1. Children's titles	
Kidspace 1 - Toon Tunes	American Interactive Media
Kidspace 2 - Sandy's Circus Adventure	American Interactive Media
A Visit to Sesame Street - Letters	Children's Television Workshop
A Visit to Sesame Street - Numbers	Children's Television Workshop
Children's Bible Stories 1 - Noah's Ark	Children's Television Workshop
Children's Coloring Book	Spinnaker
Children's Musical Theatre	Sonic Images
Cartoon Jukebox	American Interactive Media
Story Machine	Spinnaker
Tell me Why vol. 1	Penguin Video
Tell me Why vol. 2	Penguin Video
Video Paper Dolls	Green Street Gang
Classic X-Man	Marvel Comics
2. Games	
Dark Castle	Silicon Beach

Uninvited	ICOM
Deja Vu	ICOM
Sherlock Holmes	ICOM
Space Lords	Spinnaker
Sargon Chess	Spinnaker
King’s Quest	Sierra On-Line
Space Quest	Sierra On-Line
Wings	
Rocket Ranger	Cinemaware
Wolfpack Submarine Game	Novalogic
Clue	Parker Brothers
Bridge	Great Game Products
Caesar’s World of Gambling	CD-i Systems/UCLA
Palm Springs Open Golf	ABC/Ultimate Athlete
Street Fighter	Virgin

3. Education & Special Interest

Grolier Multimedia Encyclopaedia	Grolier/New Media
Stamps	Glyn/NET
Coin Collecting	Glyn/NET
US Atlas	Rand McNally/VPI
Treasures of the Smithsonian	Smithsonian Institution/AIM

Photography	Time-Life/Compact
Sexual Sphere	Intracorp/Vortex Interactive
Reading Readiness	Harcourt Brace Jovanovitch
Growing Pains/The Urban Gardener	Metrolight
Animals	National Geographic/VPI
First Aid	Actronics
Wellness	Actronics
Spanish	Berlitz Language Centres
Rockschool	WNET/Educational Broadcasting Corp
Ultimate Alphabet	Interlight
Wines of France	INA
Astronomy	PolyGram
Health and Fitness	PolyGram
Buyer’s Guide	Consumer’s Association
National Curriculum	SPIN

4. Entertainment

Classical Jukebox	PolyGram/IPA
Oldies Jukebox	PolyGram/IPA
Frank Sinatra - My Father	Sinatra/IPA
Jam Session	Broderbund

Where in the World is Carmen San Diego?	Broderbund
Kaleidoscope 1 & 2	PolyGram/IPA

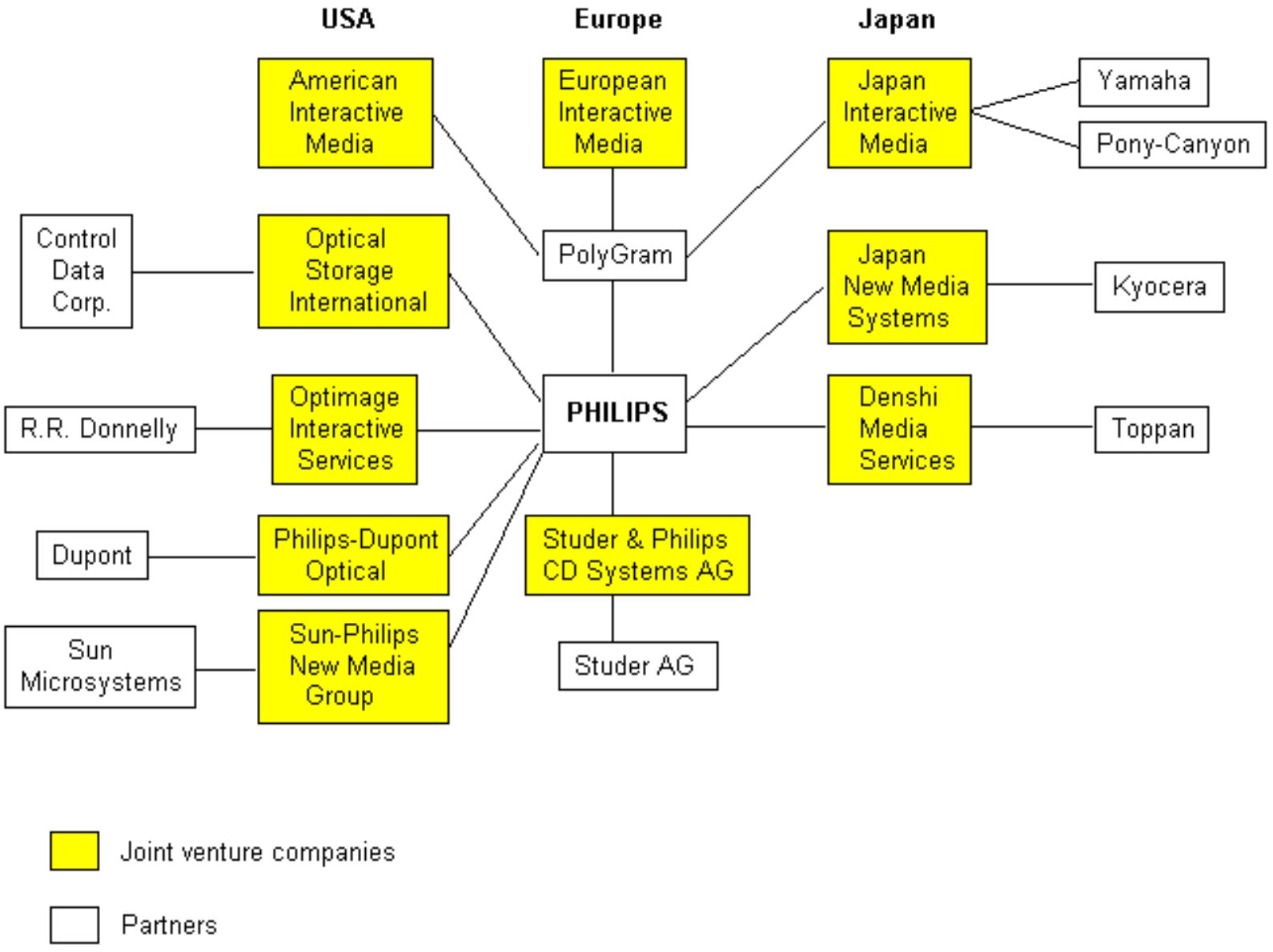

Figure 5.3 Joint ventures for the development of CD-i (as of 1988)

Chapter 6

The innovation process in consumer IT products

Introduction

As we saw in Chapter 1, studies of innovation have been mainly concerned with the diffusion of 'professional' technologies into institutional markets, although we argued there that there is evidence that the differences between the two types of market have been overdrawn, and besides, it appears that there is a process of convergence underway which is reducing the extent of difference.[1] As we suggested, part of this process of convergence can be explained by more recent theories of socio-technical change developed within a Schumpeterian framework, which seek to identify 'heartland' technologies whose application across a very wide range of sectors and markets - including consumer markets—is argued to lead to a fundamental transformation of the economic structure. Some of these ideas have led to the revision of older approaches; for example, the diffusion of microprocessor-based technologies into machine tools and manufacturing processes led commentators to reconsider their views on the product life cycle and the maturation of industrial sectors. To take just one instance, steel production - a classic 'sunset industry'—has been radically changed by new process technologies. The sun has once more risen over a smaller but clearly more productive steel industry, but of course it does also face fierce competition from new materials being developed in 'first time' sunrise industries, which has in turn led to product innovation in special

steels. Examples such as this alert us to the importance of seeing innovation as a continuing process, rather than a series of discrete events, and underline the dangers of sticking too rigidly to the idea that industries and products follow a specific life cycle.

The bias towards institutional markets in the innovation research literature is paralleled by a second bias concerning the scope and meaning of the familiar term 'Information Technology.' The emphasis on the links between computer technology and telecommunications, which is at the centre of most current academic and governmental conceptions of IT, ignores the fundamental importance of innovation in consumer electronics for the future of the information industries.[2] It is useful to distinguish between 'core' IT technologies which are increasingly defined in terms of ways of storing and processing information in digital form, and IT-using industries which apply core IT technologies to the production of goods and services. Some of the most important recent innovations in consumer IT products, such as the Compact Disc and Digital Audio Tape, have found significant applications in the professional sector, in data storage using CD-ROM, and professional broadcasting respectively. With products like these, and with non-consumer applications of High Definition Television,[3] there seems to have been a reversal in the traditional pattern of innovation in consumer products being a derivative of earlier innovations in industrial products.

Our case studies, reported in the last three chapters, have sought to bring a wider perspective to bear on the process of innovation, drawing on a range of sociological approaches to compensate for the biases in the innovation literature. We chose to concentrate on information technologies and IT products with at least a potential application in the home, to explore how critical design decisions were taken. We were particularly interested in how managers, engineers, product designers and marketers incorporated knowledge of consumer markets and consumer behaviour into the process of innovation.

The three case studies have in common an analysis of the efforts of producers of new IT products and services (defined broadly to embrace consumer electronics) to develop new markets. But the technologies themselves, and the nature of the producing firms, differ considerably between the three cases, which leads us to some caution in suggesting general conclusions which might apply to other consumer IT products. We do, however, suggest that there are significant technological trends at work in IT which promise to lead to the kind of convergence that was widely discussed a decade ago. We think, however it will come incrementally and much later than initially expected. For many years commentators have pointed to the convergence between computing and telecommunications, but attempts by major firms to align their corporate strategies with the direction of this convergence have more often than not come to grief.[4] However, there does now seem to be an unstoppable trend towards the adoption of digital technologies across the whole spectrum of IT. Just as telecommunications exchanges

became in effect specialised digital computers in the 1980s, so in the 1990s will television sets use very large banks of memory and processor chips to store process and display digitally coded information in the form of video images.[5] In each of our case studies there is an example of this trend: in electronic messaging, the development of Group 4 fax machines may permit their integration with a wide range of computer and telecoms peripherals as terminals attached to the Integrated Services Digital Network (ISDN); in home automation, technologies such as those used in the Digital Data Bus (DIB) have replaced earlier analogue signalling techniques; and in interactive multi-media the last remaining technological obstacle to the launch of products for the mass consumer market has been the perfection of digital video compression technology in the form of MPEG chips.

We do not propose in this chapter to compare and contrast the minutiae of the detail reported in the case study chapters to provide a checklist of similarities and differences. Instead we have chosen to get to the heart of the issues by developing a dynamic model of the innovation process in consumer IT products, which we then use to explore some of what we think are the more important empirical features of the three cases. The concluding chapter then identifies how such an approach might be refined through further research.

Innovation as a cyclical process

Innovation is a process, not a discrete event which can be detached from other events. Even at the very early stages of new product development, R&D engineers and scientists are in the middle of a set of innovative processes which feeds into their thinking. Thus the engineers at Philips, who were exploring the applications of the laser in the 1960s, worked for a company which was at the same time introducing a major change in the product design of the tape recorder: the shift from reel-to-reel to the compact cassette. That ‘product’ was maturing, but changing through important incremental innovation (i.e. the storage technology for the tape), at precisely the same time that very early research was started on what was to become the radical innovation of the compact disc. The management of innovation in a very large company like Philips is a complicated organisational problem of linking innovative processes at very different stages, but which may come together at a later stage in competing or complementary products.[6] Coupled to that is the problem—perennially acute for Philips—of moving from the laboratory to the market, from the domain of the engineer and the designer onto the agenda of the marketers.

Innovation is also iterative: there may be identifiable streams and tributaries within the process, but unlike a river, the innovation process feeds back into earlier stages of the cycle. When new products are being designed, one of the most crucial pieces of

information available to designers and marketers is the experience of past products. For example, a common set of experiences for designers in all three of our case studies was that of the home computer. Design teams and marketers read that experience in very different ways, tending to look for confirmation of their initial assumptions. The early pioneers of e-mail saw home computer owners as the vanguard of a wider market, and Prestel incorporated e-mail as a service as part of the promotion of videotext to home computer users. By contrast, the designers of Compact Disc-Interactive sought to distance their product as far as possible from the home computer, arguing that its associations would unduly restrict the mass market potential of CD-i. In the case of home automation, the home computer was one influence among many: only a few product designers developed product configurations based on it, since most carried to the process quite different ideas of appropriate precedents.

In other words, a knowledge of the history of relevant products is crucial, but their relevance is itself a important issue, especially when radical rather than incremental innovations are involved. We suggested that the concept of the ‘product space’ is a useful way of defining the boundaries of a radical innovation. In each case study we can be confident that there is a product space: for electronic messaging, for home automation and for interactive multimedia for applications within the home. But some aspects of this space present a radical departure from the past, so that the relevance of past product experience is at issue. Within the product space there may be a range of product ideas, some competing, some complementary, and what determines market success may turn out to be quite unforeseen. We suggested that post-purchase innovation by users themselves may contribute to the overall process in quite significant, but as yet insufficiently explored ways.

Figure 6.1 shows the bare elements of a dynamic model of the innovation cycle. It refers to the whole process of innovation, and not simply that part of it usually associated with product design. The model suggests that the process of invention—the development of new ideas—coupled with the experience of past innovation leads to a technological understanding from which the boundaries of a new product space might emerge. It should be stressed that this could be just as easily be‘technological misunderstanding’ when the experience of past innovation is misinterpreted. The difference between understanding and misunderstanding for consumer products is tested in the marketplace, and there is no suggestion here that technology is ‘good’ or ‘bad’ for such judgements lie outside the scope of this study. The criterion at work for the diffusion of consumer products into everyday life is market success. Thus from within the product space there arise different possibilities for configuring products, and from these one or more is launched into the market. What we have been principally interested in is the extent to which information about consumer behaviour (including, but not confined to, purchase decisions) has been fed into the product development process, and how this information is acquired and deployed within the firm. We do not treat 'the market' as an external omniscient referee judging product success and failure; the market is, rather, a set of

relationships between producers, and between producers and consumers, which can be shaped by the actions of producers just as much as it is determined by the decisions of consumers. In this sense 'the market' can be seen as a set of information flows in which successful producers listen and learn from, as well as speak to consumers.

Consumers often use products in ways which are not anticipated by producers. Such 'post-purchase innovation' or 're-invention' can be monitored by producers and fed back into reconfigured or redesigned products, or in changes in marketing strategy. Thus feedback is not confined to interpreting the sales figures and diffusion curves of past products as simple 'experience,' it is a crucial ingredient of the process of invention itself.

Firms differ considerably in the way in which they organise the elements of this process. Innovation is not confined to the process of invention, but can occur at any stage in the process. For example the Amstrad PCW word processor, which pioneered the mass market for word processing in the home in Europe in the late 1980s, was based on existing—some would say obsolete—computer technology. The innovation—or the genius—arose from configuring this technology in a new way which allowed production costs to be trimmed and the product launched at a low enough price to compete with the electric typewriter rather than the then existing array of (professional) word processing systems. In this case an incisive analysis of potential user needs fed into the product configuration stage; the belief that there was indeed a product space in the home for word processing seems to have been based on market experience rather than technological understanding as we have used the term here.[7] A rather more engineering-led approach to the same product space was followed by Philips, who introduced a competing product—the Videowriter—which was developed in the Home Information Systems division of Philips and not by the division responsible for consumer electronics products such as televisions and videocassette recorders.

The elements of Figure 6.1 should not be seen merely as abstract concepts; they are labels for human action and interaction. Thus the actual definition of the ‘product space’ arises from the continuous interaction of scientists and engineers, product designers, line managers and (sometimes) marketers. These people may be employed by the same company (even if in different organisations in different countries), or they may be outsiders contracted to work on specific projects. Sometimes this interaction can take The form of conflicts over priorities and ideas, often with a ‘product champion’ struggling to gain acceptance for the ideas against the resistance or indifference of others. For example, the innovation of the VHS domestic video recorder within the Japan Victor Company was in its early stages concealed from the company’s senior management.[8]

The management of innovation involves a considerable range of choices, but some of

these choices may be heavily constrained by the firm's history and organisation. Conventional economic theories often refer to 'barriers to entry' in oligopolistic markets with very significant economies of scale. The consumer electronics (Audio, CTV and VCR) industry was often argued to be such a case in the 1970s, and indeed the departure of smaller players and the apparently relentless concentration of the larger ones was often taken as empirical evidence of the barriers to entry thesis. Amstrad's success against this tide with its innovative Products was not, however, followed by success in institutional markets for its range of personal computers, where Amstrad's image may have counted against the firm amongst corporate buyers. More attention should be paid to organisational factors in explaining how some firms can react quickly and speed up innovation to take advantage of the opening up of an identifiable new product space. The product space opens up within a range of opportunities presented by technological advances, but it is not always the primary innovator who captures value from the innovation. Other firms may be more able to move to the configuration of actual products, and be more astute in spotting markets for them.

Figure 6.2 captures the knowledge and skills that different actors bring to this process, whether in-house, brought in under contract, or acquired through more complex procedures of inter-firm alliances and joint ventures. In the case studies we show how the technological characteristics of different products poses distinctive problems for firms in managing the integration of skills. For software-dependent products the crucial issues concern the supply and timing of software; the conception of 'the product' embraces the combination of software and hardware, and decisions about software production depend upon the nature of the required skills. In the case of CD-i, these comprised a blend of computing and audio-visual components which was not found in existing computer software houses or video Production firms. For innovators of network-dependent products such as e-mail, among the important issues are access to and control of the network. In both cases the organisational dimension is crucial to the innovation process.

The balance of the contribution of the different actors involved in the 'whole product' varies considerably between firms, but also between different product spaces within the scope of the same firm. Philips is a major player in both home automation and interactive multimedia, but it has organised the innovative effort in these product areas in very different ways. In both cases the original product space was understood as 'IT in the Home' so that the D2B home bus and CD-i were product configurations within the same product space. Later on, however, as the technologies developed and market conditions changed, interactive compact-disc-based multimedia was identified as a product space in its own right and detached from home automation. Philips management at main board level identified CD-i as an important product for the future of the company, and in effect put home automation onto a back burner. A separate organisational structure was created—Philips Interactive Media Systems—better to co-ordinate the complex tasks involved in launching CD-i. In many ways, as we discuss in

Chapter 3, home automation is yet more complex, involving as it does the co-ordination of efforts from an even more heterogeneous range of actors such as house-builders and public sector utilities.

All of the different actors draw knowledge and experience from different sources. In our research we have concentrated in particular on the extent to which the knowledge base of the various actors incorporates information about consumer markets and consumer behavior. We have been concerned to discover how systematic this knowledge base is, and the processes through which its relevance for conceptions of the product space is assessed. What we have found, and described in detail in this book, is not altogether encouraging. The use of systematic theories, e.g. in marketing and consumer psychology, is more than offset by unsystematic experiential knowledge gleaned from a wider community of actors which meets at industry conferences and exhibitions, or in trade associations, or is passed on by trade and professional journals. Such knowledge is not necessarily 'inferior' to the use of systematic theories, since we have reason to question the real-world relevance of some of those theories, for example, the lifestyles approaches used by marketers in segmenting potential markets. What seems to be important is whether and how such knowledge is tested. Japanese consumer electronic companies seem not to employ conventional market research techniques at all; indeed Akio Morita of the Sony Corporation rejects them explicitly as having no relevance to new technology products.[9] But what many of them do, successfully, is create product teams which embody marketing knowledge even at very early stages of the design process, and operate a very rigorous system of testing prototype products, both with users and early purchasers. The results of such empirical tests are fed back rapidly into the innovation process so that improved designs can be brought quickly to market. The quality of the institutions within the firm which organise and deploy experiential knowledge is in some sense a substitute for, and in another sense an improvement on, formalised theories and techniques of decision-making such as the AIDA method employed by Philips in designing CD-i, as discussed in Chapter 5.

The firms in our case studies do use some systematic techniques for pre-market tests, for example focus groups to tease out consumer reactions to both the product space and to possible or probable product configurations. User reaction to electronic messaging, home automation and interactive multimedia has been tested and will continue to be tested. The difference, at least at first sight, seems to be that in Europe such techniques are used before product launches, whereas in Japan they are used extensively after test marketing to early adopters where the final designs for the eventual mass market products are not yet fixed. Early purchasers are offered prototypes at prices which reflect estimates of later mass-production costs, rather than development costs. If the market tests and monitoring of consumer reaction are favourable, then the firms ramp up mass production very quickly. If not, the products disappear even more quickly back into the labs. In Europe 'the launch' is a major event, with pre-publicity and often major advertising effort. In Japan early versions of new products appear in the major Tokyo

consumer electronics stores without pre-publicity, and ‘the launch’ takes place later when the probability of final success is higher.

Innovation can take place at any stage of this cycle, and indeed beyond it when products are in use by consumers. Firms which monitor post-purchase use of their products are able to take advantage of consumer-initiated innovation and add this to their knowledge base. This amounts to more than simply ‘knowing who your customers’ are; it extend to ‘knowing how your customers make use of your products.’ We have not been able fully to examine how firms do this in respect of all aspects of our case studies, since we chose to study technologies which have not (yet, if at all) reached a mass market in the UK. But we have collected evidence of post-purchase innovation in past products and related areas,[10] and we have some indirect evidence of this for electronic messaging. Contrary to the initial expectations of the producers, the home computer was mainly used in the home as a machine for games playing rather than a general purpose tool for household management, education and entertainment. As a result of the way that users appropriated the technology, it was reconfigured in different ways: the dedicated word processor found a market in the home, and a range of dedicated games consoles was launched. The ‘worthy’ intentions for CD-i, such as the multimedia encyclopaedia, which characterised discussions of the product in its early days may be confounded by quite different patterns of use, including games playing, interactive pornography and the like.

Given the complexity of the overlapping product spaces in IT, and the level of uncertainty which surrounds all new IT consumer products, we think that post-purchase innovation is likely to be of growing importance, especially as the distinction between ‘professional’ and ‘consumer’ IT products is becoming more and more blurred. Products now used in the home offer power and functionality which only a few years ago was available only to professionals. We should not be surprised if the imagination of millions of consumers surpasses that of a small number of professionals. The next generation of interactive multimedia products which will be based on recordable CD technology will offer almost unlimited scope for innovative usage, and opportunities for small businesses in much the same way as independent video rental stores helped to shape the pattern of how VCRs were used. Likewise Kodak’s PhotoCD will offer home users a powerful range of image handling tools which can be incorporated into innovative ways of recording and displaying, for example, family histories.

Thus Figures 6.1 and 6.2 should be read as a rough guide to a complex set of processes. It is a task-related representation of innovation, rather than one which builds on product characteristics, or firm or industry characteristics. To that extent it is very general, and useful insofar as it can help us to identify commonalities and differences within more concrete processes of innovation. The next section of this chapter attempts to do this for the case studies developed in this book. It examines the specific nature of the general concepts like ‘technological understanding’ as revealed in the innovation process for

specific technologies. It will be applied Exhaustively, but will be used to identify some of the more important issues in consumer innovation in IT.

The innovation process in consumer IT products

Technology streams, parallel innovation and standards

The particular technologies and products described in this book which may have an impact on the mass consumer market in the 1990s. In all of these cases some products are already on the market, often for professional applications, and in most cases there have already been products offered to individual consumers for home use. The technological heritage of these potential products is in effect the confluence, and then sometimes the separation, of a number of streams of innovation, including the development of some of what have earlier been identified as 'heartland technologies.' The specific technology that is common to our three cases, and beyond them common to IT in general, is the microprocessor. All of our cases use, and indeed depend on microprocessor technology, for their potential in the domestic market. Although, as we have pointed out facsimile (fax) technology dates back to the 19th century, until the 1980s it was a 'professional' technology with very restricted applications, especially in the newspaper industry. Thc respecification of the product as an everyday 'personal' technology, easy to use and affordable for the home, would not have been possible without the microprocessor. Likewise e-mail originated amongst professional computer users, but with the diffusion of cheap micro-computers and modems into the home, it became possible to offer e-mail as a consumer product.

The two heartland technologies which are the most important for our case studies are the microprocessor and the laser. It is the application of these which has created and helped to shape the product space for the new domestic ITs we have studied. Neither of these technologies completely 'redefined the product space, since the new products are sub-sets of more general forms of communication which have been developing for a very long time. They did, however, allow for a radical re-shaping of the products, and through this open up the possibility of their being incorporated into mass market consumer products.

Other innovation streams are also significant for our cases. For example, electronic messaging had its origins in the use to which large mainframe computers were put, and the development of networking through terminals attached to mainframes. Once computers were connected to the telephone network through modems, the possibility arose for the network operators to offer remote computing power, in the form of retrieval of information from central databases, to domestic telephone subscribers via a link to the domestic television. But it was the microprocessor which permitted cheap computing

power to become available to personal users, and opened up a product space for alternative forms of messaging (e.g. bulletin boards) not dependent on large central mainframes. Further the coupling of the modem to facsimile technology as a computer peripheral enabled a different form of electronic messaging, through the medium of paper as well as electronic pulses, to appear as a competitor to earlier forms of e-mail. Such confluences of major and minor innovation streams shift the understandings of the product space, as well as change the identity of competing products and the nature of the competition between them. Again we find that the vision of e-mail in the home begins with the simple idea of users leaving messages for each other in a central mailbox, but then becomes more complex and more uncertain as parallel technologies are fed into the process. The separate fax machine appears as a potential home product and competitor to e-mail, and subsequently the fax card and the fax modem are developed for the PC, and, more importantly for its take-up by small businesses and households, switches are introduced which permit fax and telephone to operate on a single line.

This process affects all of our case studies, and the wider spectrum of IT products in general. But there are important differences which arise from the characteristics and institutional sources of the different streams. This point can be illustrated in relation to the issue of standards. Where, on the one hand, stand-alone and software-dependent products are developed in the context of the consumer electronics industry, and the target market is seen as predominantly made up of households, then inter-product competition gives rise to de facto standards around the characteristics (and often patents) of the successful product. A prominent example of this has been the emergence of the IBM and the MS-DOS operating system as the dominant standard in personal computing, and the eclipse of rival formats. In the consumer video market, for example, a long process of competition led to the emergence of VHS and the eclipse of the competing Betamax and V2000 formats. But with further innovation, especially in camcorders, a successor format battle was being waged between VHS and Super-VHS in one ‘camp’ and 8mm and Hi-8 in another, and in digital audio technologies between Digital Compact Cassette and MiniDisc formats. This battle was only the latest in a long line stretching back through cassette versus 8-track tape technology to drum and disc phonographs. De facto standards setting can be extremely expensive for the loser, and provides an incentive to collaborate in setting standards before market launch, as was successfully done between Philips and Sony with CD-Audio, and was attempted with CD-i.[11]

Where, on thc other hand, the innovation stream runs through public sector institutions and public markets, and/or the technologies are network-dependent, it is more likely that there will be a common interest in either collaboration towards defining de facto standards, or institutional pressures for the definition de jure standards through public standards bodies such as the International Standards Organisation (ISO) or CENELEC. The home automation case study is a good example of a situation where producers’ interests lay in ensuring that different products should be interconnectable, so that much

of the early emphasis consisted in a collaborative effort to determine standards through the Eureka and Esprit programmes. Such collaboration gives rise to shared perceptions of the product space within a social network, and a good deal of consensus about product features.

Standardisation itself, however, does not ensure a successful product, especially where success requires consumers to make purchases from their own pockets. There is a danger of standardisation locking-in firms to a particular stage of technological development during the process of product development, which may lead to unexpected competition at the marketing stage due to unanticipated technical change in other technologies. An important example of this was the Eureka 95 project to define a high definition television (HDTV) system for Europe based around transmission technology(MAC). Since the project began in 1986 there were important advances in digital compression and television signal manipulation technologies, which enable some of the advantages of HDTV to be realised through incremental improvements around the existing PAL-SECAM transmission system, or through digital technology applied to standard definition and standard aspect ratio television.[12] The first version of MAC, used by the ill-fated British Satellite Broadcasting venture, offered few evident advantages to consumers over the PAL system used by its rival Sky. Consumers, unlike public sector broadcasters, cannot be compelled by government regulations to buy and use new technologies which are marketed as individual consumer products.[13]

The home automation case demonstrates this process very well. Since it is a network technology, both within the home, and connecting the home to the outside world through telephone or television cables, the various actors can quickly perceive the benefits of early moves towards common standards so that the various products of different manufacturers will all work with each other. Individual manufacturers do not themselves make the whole range of home automation products, but the fact that their products can be connected to those of other manufacturers adds value to their products. Insofar as telecoms network operators and public utilities are involved, the latter, for example, in mainsborne signalling technology, there is a predisposition towards agreed de jure standards in advance of mass market launch. The Eureka and subsequently the Esprit projects have had the definition of common standards as their prime objective. But the process, which once again seemed relatively uncomplicated in its early stages, became more complex as parallel developments occurred in telephony, especially the development of the Integrated Services Digital Network (ISDN) pioneered by the public network operators. A network technology for inside the home, like Philips' Digital Data Bus (D2B), is greatly affected by ISDN technology, and at the very least engineers have to develop interface technology and interface standards to allow communication to flow between the two networks. While this process was taking place, parallel innovations in digital communications, involving Asynchronous Transfer Mode (ATM) technologies have made the future of ISDN uncertain, since more can now be accomplished using existing lines. The result is a familiar story: technology takes much longer to introduce

than was originally expected.

The expected diffusion paths for e-mail into the home have been diverted by the development of the low cost personal fax. Likewise, Philips and Sony expected that the CD-i standard that they had agreed in 1986 would lead to the early launch of CD-i as a consumer product. However, parallel technological progress in digital video compression by the RCA Sarnoff Research Laboratories, and the announcement of Digital Video Interactive (DVI) by RCA in 1987, forced Philips to reconfigure CD-i to include full-screen full-motion video for the consumer product. Parallel work on digital video compression for the motion picture industry and the telecoms industry has put compression technology into the institutional domain where de jure standards are critical. The result was a further delay in the launch of CD-i whilst the ISO considered draft proposals, including CD-i, for a common standard for video compression, which was eventually agreed (as MPEG-1) in 1991. Even before its launch as a professional product, the new owners of DVI, Intel, were forced to adopt a new video compression technology in order to keep abreast of technical change. The longer the delay, the more likely it becomes that competing products will be launched and yet another format battle joined. The advantage of such battles, however, is that they avoid the danger of prescribing the future course of the innovation process through non-market-sensitive collective decisions.

The heartland technologies considered in this book are leading towards a convergence around digitalisation as the central thread of all communications technologies, and the convergence of digital compression techniques around Discrete Cosine Transform (DCT).[14] Once this convergence occurs, the once solid boundaries between computing, broadcasting, audio-visual manufacturing, telecommunications provision and equipment manufacturing will have all but disappeared in terms of technological differentiation. This does not, however, mean the integration of all of thc institutions involved, since firms, professions, trade associations, government departments, regulatory provisions and standards organisations have developed around historical boundaries. Institutional change can be set in motion by such technological trajectories, but it is constrained and often slowed down by the resilience of embedded patterns of behaviour, and clearly lags behind technological momentum.

From ‘invention’ to ‘product space’

We have suggested that there are major and minor innovation streams, which can divide and join in unexpected ways. It has been a constant feature of innovation that technologies developed in one context are applied imaginatively — sometimes through the genius of a single individual — to areas quite unrelated to their origins. Entirely new industries such as semi-conductors and biotechnology have arisen through spin-offs

from existing technologies. At a more modest level, the application of laser technology to ‘recording sound and pictures onto an optical disc was one such spin-off. In order to turn this into a marketable product complementary innovations in both materials and processes were required, as was the further development of microprocessor and integrated circuit technology. But as we have stressed repeatedly, the definition of the product space, as well as the process of configuring the first products, took place against the realisation that the designing of appropriate applications software was going to be crucial to the success of the product. This software could not be created using existing skills and firms; new kinds of integration were required for multimedia design. Work on the software infrastructure led Philips to the web of intemational joint ventures outlined in Chapter 5, and to a considerable investment over a period o several years before any return could be expected from the consumer market, with the expectation of few, if any, returns from hardware manufacture. The lead time before profits could be realised led to a further reconfiguration of the product as a professional as Well as a consumer technology, and a reconsideration of the product space in relation to institutiona1 and consumer markets.

In contrast to CD-I, home automation has been a ‘spun-together’ technology, or in another terminology, an example of ‘technology fusion,’[15] in which quite separate innovation streams came together to create the potential for home automation products. Innovation in domestic electrical technology, mainsborne signalling, building materials, audio-visual network-ing and local area computer networking offered potential for inter-linkages, or fusion. The tendency to control electrical appliances through built-in microprocessors offered the potential for their being linked together via a network and controlled remotely. Here the product space was deeply influenced by technological possibilities envisaged by public sector utilities and in many cases derived independently of any systematic understanding of consumer needs or demands. But in Britain, under the auspices of a quasi-governmental body (NEDO), some consumer research was undertaken which helped producers to see how they might configure products. In this case, however, the range of players and the variety of configurations is enormous, and the boundaries of the product space are less clear than for interactive multimedia. Different combinations of actors, such as the Esprit group and the Home of the Future consortium, represent different kinds of firms, and they tend to define the product space in different ways. Smaller hardware firms can identify market niches, e.g. in products for the disabled, and develop products within the space that can be marketed independently but may later be adapted as standards are set.

Electronic mail to the home via the telephone network is a classic example of a technological solution in search of a problem, and can be described as technology-focused product space. In Britain Prestel was devised as a means of using available computer technology to get more revenue from the network, but its introduction pre-dated both the home computer and the development of more user-friendly man-machine interfaces. Thus in its original form it used a numerical keypad, a modem and a

television, and its marketing was based on the (unresearched) concept of there being an unfulfilled consumer demand for general information held in computer databases. The inter-personal electronic messaging was added to the system later on, when the means of accessing Prestel had become the personal computer. Its diffusion into the home was largely restricted to home computer hobbyists, and assisted by the development of cheap modems for Sinclair machines.

The potential of e-mail for a wider consumer market remains uncertain, especially in the face of advances in personal fax technology made by Japanese consumer electronics and office equipment suppliers. Their ease of use and familiarity suggest a much greater potential for people working at home, but perhaps later more generally as a consumer product. Both examples of electronic messaging illustrate the more general proposition that the boundaries between consumer and professional products and technologies are continuing to become more blurred. Domestic fax is more clearly demand-focused, in that it has been market trends which have shaped the direction of product design and development. Its diffusion has been easily observable through signs and letterheads, and its user interface is less complex and already familiar to those with experience of the telephone and the photocopier.

The actors

Within firms and inter-firm networks we have identified the key actors as engineers, product designers, marketers and line managers. Their numbers, designations and distribution within the firm varies considerably according to the type of firm, and the nature of the technology.

CD-i involves as core partners three of the world's biggest consumer electronics companies and a major manufacturer of microprocessors and integrated circuits. Its early development was engineer-driven; indeed, the original two core partners, Philips and Sony have long been regarded as innovators and pioneers of new technology with very large corporate R&D centres. Philips experienced some difficulty in securing an organisational home for CD-i development within the corporate structure once the basic R6tD was completed and the product development phase in progress. For many years Philips had twin hierarchies of engineers and commercial managers at each level of the company, and its multinational operations were Composed of a loose federation of semi-autonomous national organisations. During the lifetime of CD development, Philips has attempted to move to a product division structure across its entire field of activity. CD-Audio player manufacture was established in a single vast plant in Belgium to serve the global market. With CD-i however, the more complex relationship between hardware and software, and the overlap between professional and consumer markets, has meant that the company has found it difficult to establish secure boundaries. Traditional inter-divisional rivalries between telecommunications and consumer electronics, and between consumer-oriented divisions and business systems, confused the innovation strategy for

CD-i and led to the radical shift in emphasis described in Chapter 5. The variety of skills required for software development led Philips to try to manage a number of different groups of creative professionals in computer software and the audio-visual industries with whom their line managers had little experience of dealing. The web of joint ventures that made up American lnteractive Media proved expensive to operate and difficult to control. The eventual solution may well be that Philips goes even further than it has already gone in relaxing its attempt to control software development and enforce quality standards. In 1990 Philips went into the red for the first time in its 99-year history, and realised it simply could not afford to carry all the costs of developing the software infrastructure.

Home automation reflects some of the same diversity of skills and professional communities, but unlike CD the number of firms involved in hardware development is large, and includes many medium-sized and small firms. Many of these firms combine the tasks of R&D, product design, line management and marketing. It is for this reason, as well as for the standards issue discussed above, that formal and informal means of collaboration have been embraced. However, it is clear that many of these smaller firms feel excluded from the processes at work in Eureka and Esprit, and the large firms appear to benefit disproportionately from the public money distributed through such programmes. The US experience in the Smart House programme reflects similar pressures to involve a range of firms in a common programme, and also reflects the problems arising from the different interests of diverse firms. The control of intellectual property has become a divisive issue in the Smart House programme, and many of its original goals have been dropped or postponed. The experience of home automation shows how difficult it is to manage inter-firm collaboration in a way which is seen to be just by those firms excluded from formal participation. An as yet unresolved issue for Esprit is that of what happens when the phase of ‘precompetitive collaboration’ ends, and the phase of fierce inter-firm competition in the marketplace is supposed to begin. It will only become a pressing issue, however, if specific products appear from the collective effort which promise to achieve a substantial market. As yet the market potential analysed in consultants’ reports has yet to be tested.

Electronic mail presents another variation in terms of firms and industry structures. The network is managed by a very strong firm (BT) with a smaller competitor (Mercury), and both have already launched e-mail services aimed at both professional and small business/residential markets. Other providers will include cable TV operators and a number of other organisations (including British Rail) licensed by the government to offer competing services to those of BT and Mercury. All of these new players will investigate the provision of domestic e-mail alongside smaller firms which offer services over BT or Mercury (or soon, other) networks. The different versions of product configuration for domestic electronic messaging tend to include the same hardy perennials like home banking and home shopping, none of which has yet proved to be a mass market proposition. Fax may offer a more perceptible cost and efficiency

advantage over the postal services, especially as the number of users increases beyond the critical mass threshold which has yet to happen in the consumer market for e-mail. The suppliers of fax equipment are mostly major Japanese and S.E. Asian consumer electronics firms, many with a wealth of experience of responding to consumer demand. By contrast e-mail providers are new service operators targeting niche markets, or BT (which lacks experience of selling in a competitive market directly to consumers).

Configuring the products

The nature of the product space, and thus the constraints which affect product configurations, are crucially affected by the different characteristics of the various kinds of information technologies that we outlined in t; opening chapter. We analysed these in terms of different kinds dependencies, the most important of which we called software- and network- dependencies. What such dependencies mean is that 'the product' cannot be properly defined except in relation to the nature of the software, or the characteristics of the network(s). In our case studies we have one example of a software-dependent product (interactive multimedia), and two examples of network-dependent product which embody different types of network. We did not include a study of a stand-alone product, such as the microwave oven or the video camcorder.

Our case studies revealed the importance for innovation in consumer products of different kinds of technical networks, the most significant of which is the public telecoms network which provides the carrier for most forms of electronic messaging (although in professional applications, such as banking or factory automation, dedicated private networks, or virtual private networks within public networks, are more important). The strategies of the public network operators, principally BT in Britain, have had a determinant effect on the diffusion of e-mail, with once successful entrepreneurial operations such as Micronet 800 developed for home computer users coming under the BT corporate umbrella. Unlike in France, where public investment secured a mass user base for Minitel, BT has preferred to adopt a low-key demand-led rather than supply-push approach. Other suppliers have attempted to configure their products rather differently to BT within the same product space. For example, a new company, Keyline, announced plans in 1990 to introduce a home shopping service, attempting to secure support and investment from large mail order firms in order to build up its critical mass of users so that additional services such as e-mail could be added at a later date. The service was scrapped even before market launch.

The critical mass problem is not unique to network-dependent technologies, but poses more serious problems for the initial diffusion of the technologies than it does for, say, software-dependent products. In the latter availability and price of software is affected by the size of the hardware base, but the utility of the product itself is less affected than it is for communications technologies where utility increases in proportion to the number of users. This problem has not seriously affected the penetration of fax in the corporate

sector, but it may well make diffusion into the home more difficult where, in the absence of a large domestic user base, the justification for purchase is less evident than for business users. New entrants, such as Amstrad, have configured their fax machines so as to appeal to the small business user and the home worker by incorporating into some models a line switch and answering machine so that to use fax does not require the rental of a second telephone line, and this feature has now been built into all the most basic models which might be bought by individuals or small firms. E-mail, at least for the immediate future, is likely to remain the preserve of those who work at a terminal every day. It is a little early to say in what way cellular radio networks might open up new product configuration possibilities for e-mail. The advent of the Personal Communications Network (PCN) in the 1990s may see novel combinations of speech and written messages on quite new kinds of terminal equipment. Clearly both the product space and specific products based on telecoms networks are continuing to evolve, and much will depend on how far the entry of new competitors, and new forms of regulation, affect the now dominant players.

Home automation is network-dependent both internally within the house, and for its communication potential with remote locations. The technology of intelligent wiring as attempted in Smart House has proved difficult and expensive to implement, which suggests that the alternatives using the mains as a carrier for signalling, or a special circuit as in D2B, may be more likely to be commercialised in the short term. The need to standardise the network places severe constraints on at least the technical features of product development for home automation, but at the same time it provides great opportunities for suppliers who can offer one or more products which gain added value from their compatibility with, and enhanced utility from, their connection to other such products through the home network. In such cases their utility is not governed by how many other consumers have purchased home networks. But it may be hard to justify the extra expense of purchasing, say, a network compatible oven against a stand-alone unit when to gain full utility the network hardware and other linked products have to be purchased. Such factors have led producers to move towards distributed intelligence in home automation systems, so that the network can be built from the bottom up, rather than having to be installed as a whole, before any connected product can be used. This solution has obvious attractions where the largest part of the consumer market is likely to be retro-fitting of home networks to existing houses.

Interactive multimedia systems like CD-i are likely to find a mass market only if the software is attractive to consumers. There is some evidence from the personal computer industry that really successful hardware products (like the Apple II and the Macintosh) have been successful because of the appeal of specific software products (Visicalc and desktop publishing respectively)

or the reputation and clout of the supplier in cautious institutional markets (the IBM PC). CD-i (and its competitors in the consumer market, such as VIS) must be seen as

hardware/software combinations whose ‘image’ is as much constructed by the nature of the software as it is by the hardware. Given the novelty of the whole concept of interactive multimedia, the major constraint for software development has been the limited ability of the hardware manufacturers to persuade potential developers to invest in software for a product which has not been launched. Moreover the hardware suppliers are aware that, as the market expands, the value of software sales soon outstrips that of hardware, so that to capture an adequate return from the initial investment they must become involved in software production. The trend has begun in the last few years, spearheaded by Sony’s purchase of CBS Records and Columbia Pictures, and Matsushita’s following suit by taking over MCA, for the Japanese consumer electronics majors (now including Toshiba and JVC) to invest in software production to complement their range of consumer products. These have been multi-billion dollar investments in support initially of existing audio-visual products like CD-Audio and VCR, and new ones like Sony’s MiniDisc, but the importance of software archives for recycling as multimedia products in the future is evident.[16] Software production for computing and multimedia is, however, a part of the industry which has fewer barriers to entry, not least compared to the patent protection surrounding the CD-i and DVI standards and hardware, and the potential for small firms is the greatest. This is less evident for consumer applications of CD-i however, where as we have seen a substantial investment is required to produce image qualities and special effects comparable to broadcast television.

From invention to innovation: the market test

Successful innovation in consumer products can only occur when a product or a technology finds buyers. There are several examples, such as the V2000 VCR, where the ‘better’ technology has failed and the ‘inferior’ technology has succeeded. All of our case studies come from the field of consumer electronics, and involve technologies where there is unlikely to be a substantial amount of public purchasing. In addition the technology cannot usually be argued to have strategic implications for national economic or defence security, which might justify public subsidies.[17] The test of successful innovation in these product spaces is almost entirely a market test.

In such cases the advertising and marketing effort is an important determinant of success, and the winning firms are likely to be those where marketing criteria are built in to the innovation process at all stages, and not simply at the final stage after products are designed. Market intelligence can

help to shape a product, and it is often innovative configurations of existing technologies, rather than sallies into novel product spaces, which provide substantial rewards. The radio/cassette combination, twin-deck cassette players, and, above all the

Sony Walkman, are examples of imaginative reconfigurations of ‘maturing’ products. Such innovation can take place in software as well as hardware, and it is likely that we will see existing audio-visual material creatively ‘reworked’ to provide quite new interactive programming. In CD-i hardware we will see lap-top and hand-held players, as well as a spate of attempts to provide combinations of CD-i with existing audio-visual products like CTV and VCR. As we have seen with VCRs, the development of a standard can lead suppliers to differentiate their offerings from those of their competitors by way of adding more and more features. The advent of recordable CD in the 1990s will add considerably to the importance of post-purchase innovation in CD-based products on the part of users, which will greatly shape the social impact of the technology.

Home automation provides the most scope within our chosen case studies for different product configurations, in part because of the much larger number and diversity of suppliers which means that the product space is less densely populated. For the mass market, early indications suggest that, at least in Britain and the USA, home security will be an important initial application. But also significant, specially in offering opportunities to small firms, is the application of the technology to the needs of the elderly and the disabled, where public policies may well influence at least to some extent the direction of the market. However, such diversity leads to acute problems for suppliers of how to market home automation products, and how to give it a consistent (and non-threatening) image when many consumers express fears of being controlled by machines. Such problems suggest a slow and incremental build-up of the market, with as many failures as successes. Here the ability of suppliers to test prototypes and respond quickly to market signals may be a critical factor in determining which of the vast number of players accumulates a winning hand. The possibility of world standard products, like the fax machine, VCR and CD-Audio and eventually CD-i, is a remote one in home automation, given the sheer heterogeneity of consumer habits and tastes in most of the various application areas, and the mosaic of national regulations in areas such as building and public utilities.

Conclusion: innovation as a process

The emphasis in this chapter has been on seeing innovation as a dynamic and cyclical process which encompasses the sale of the products as well as their research, development and design. We have argued that the idea of the product space can be useful in highlighting the extent to which technological spin-offs and convergences present opportunities for new products, but by no means guarantee successful innovation. It is not, however, our task in this book to predict what successful products will arise from those examined in our case studies. We have given some considered views, however, on those factors which affect the boundaries of the product space and which affect the configuration of products within it. We have drawn particular attention to organisational factors within the firm, and in inter-firm collaboration. In consumer markets the

important role of such organisational structures should be to collect and interpret data on market characteristics, and feed it continuously into the innovation process. We have commented on the weight put on anecdotal and indirect evidence of consumer preferences and behaviour, which arises in part because of the difficulties of applying standard market research techniques to radically new technologies. What could be done, but is rarely done in any serious way, would be to collect evidence in detail and in depth about the way in which consumers use technology in the home.[18] It seems to us that a better appreciation of domestic life, and the role played within it by specific products, would help to identify specific needs around which firms could organise product design, and even allocate resources for research and development.

Notes

1 An earlier version of part of this chapter appeared as A. Cawson, L.G. Haddon and I. Miles,'The heart of where the home is: The innovation process in consumer IT products,' in P. Swann, ed., *New Technologies and the Firm: Innovation and Competition*, London: Routledge, 1993, pp. 242-264.

2 The Japanese electronics companies have put consumer IT at the centre of their IT strategies, and have reaped handsome rewards from the mass markets they have helped to create.

3 For example, in the application of the Japanese Hi-Vision HDTV technology to special effects in the motion picture industry, such as those in the film Jurassic Park.

4 For a discussion of the experience of the 1980s, see Cawson et al, (1990).

5 Initially the application of digital technology to television is likely to be in the form of multichannel (upwards of 150 channels) TV, but 'video on demand' (where films are downloaded from a central server in compressed form through the telecommunications or cable TV network, and then stored and decompressed for viewing within the TV set) and various forms of interactive television are likely to follow.

6 Diversified companies like Philips can follow many innovation streams through in-house activities. For more specialised companies, survival as existing markets saturate may depend on acquiring knowledge about innovation trends in other industries and applying these to their own business. One example of this is the innovation of fibre optic cable in glass companies such as Corning in the United States. Alternatively, some very successful companies such as Canon have applied their existing expertise (in Canon's case in optics) to new areas (such as photocopiers). For an analysis of these activities within Japanese companies, see F. Kodama, forthcoming.

7 David Thomas, *Alan Sugar: The Amstrad Story*, London: 1990.

8 P.R. Nayak, and J.M. Ketteringham, *Breakthroughs!* New York: Rawson Associates, 1986, chapter 2.

9 Morita, *Made in Japan*.

10 E.g. the home computer, see Haddon, 1990.

11 In mid-1993 eleven major multinational electronics companies announced agreement on standards for the new generation of digital VCRs prior to product launches in 1994/5. If this agreement does prevent a format battle, it will be only the second time it has happened (the first was Compact Disc-Audio). It seems likely, however, that a digital disc recorder will prove more successful in the longer term.

12 See Cawson (1993) for an elaboration of this point.

13 Although as the Minitel case in France shows, the diffusion of technologies can be accelerated when hardware is given away or subsidised.

14 Beyond DCT in a subsequent generation of compression technology lies fractal geometry, which promises much higher compression ratios, and thus the possibility of squeezing much more information into existing channels and carriers.

15 F. Kodama, 1989

16 Sony has recently collaborated with Fox Television in the United States to digitise the entire archive of 20th Century Fox newsreels.

17 High definition television appears to be a unique example of a consumer technology with applications in ‘strategic’ areas such as defence.

18 Leslie Haddon and Roger Silverstone are doing just this in a project at the University of Sussex, supported by the Economic and Social Research Council.

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Figure 6.1 A Dynamic Model of the Innovation Process

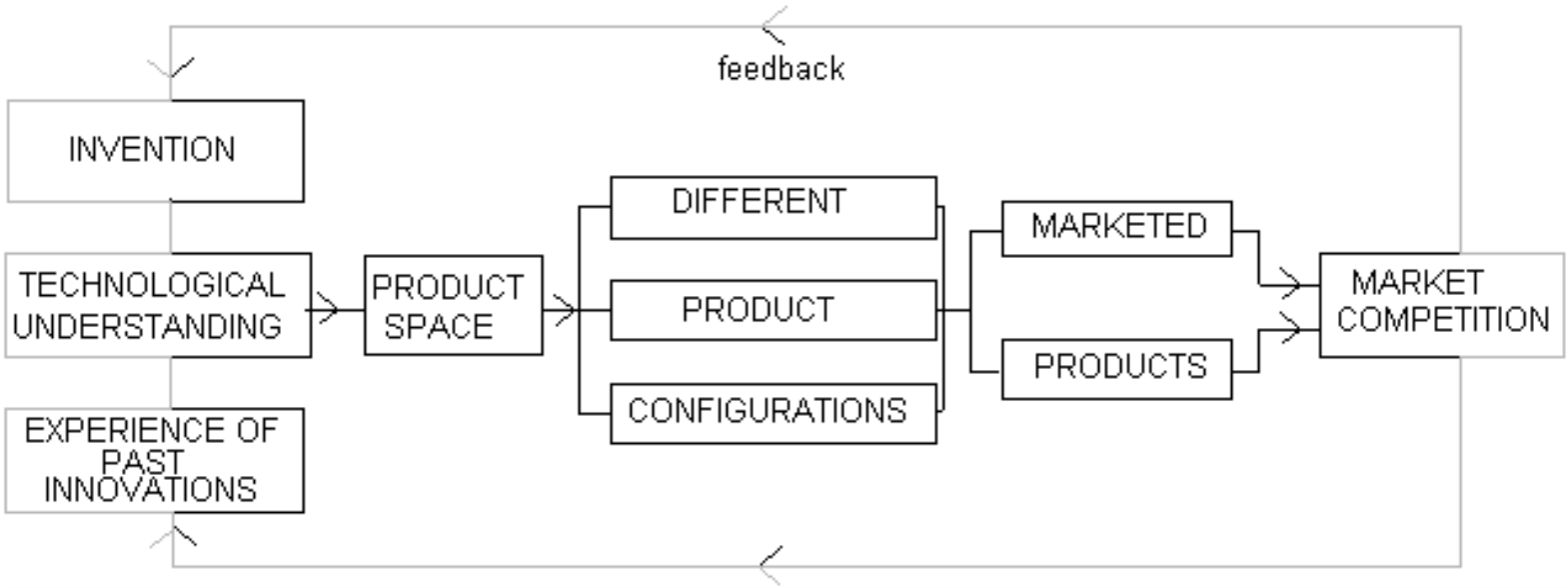
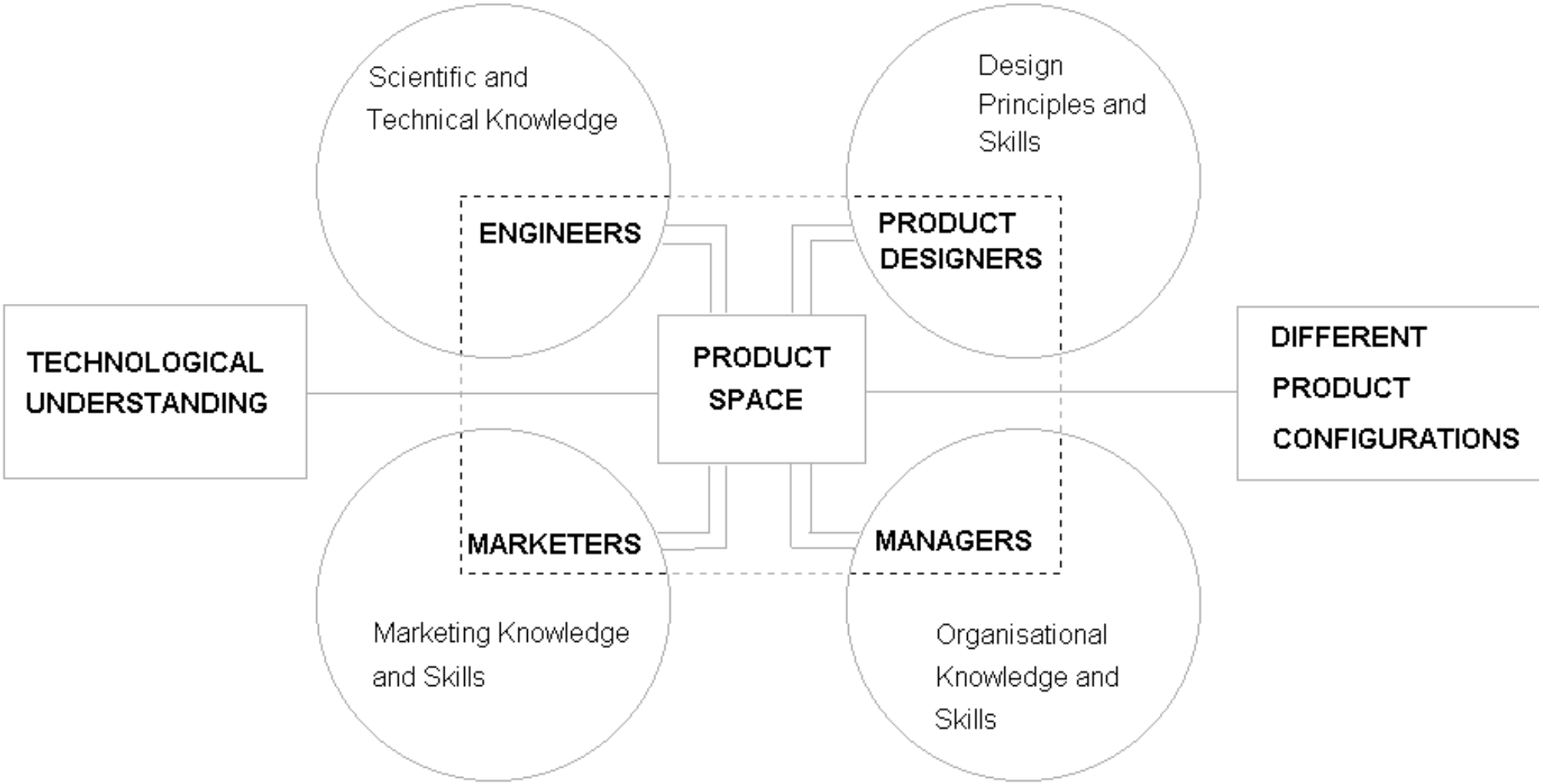


Figure 6.2 Organisational Aspects of the Innovation Process



Chapter 7

Conclusion

Conclusion

This book provides an account of the development of new products in an area neglected by previous innovation studies: consumer IT goods. The case studies we have chosen are fascinating in their own right and we know that there a number of readers will be keen to discover more about these particular product areas. Beyond that, we feel that taken together they cast new light on contemporary innovation in consumer technologies in general. These studies provide, at last, sufficiently complex histories to move debate on from some of the previous rhetoric about the technological and social shaping of new products. But first, let us be clear about what innovations have, and have not, been the object of our investigation.

To start with, this research has dealt principally with innovation initiated from and occurring within large companies. The presence of smaller firms has been noted: including a range of small producers in the case of home automation, modem and switch producers in the case of e-mail and Fax respectively, and some of the software houses in the case of multimedia CD. But, these smaller firms have mostly planned an ancillary,

though sometimes significant, role in relation to product developments promoted by larger corporations. Our observations apply mainly to the latter, so we should point out that some of the processes of innovation within small firms may well be different from those outlined here. For example, knowledge about consumption will probably be derived from a more restricted range of sources, such as an even heavier emphasis on personal experience and preferences, where there is less scope for market research inputs.

We have also focussed specifically on companies producing IT products. Once again, some of our observations may well apply to innovation occurring in relation to more traditional, non IT based, products. But recent writings with the marketing literature suggest that the field of IT has some particular features which may well make a different to the process of product development.[1] One such feature is that the speed of change in this area creates a great deal of technical uncertainty. Another, as we noted earlier, is that market uncertainty is high because of the rapid appearance and radical nature of the products. Previous consumer technologies, such as white goods, diffused over a far longer period.

Lastly, there are the convergence arguments: that IT is forcing more and new forms of collaboration, as well as a rethinking of traditional specialisms and product boundaries. Certainly, we felt this sense of change in our case studies. These convergence debates had initially made the choice of software-dependent multimedia and hardware interdependent home automation attractive. And even some of the messaging facilities, when packaged with other services, involved more than one actor. The development of purely stand-alone products offered less chance to observe such interaction, and so such goods were not covered. Nor, for different reasons, were broadcast IT products. These possess distinctive features, for example, through the fact of regulation (although forms of regulation are also experienced in the area of telecoms). Broadcasting history has also shaped knowledges and ideas about production in particular ways. However, we decided that there is already a vast amount of audience research and sophisticated academic theorising of the audience, some of which has fed back into media production.

The three case studies each pose different problems and offer innovators different strategies because of the nature of the technology. For example, there are the critical mass issues peculiar to products using public networks for some form of communication. With software-dependent products, hardware producers have to react to the fact that the software outside their control becomes as important as the hardware. But aside from such differences, we can now turn to the important, common lessons to be learned concerning how product opportunities are created, negotiated, recreated and represented.

Starting points for innovation

Producers often talk about the preeminance of consumer demand. But, in practice, how far does such demand guide the development of new products? This was one of the key starting questions which we can now go some way towards answering.

Occasionally, technological products are inspired by a very close relationship with a particular set of consumers and a perception of their wants or needs. In the case studies, we had the example of environmental controls for the disabled, where some small firms became involved precisely because they had experience of a (physical) problem in need of a solution.[2] Another example of close contact between suppliers and a particular niche market would be the early hobbyist microcomputers, produced by fellow enthusiasts who were setting up in business. Similarly, hobbyists provided a considerable amount of feedback to Micronet in the electronic messaging case study.

However, such a starting point for innovation would appear to be rare in the case of larger firms geared to mass markets. Here, it is less common for a simple vision of consumption to be the prime inspiration for product development. In the areas we have studied, producers do not simply start with the questions: what do people need, what are they interests or what do they desire. Instead, producers search for any such vision through the lens of technical change, trying to spot any ways in which a technological opportunity might be taken up. The marketing literature suggests that innovative ideas can emerge from diverse sources. However, in the case of our IT product concepts, it was mainly the staff with technical insights who actually generated these ideas. Only afterwards could consumers or other staff comment on these proposals.

A second observation involves the question of what technology is involved. One key point of departure is the firm's own existing expertise and past experience, e.g. Philips and CD technology. This, after all, is the main resource from which it may derive a competitive edge against other firms. This reminds us of a point that tends to be all too easily forgotten in some discussions of what products to develop. Innovation takes place under conditions of inter-firm competition. Hence, companies are interested not just in consumer demand, nor in technological opportunities in general, but in the particular technologies where they have advantages (if only by virtue of being first into the field) and so have better chances of making a profit.

In addition, firms develop perceptions of the wider technological trajectories — which brings us to our interest in ‘heartland technologies.’ For example, the awareness of potentially declining costs of chip-based technology led many firms to embark on a search for relevant applications, for market possibilities. This was particular important for home systems.

To put these two observations into context, we can return to the line of criticism expressed by, among others, some feminist writers. Such critics argue the case for more 'socially useful' innovation than they feel exists at present.[3] Currently, too many firms fail to develop what people most pressingly want or need. We saw how these writers cite, for example, the desirability of innovations which might reduce the physical labour involved in such activities as vacuuming and ironing. In fact, this was the basis of one criticism of home automation — that home systems failed to address the really important issues in women's lives.[4]

Such issues were not prioritised by the firms analyses in the case studies. Here, these heartland technologies were not applied to finding labour-saving applications. Instead, the technologies were translated into products which delivered other forms of 'benefit': new channels of communication, access to information, new forms of audio visual experience, security, the convenience of remote control or time-shifting, etc. While we might still lament that fact that more labour saving products are not developed, this cannot be the sole basis or criteria for evaluating those products which are developed. Communication, security, 'leisure' experiences, etc., are meaningful in people's lives, as some writers on technological innovation are now beginning to acknowledge.[5] So, we would object to any or all of our case studies being simply dismissed: what counts as 'socially useful' needs to be broadened.

In the introduction, we referred to the way in which such analyses stressed how technological products were expressive of values. It was emphasised then that such an analysis of how products were socially shaped was to simple, attributing too much control to particular designers. Now, our examples have shown how product developers have limitations imposed upon their choices by the fact that innovations are built on the back of other innovations. In other words, there are limitations derived from the nature of the technology itself.

We can reiterate that the heartland technologies, or the past innovations to which firms look, are not infinitely malleable, to be shaped in any form and given any meaning. Technological 'texts' clearly do have their own 'material constraints. This also becomes clear when technologies take far longer to develop than anticipated, by virtue of technical difficulties, which may from the view of particular firms mean missed 'windows of opportunity.'

The meaning of 'technology driven'

Once the staff of large innovating firms try to conceptualise applications, they have to think about potential consumption. As we have seen, this may be though imagining their own household, and how innovations might find a place among the interactions within

their family. In fact, this approach is more common than we had anticipated. The significance of this practice is that the perspective and preferences of innovators coming from certain social niches (in terms of class background and technical training) may be substantially different from those for whom they develop new products. Feminists have already drawn attention to the fact of male technical staff producing for female consumers — asking whether female innovators might make different choices.

But, one qualification needs to be added here, which is sometimes neglected in critiques of innovation. This is that there are more staff involved, in different capacities, than just those from the R&D labs. In other words, there is more to bringing products to market than just technical development. A range of actors are involved, both within the firm and outside, in the process of prioritising different lines of innovation (which compete for resources within firms), in marketing and advertising, in helping to organise the various forms of collaboration which have been noted, in the industry press, in distribution and retail, in supplying installation and maintenance services, etc. These all make contributions along the path from original product idea to its final appearance in the market and the manner of that appearance.[6]

With this caveat, it remains true that in the early stages of product genesis, the initiatives often come from, and have to be championed by, the labs. This has a bearing on both the early prototypes and such matters as the broad shaping of technical standards, as was the case with home automation. At this stage, the scenarios envisaged by technical staff can already add design constraints to the technology. Hence, a process sometimes described as being ‘technology driven’ innovation might be better characterised as being ‘technologist driven’ (as opposed to marketeer driven).

So what of more direct consumer inputs to the whole process? On the whole, consumers play little part at the very early stages. The common view of many technologists is that it is difficult for end-users to appreciate the potential of radically new technologies. Many such innovators are already somewhat sceptical that consumers might even be able to evaluate the proposals of the labs, which is the normal stage where ‘the public’ is introduced into the process. It is not surprising, then, that such staff would be incredulous at the suggestion that such consumers might actually generate radical product ideas which would in any way match the competences of the firms concerned. Consumers might state a desire to avoid ironing. But they are less likely, apart from technical hobbyists, to generate the idea of, for example, a Minitel system.

Yet, we saw in the introductory chapters that a number of writers specifically addressing themselves to innovators have been promoting the idea of a ‘marketing revolution.’ This advises producers to identify latent consumer wants rather than sell simply what they could produce. Despite doubts about the early involvement of actual consumers in the innovation process, it would appear that this more general marketing message has to

some extent filtered into firms.

During the interviews, product managers, who usually but not always had technical backgrounds, regularly differentiated themselves from those enthusiasts in the labs whose horizons were limited by thinking in engineering terms, or whose ideas were ‘unrealistic’ given the firms past experience of the market. Such managers attempted to learn from past experience, which is part of the motive for the intense producer interaction and pooling of ideas which are discussed below. In addition, the firms which can afford it seek the views of outsiders, be it from marketing consultants or academics (as we found out in the course of research) to supply the information which they often feel they are lacking about the interests and behaviour of end users.

Perceptions of consumption

With industrial goods, the size of the markets involved often means that suppliers could find out a good deal about a limited number of major clients. Indeed, some clients become intimately involved in the innovation process. This enables suppliers more easily to observe how their clients ‘consume,’ or might consume, innovations. Indeed, such clients may even articulate their perceived requirements sometime.

In the case of consumer products, where we are talking about the homes of a huge number of end-users, this kind of visibility and involvement is less possible. There are some intermediary agencies who might speak on behalf of social groups. For example, the Consumer Association summarises and passes on to producers complaints and suggestions sent in by the public, as well as commissioning its own studies. Agencies such as Age Concern are currently considering a role in advising firms about the needs of the elderly.[7] But these indirect sources of knowledge about consumers still only play a limited role.

The picture emerges of innovators in consumer markets piecing together evidence, constructing a picture of family and social life which is far less visible than the operation of an organisation, This process involves considerable interpretative work on the part of the producer rather than simple observation — leaving scope for some of the disagreements over the scenarios which emerge. Nevertheless, producers as a community may equally act to reinforce each others’ images of end users.

In broad terms, then, producers are clearly constructing their visions of consumption as opposed to the view expressed in some of the marketing literature that there are potential or even articulated needs which are ‘out there’ among consumers waiting to be discovered if the right techniques are used.

Selection and struggle

The process of spotting applications is by no means straightforward. There are doubts as to whether some ideas provide serious or merely trivial benefits. Worse still, some products ideas might be thought to be 'gimmicks,' which is not the image with which large mass consumer companies want to be associated. These selection and refinement processes take place against a background of on-going dialogue amongst producers, were the evaluations of competitors are valued as much as those of firms delivering complementary products and services.

An element of struggle, both within and between firms, is involved as different staff champion their consumption scenarios, and try to mobilise support within the firm and the industry for their product ideas. This includes struggle over the viability and exact definition of the product space itself, with attempts to exclude alternative definitions.

Home Automation provides a case in point, where an significant amount of time and effort was, and still is, involved just in producer discussions to establish the viability of the area, to create confidence and to promote the approach of the domestic appliance firms as the appropriate route. Or we have Philips initial attempts to define CD-interactive as the sole mass consumer product, and deny DVI was a competitor. Obviously, we as researchers enter into this process when drawing the boundaries of our case studies. These have had to change over time as we became aware of alternatives and have moved to broader definitions of home automation, interactive multimedia and electronic messaging to show some of these processes of exclusion at work.

Ultimately, innovators pay far more attention and effort to interacting with other producers than with investigating end-users. This reflects some of the realities of product launches and perhaps the uncertainties innovators feel about consumption. Other producers not only provide sources of judgements about the market but their support is necessary to 'put the market together' — i.e. to create the preconditions seen as necessary to give an innovation some chance of success with end users.

Strategies

The previous chapters have indicated some of the diverse strategies, and forms of alliance, at work. However, their remain some general points to make about this dimension of the innovation process.

First, it is worth adding a note that goes beyond the particular products discussed here. Firms, especially large firms, produce a range of products. In some areas they may co-operate, but in some they compete. So while we have observed some alliances emerging

in the product areas we examined, it is important to remember the wider context: some of this producer interaction amounts to conducting diplomatic relations with the enemy.

In fact, we can see how firms can adopt several strategies with the example of Philips. The Dutch multinational was involved in two of the case studies but with very different product development and marketing strategies: with home automation involved in quasi public collaboration with other firms; with CD-i engaged in a series of bilateral joint ventures to create the infrastructure required for the development of multi media software

Strategies are influenced by the nature of the particular technologies in that all three studies were more complicated than the case of stand-alone products where the product development and marketing is within the hands of a single producer. The systems-like nature of our case studies created dependencies which entailed some form of co-operation between different kinds of suppliers. This sometimes meant bringing together a diverse range of technical skills which lie beyond the boundary of even the largest firms.

In sum, the case studies have indicated the different motivations involved in the various forms of collaboration: from providing a means of monitoring developments of new technologies and keeping up with what competitors doing, through shaping competing and complementary firms' view, to providing a source of legitimacy for further development within firms.

The symbolic nature of technological products

Finally, we can make a number of observations concerning how firms have dealt with the symbolic nature of their products. This is of interest not simply because various critical academic analysts had drawn attention to this dimension of technologies.[8] It is of also interest because we view products as consisting of more than physical artefacts, with the corollary that innovation involves more then just the technical development of hardware. Even though our case studies were often championed by the technical staff, these innovators were still, to an extent, conscious of image. And this is not only in terms of how the product is to be represented to end-users presenting product images to other companies is just as important.

The field into which home automation enters is a replete with imagery because of the long history of visions of homes of the future. Some of the ideas about control functions are already familiar to consumers through past and current book, TV and film coverage. So producers in this field cannot but be aware of some of the potentially negative images — and consumer research research has consistently reinforced this point. The response

by innovators has generally been to avoid any connotations that the technology is futuristic — i.e that it involves a transformation of our way of life to science fiction scenarios. Instead, they stress how home systems represent simply a new generation of consumer electronics. The emphasis is that the improvement is incremental, simply an additional set of functions for tired and tested products not, a leap into the dark. And such functions providing serious benefits for users — they are not just gadgets with which to play.

CD-i and other interactive products do not evoke quite the same fears since they have no such precedent as homes of the future. Producers in this field have stressed the radically new experience of television enabled by interactivity. Multimedia CD has one advantage in this respect. It can attract media coverage by virtue of being visually interesting to watch.

Meanwhile, although electronic messaging may have a more mundane role in the office, its radical nature has been emphasised as least for the home computing audience to which it was originally addressed. E-mail was to be part of the communications revolution, on the road to networked nation (an image which itself has led to some disappointment when seeing how services like Micronet are used — they have not lived up to their potential for serious hobbyists). Fax is presented without such futuristic connotations.

Apart from the issue of how radical an image the product shouldhave, we noted in all three case studies that producers have been concerned to evade one particular label — that of being a ‘gimmick.’ In the case of home automation and the CD-i product, this has meant distancing their innovations from one precursor — the home micro. While a successful product in many ways, the home computer remains an enigma to larger firms, with far too many connotations of hobbyism which are not appropriate to a mass market. In the case of CD-i, there is the particular problem of avoiding any hint that their product may, like the micro, end up as a predominantly games machine, as opposed to being an asset for all the family. But note that other multimedia producers, such as 3DO, Sega and Nintendo, see games playing as a means to achieving a large installed base of machines, on which to develop other types of application. Obviously the fate of e-mail is very much tied to the micro, but many argue that therein lies its limitations and that fax has more potential precisely because it is not designed or represented as a keyboard based computer technology.

Attempts to control the image and hence definition of products have already been clear even while the products are in the pipeline. Where there have been contacts with the outside media, the innovating companies have been at pains to present their products in a certain light. In the case of CD-i, Philips had been concerned to control what software is available (e.g. avoiding the porn that helped launch video) — but it had to relinquish some control if only to encourage more software support. And with e-mail, we have seen

the regulation of what messages can be carried, especially because of BT's corporate image.

On the other hand, we still feel that the innovating companies often shelve much of their thinking about the symbolism of their technologies when they would be better to address them earlier. For example, marketing and advertising staff are often only brought in at the last moment when the product is near to launch. It is possible that earlier considerations of some of the symbolic aspects may have actually affected some design considerations. In the case of home automation, fears associated with the house really being in control might effect decisions as to which pre-programming function to incorporate. Instead, such issues, as well as the details of the marketing platforms from which to launch products, are left to late in the development process.

End note

It was always intended that a number of audiences should be addressed in this book. We are pleased to note that our work has already extended beyond academic circles to attract the interest of actual companies involved in our studies. They too realise the uncertainties of consumer goods innovation and want to understand the process better (besides just 'picking winners'). Since our future consumer goods will come from these producers, we feel it is important that such companies can utilise our research — e.g in thinking about how they assess what end users might prefer.

But clearly, as academics ourselves, our work is also directed to the research community. First and foremost, we have leaned towards engaging with the innovation studies literature, aiming to expand its conception of both products and innovation processes. More indirectly, we believe that our work can inform other debates, including those critical of current technological innovation. There is something for everyone to glean from this empirical work. We are satisfied that the research will not only indicate the shape of things we might on offer to us as consumers: it can help to show us how we might shape future technologies of everyday life.

Notes

1 This theme emerged in several of the papers at the workshop on 'The Marketing of Information Technology Products and Services', Manchester School of Management, UMIST, 16 October 1990.

2 Although, since the firms concerned were run by engineers they chose technical solutions rather than, for example, alternative home designs or social arrangements.

3 Although not just concerned with gender issues, Collective Design/Projects, *Very Nice Work If You Can Get It: The Socially Useful Production Debate*, Nottingham: Spokesman, 1985, provides a useful introduction to this viewpoint.

4 A. Berg, 'He, she and I.T.: Designing the home of the future' in K. Sorensen, and A. Berg, eds., *Technology and Everyday Life: Trajectories and Transformations: Proceedings from a Workshop in Trondheim*, Norwegian Research Council for Science and Humanities, Oslo, 1991.

5 For example, the collection edited by C. Kramarae, ed., *Technology and Women's Voices: Keeping in Touch*, London: Routledge and Kegan Paul, 1988 focuses on what implications new technologies can have on communication between women.

6 For example, in the case of home automation, there were some, if few, women from marketing who organised consumer research, coordinated different groups within firms and drew up business plans; several of the consumer research organisations and journals are led and heavily staffed by women; and women played key roles in some of the forums which have debated home automation, such as the NEDO committee and Home of the Future Group.

7 L. Haddon, 'Age Concern Conference', *Intelligent Home Newsletter*, Vol. 1, No.4 (1990).

8 For example, the following works focus particularly on the meanings portrayed in industrial design: D. Hebdige, 'Towards a cartography of taste: 1935-1962', in B. Waites, et.al., eds., *Popular Culture: Past and Present*, Beckenham: Croom Helm, 1982, pp. 194-218; and A. Forty, *Objects of Desire: Design and Society 1750-1980*, London: Thames and Hudson, 1986. See also R. Johnson, 'The story so far: and further transformations' in D. Punter, ed., *Introduction to Contemporary Cultural Studies*, Harlow: Longman, 1986, pp. 227-313.

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