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SWP 22/89 TECHNOLOGY, MARKETING AND CULTURE: THE POLITICS OF NEW PRODUCT DEVELOPMENT AND THEIR IMPLICATIONS FOR PRACTICE

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Technology, marketing and culture: the politics of new product development and their implications for practice

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SYNOPSIS

One of the most persistent themes in the literature on the management of technology-based innovation relates to the need to balance "technology-push" with "market-pull". There is a large body of evidence to indicate that, for relatively small innovations at least, there is a broad correlation between the success of new product innovations and the extent to which their development is market-led, and based on this evidence a number of writers have advocated the general desirability of marketing-led approaches to research and development. Others, however, have argued for the opposite position, drawing attention to the dangers of a market-push approach, especially where substantial innovations may be required.

From this debate have emerged two stereotypes, of the technology-led firm developing and designing products that nobody wants to buy and of the marketing led firm unable to generate the new technology opportunities needed to safeguard its long term future, and a variety of recipes for success based on a close and constructive relationship between the marketing and research and development functions. The general consensus, revealed by developments in practice over the last 20 years, has been in favour of either a matrix organization for research and development or a project-based organization in which individual project or venture groups cut across the functional divisions of the organization. In recent years these structural recipes have been combined with a range of cultural prescriptions based on the cultural context of innovation in successful firms.For many companies such recipes and prescriptions appear to have been successful, but for many others, they remain almost impossible to enact. A review of the existing literature indicates a range of major problems encountered in this respect, both in the operation of the prescribed organizational forms and, more generally, in the attempt to reconcile a number of apparently conflicting organizational needs.

In this paper we disaggregate the problem of managing technological product innovation into two separate problems, one concerned with fundamental research and the other with new product line development, and argue that in neither context is the concept of technology-push particularly helpful. In the case of the development process on which we concentrate we argue that this concept is indeed quite inappropriate. Drawing on a series of major in-depth historical studies of the new product design and development process, we show that the key driving force in opposition to market needs is not technology per se but the political and cultural organization of the firm. The situation with which we are faced is not one of technological determinism, but of socially created and maintained technological preferences. Moreover we show that the problem is not one of imposing organizational control but rather one of freeing the development process from cultural and political constraints, and especially from those reinforced by political conflict, and to this extent the concept of a marketing-led approach is itself misleading.

Central to our core analysis is the analysis of the forces which determine which of a variety of possible technologies are to be applied in a design and development process, and how. These forces are, we argue, predominantly social, reflecting the objectives, values, experiences and political structures of the sub-organizations involved and the political structures of the relationships between them. We are therefore led to relate our problem to studies of the politico-cultural problems of implementing change in organizations, and to interpret the existing literature on the management of innovation and of related interfunctional relationships from a politico-cultural perspective. This perspective, combined with the emphasis upon freedom from constraints rather than the imposition of controls, suggests that the key to the successful and practical management of innovation lies in the development of the marketing and research and development functions rather than in the development of organizational structure, a conclusion which is finally illustrated and supported by a review of the observed practices of successful technology-based firms.

Introduction: review and problems

One of the more persistent themes in the literature on the management of technology-based firms has concerned the dangers of a technology-driven approach to the management of innovation, and the need for a strong marketing lead. In the 1970s attention focused on the need to combine marketing and technology inputs in the innovation process, with the emphasis on structural procedures such as the introduction of matrix organizations or project teams. In the last decade the emphasis has shifted to include the need for internal competition and strong corporate cultures with a commitment to innovation alongside the structural recipes, but with marketing playing if anything a stronger, though perhaps less formal role.

There is now a large body of evidence to indicate that, for relatively small innovations at least, there is a broad correlation between the success of new product innovations and the extent to which their development is marketing or user led. In the course of a major quantitative study of two hundred R&D projects in three large industrial laboratories, Mansfield and collaborators (1971) found that it was much more likely that a project would meet its technical aims than that it would generate an economic profit having done so. The commercial risks were much greater than the technical ones. They also found that these commercial risks were significantly reduced when there were inputs from the marketing function at an early stage of the project development decision-making process. Following up on this Mansfield and Wagner (1975) found in a study of 16 firms considerable evidence that success was affected by the speed with which a product was analyzed from a marketing viewpoint.

Meanwhile Marquis had drawn similar conclusions from a study of 500 "nuts and bolts" innovations (Marquis, 1969; Utterback, 1971), concluding in particular that successful innovations were characterized by a prior recognition of market demand. About half of the innovations analyzed, all of which had been identified by the firms concerned as their most important new products or processes, were initiated in response to market needs, while over a quarter were in response to production needs. Only a fifth arose from new technological opportunities. In a study of 47 small high-tech Canadian firms, Litvak and Maule (1972) observed that "the love that the entrepreneur has for his product innovation often blinds him from perceiving his real opportunities and the state of market competition", and concluded that the lack of a strong marketing input was the main problem faced in the innovation process. In another major study carried out in the 1970s, project SAPPHO, Rothwell and collaborators analyzed 29 matched pairs of innovations (one successful, the other not) in the chemicals and scientific instruments industries on 200 different measures. They found that the principal measure distinguishing between success and failure was an understanding of user needs at an early stage of the project (Freeman, 1982; Rothwell, 1974). In a study of 114 new industrial products, Cooper (1975) found that while much less was spent on marketing than on R&D, marketing rather than technical reasons were the prime causes of failure, with 2/3 of all product failures being attributed to a lack of marketing skills.

These conclusions have been further supported by the work of Utterback (1974), von Hippel (1976, 1978, 1982) and Quinn (1985), and in the last few years two more major studies have reinforced the message. Cooper and Kleinschmidt (1987) studied 203 new product innovations in 115 companies and isolated the leading predictors of three different measures of success: financial performance, opportunity window, and market share. For the first measure the leading predictor of success was that customer needs and preferences were well defined before the product development. For the second measure the leading predictor was the perceived ability of the product to perform a unique task, another market criterion. And on the third measure the leading predictor was

that the product was superior to and of higher quality than rival products in the eyes of the customers. Of the top ten predictors from each measure only a few were not market-based. Finally a large study of the post-innovation performance of 35 technology award winning firms by Georghiou and collaborators (1986) highlighted the need for firms to keep within the "corridor" of user requirements if the firm was to survive and prosper.

On the strength of these studies it is tempting to conclude that the innovation process should in general be market-led. But as most of the researchers have themselves recognized this conclusion needs to be qualified. The first qualification to be made is that the major studies have been concerned with relatively small, incremental innovations, and not with large technological breakthroughs, or major new enabling technologies. As Marquis (1969) has pointed out, small innovations do contribute significantly to commercial success, but it would clearly be perverse to exclude larger innovations altogether. And, as Tauber (1975, 1979) and others have pointed out, these larger innovations could be seriously endangered by the early application of market-based criteria. Even for essentially non-technological product innovations such as new confectionery items, attitudes revealed by early market research are not in general good predictors of later adoption behaviour. Where major new technologies are concerned it is often impossible to predict anything about the potential market until users have had some experience with the product. In the early days of computer development, for example, a number of authoritative experts concurred in placing the world market for computers at about 4 or 5 units (Hendry, 1989). IBM turned down the photocopier invention twice before Xerox took it up because they couldn't see a market for it (Dessauer, 1971). And while discussing the marketing-oriented handling of new product development processes in Japanese industry, Imae and others (1984) have identified the closure to major breakthroughs as a principal limitation of an otherwise exemplary approach.

Even where smaller innovations are concerned, a market-pull approach can be as dangerous as a technology-push one. Little and Sweeting (1984), studying new business developments in mature firms, noted a tendency to get carried away by a product concept for which there was no appropriate technology alongside the more commonly noted tendency to get carried away by a technological idea for which there was no appropriate market. Georghiou and collaborators also noted that the technology-based firms in their study needed to maintain their technological inventiveness as well as keeping their eye on the market place if they were to survive. Voss (1984) noted that innovations arising from user requirements were themselves dominated by technology push. And Gupta and others (1985, 1988), following Blois and Cowell (1979), have drawn attention to the point that market failures of technology-generated innovations may arise as much from the failure of the marketing department to find a way of exploiting these as from their intrinsic un-marketability.

As Little (1979 and see also Cooper and Little, 1977) has observed, there is a tendency for firms which develop new-technology-based products to be relatively weak on the marketing side, and indeed to put less effort into marketing than other firms, and to some extent the advocacy of a marketing-led approach to innovation is certainly appropriate. But the major conclusion drawn by the researchers from the studies mentioned above concerns the need for a close and constructive relationship between the marketing and R&D functions. Thus, for example, Mansfield and Wagner (1975) concluded that the probability of commercialisation of innovations was directly related to the degree to which the marketing and R&D functions were integrated. Mansfield (1971:210-211) argued that "the problem of properly coupling R&D with marketing cannot be overemphasised." Freeman (1982), on the basis of the SAPPHO results, argued that "innovation is essentially a coupling process", and that

"one-sided emphasis on either R&D or sales does violence to the real complexity of the process" (p.127), and that "the test of successful entrepreneurship and good management is the capacity to link together ... technical and market possibilities. ... Innovation is a coupling process." (p.111) Cooper (1975) advocated that the industrial goods firms that formed the subject of his study "must be prepared to balance their heavy R&D expenditure with marketing research." Other research also backs up this message. Thus Aram and Javian (1973) observed that the success of customer initiated R&D projects was correlated with the existence of a direct line of communication between the R&D and marketing functions, and a number of more general studies in the 1970s emphasized the importance of the structures coordinating between these functions for the success of new product development (e.g. Rubinstein and others, 1976; Souder, 1977).

The need for coordination between marketing and R&D is now well established, and a variety of prescriptions have been put forward to this end. Broadly speaking, these prescription are of two kinds. One kind focuses on coordinating structures, and in particular on the use of a matrix organization for R&D or, carrying this further, of a project-based organization for new product development in general, with all the functional divisions of the organization represented in each project team. The other kind, dominant in the recent prescriptive literature, combines this with a range of "cultural" imperatives extracted from the observed practices of exemplary "successful" innovating firms, and reflecting other trends of research into the characteristics of successful innovation.

This second body of research has been concerned with the barriers to innovation experienced in companies, especially in large companies, and the characteristics of innovating projects that successfully overcome these barriers. Most prominent of these characteristics is the need for product champions within the firm. Schon (1963) was the first to make the assertion that a successful innovation path typically hinged on a product champion operating at a senior enough level in the firm to effectively sponsor the innovation and overcome the organization's natural resistance to change. The role of champions was further emphasized by Roberts (1968), Chakrabarti (1974) and Maidique (1980), and by Burgelman (1983), who analyzed the path of an internal corporate venture through the hierarchy of an organization and stressed the need for championing at each stage of its progress. Of all the factors making for successful innovation the existence of a powerful product champion is probably the most universally accepted as important. The other major factor identified in the literature is a general commitment of top management to innovation (e.g. Roberts, 1968; Quinn & Mueller,1963), which may be embodied in the practice of managing failure as the accepted norm (Bachus, 1984).

Most recent prescriptions for the successful management of innovation have combined these factors with those discussed above, and although the details of the prescription vary from guru to guru the main features are common to all. The need for active collaboration between the marketing and R&D functions remains central, even if it is sometimes obscured by the surrounding cultural rhetoric, and a project-based organization is the order of the day. But beyond this there is a call for competing project teams with multiple approaches, skunk works and developmental shoot-outs. Failure is to be managed as the norm, but membership of a successful product development team is to be made into the key employee goal. Champions are to be nurtured and made into corporate heroes. Top management should be visibly committed to the innovation process, which should be a key component of a strongly pronounced corporate image. And they should also have a strong market orientation, which should penetrate and act as the driving force for the whole organization. (Peters and Waterman, 1982; Pascale and Athos, 1981; Quinn, 1985; Peters and Austin, 1985; Clifford and

Cavanagh, 1985; Imae and others, 1984; Roberts, 1980). The aim, in the phrase coined by Quinn (1985), is "controlled chaos": an environment in which all the advantages of small entrepreneurial firms are retained at the project level and corporate control is provided by the management of culture and by a pervasive awareness of and deference to the market place.

These prescriptions clearly work for the "exemplary" firms on whose practices they are based. They clearly relate also to the past tradition of research that we have outlined above. And they tie in well with more recent research results. In particular Souder (1987, 1988), in a recently published analysis of 289 new product innovations in 53 firms, found that the most innovative of these firms could be characterized organizationally by high levels of interaction and communication across traditional task boundaries, and by the use of organizational commitment in place of formal controls. It is also clear, however, that the implementation of the prescriptions is not straightforward. For many firms the prescriptions remain almost impossible to enact, and it is far from clear how the different components fit together.

The overriding problem is in actually implementing the required coordination between the R&D and marketing functions. A joint project carried out by Arthur D.Little and the Industrial Research Institute (1973) in the early 1970s concluded that the major barriers to the success of industrial innovation included the coordination between marketing and other functional groups. More recently, in a study of the interface between marketing and R&D in high-technology firms, Gupta and others (1985, 1988) found a general lack of understanding of how this interface ought to function, and strong dissatisfaction on the R&D side with the way it did. Whereas the marketing function sought to control the development process, it was not in general prepared to share its information. Nor would it take on board any ideas generated within R&D and seek market opportunities for them. In a recent study of ten high-technology firms, Bonnet (1986) found that the much-vaunted link between R&D and marketing was rarely implemented. Even when the organization structure allowed for a marketing input to the initial project assessment it did not allow for a proper collaboration during the design phase. And in a study of the design process in British and American firms Dumas (1988) found that functional coordination was severely limited by the dominance of the marketing function and the reluctance of marketing to release their specifications early enough to allow time for collaborative exercises.

Building on the literature on the sources of conflict between functional groups (e.g. Walton and Dutton, 1969; Seiler, 1963; Dutton and Walton, 1966; Walton and others, 1969) , Souder and others have explored in detail the organizational factors influencing the success or otherwise of innovative projects, and have focused on the difficulties hindering any effective coordination between the R&D and marketing functions (Souder, 1977, 1987, 1988; Rubinstein and others, 1976; Souder and Chakrabarti, 1980). Souder (1987, 1988) observed that while marketing could not understand why R&D could not respond immediately to changing specifications, R&D could not understand why marketing could not fix specifications in advance. And from this lack of understanding of each other's worlds arose a wide range of grievances and states of disharmony ranging for a mere lack of interaction to outright distrust. As Lawrence and Lorsch (1967), LaPorte (1967) and others have indicated, the two functions are typically characterized by strongly contrasting organizational subcultures, with different values, motivations and goals, differing status structures and reward systems, and differing concepts of procedure and control. And far from resolving these differences, organizational structures which bring the two subcultures into immediate contact are also apt to bring them into open conflict. Classic sources of interdepartmental conflict, such as task-related asymmetries and mutual dependen-

cies become more visible, and while any conflict may be overcome in some cases through the creation of a strong project identity and commitment, anything short of a very strong, and very elusive, degree of cohesion in this respect is likely to fatally compromise the organizational initiative (Lawrence and Lorsch, 1967; Seiler, 1963; Walton and Dutton, 1969).

Other interfunctional relationships also cause problems well recognised in the literature on barriers to innovation, but scarcely addressed by the prescriptions for success. In particular the Arthur D.Little/ Industrial Research Institute research identified conflicts between the marketing and operations functions, while Quinn and Mueller (1963) and Burgelman (1983) have focused on the problem of transferring new product developments from R&D or new product development divisions to operations.

To add to these difficulties, the dual responsibilities inherent in a matrix or project structure can also be problematical. Sbragia (1984) and Radosevich and Robles (1984) observed difficulties with the implementation of matrix structures arising from the contradictions generated by dual lines of authority, and Joyce (1986) found that while the implementation of a matrix organization led to an increase in the quantity of communication in the organization, it also led to a decrease in its quality, and had negative effects on role perceptions, work attitudes, and coordination.

The use of a project based organization in which the project teams have a high degree of autonomy faces not only these difficulties but others too. To advocate the management of failure is all very well, but as Roberts (1980) and Little and Sweeting (1984) have pointed out, internal new ventures do have a very high failure rate. In a survey of top executive attitudes to project teams and venture groups Hopkins (1975) found that while the executives recognized many advantages for such organizational structures their attitudes were dominated by persistent perceived disadvantages. They were worried about the difficulty of imposing financial control, and about excessive autonomy leading to developments that might not fit into the company's overall market strategy. They anticipated difficulties in finding the right people to head up the teams. In short, they were scared of losing control, and strongly preferred to stick to a more traditional and tightly controlled organizational structure.

Overall it would appear that, while there is a large measure of consensus on the requirements to be met if a strategy of innovation is to be pursued successfully, there is relatively little guidance available, of any practical use, as to how to go about meeting them. You cannot imitate 3M or Sony by imitating their organizational machinery. Matrix or project based structures are not universal panaceas. The objective recognition of the need for project autonomy, loose financial controls, and operating flexibility sufficient to allow for skunk works, spontaneously arising high-performance teams and multiple competing approaches, is far from equivalent to a subjective preparedness to accept the loss of immediate control entailed. And above all the call for an integration of marketing with research and development, or for a combination of a strongly marketing-led approach with technological freedom, is far removed from most firms' realities of practice. Underlying all this is a pervasive uncertainty and vagueness about what roles the different parts of the prescriptions play relative to each other, and what specific functions each part serves.

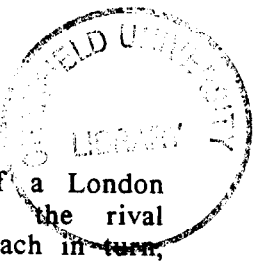
The illusion of technology push

If the existing prescriptions are unhelpful it is natural to ask whether there might be alternative and more practically relevant ways of looking at the innovation problem, In what follows we shall put forward such an alternative view. Before doing that, however, it will prove helpful to disaggregate the problem in two ways. First we shall need to keep separate the two principal components underlying the existing prescriptions: the need for a market-led approach which avoids the

dangers of technology-push, and the need to overcome the barriers to innovation typical of larger companies. Secondly, in analyzing the former component, we shall find it helpful to distinguish between the basic research of a corporate research headquarters on one hand, and the major part of the firm's R&D effort, whether in the research headquarters or in the operating divisions, on the other. When people talk of the dangers of technology-push and the need for a marketing-led approach they do not always mean to extend this, other than in a very vague sense, to the basic research of a large R&D organization: their concern is rather that the selection of projects for commercial development, and the development paths of these projects, should be commercially dictated. Many would argue that market forces should influence more basic research too, but this is really a separate issue. Because basic research is about exploring the unknown it cannot in a strict sense be market-led, nor is it technology-driven. Most often it is driven by individual interests, hunches and curiosities, and if it is to be directed it must be so through the choice of personnel or the excitation of their curiosity.

From our present viewpoint it is new product line development that lies at the crux of the innovation problem, and it is the need to integrate technological and marketing inputs here that leads to the prescriptions and problems we have outlined. But here too we would argue that the concepts of technology-push and market-pull are in fact quite inappropriate and misleading. To justify and expand on this assertion, we consider the results from two major case-studies, both historical in nature, in which the new product development process has been intimately researched and analyzed. As part of a history of the United Kingdom Atomic Energy Authority (AEA), Hendry (1988) studied the British nuclear reactor research development programme, and in particular the process by which the advanced gas-cooled reactor (AGR) and fast breeder reactor became established as the major development projects, or potential product lines, within the AEA, in preference to a range of alternative reactor designs. And in a recent book on RCA and the videodisc, Graham (1986) traced the development of the videodisc concept in RCA through its various development paths and alternative technological realizations to a major product launch and subsequent abortion. These studies do not in any way constitute a representative sample on the basis of which we could draw general conclusions as to the nature of the new product development process. But they do allow us to form certain hypotheses as to the nature of the problems encountered in this process, which can then be tested against other evidence.

Between the end of the Second World War and 1959 the AEA and its predecessor organization investigated seriously eleven different reactor designs as candidates for inclusion in the British civil nuclear power programme. One of these was the magnox reactor originally developed for military plutonium production which turned out to be a useful power producer as well and formed the basis of the first phase of the nuclear power programme. Of the remaining ten, six had already been rejected by 1959, including the pressurized water reactor (PWR) which formed the basis of the American programme, which had, for a substantial period in the mid-50s, occupied pole position in the British programme, and which has since been reintroduced into the British programme at the expense of the AGR in the mid-80s. One was carried through to an experimental reactor on a prolonged time scale as part of a European project, having been effectively rejected for the British programme. One was carried through to the prototype stage in the late 1960s as an insurance policy. The remaining two were effectively selected as future product lines and given development priority: the AGR, which duly became the mainstay of the power programme in the 1960s and 1970s, and the fast reactor, which remained until very recently the favoured approach to nuclear power development in the longer term.



Although the continued rejection of the PWR design in the 1960s became a matter of national political debate (Williams, 1980), these development decisions, which effectively determined the outcome of that political debate, are generally portrayed as technical ones, based on a combination of technological and economic (corresponding in this context to market) factors. The AGR has always looked a strange choice on these criteria, however, and the choice of the fast reactor, beset by persistent safety and other development problems, has also looked increasingly open to question. The question addressed by Hendry, therefore, was how the development decisions actually came about. And the principal conclusion reached was that they had little if anything to do with either technologically determined choices (technology-push), or economic ones (market-pull), or indeed any combination of these.

Of the various factors found to influence development priority decisions between competing reactor types, by far the most significant was the political rivalry existing between the two principal divisions of the organization, a rivalry that was founded on strong cultural differences, personal antagonism between the division directors, and overlapping frames of reference. Although the organization structure changed through time it remained the case that one division, academically-oriented and based in the South of England near Oxford, was responsible for research while another, industrially-oriented and based in the Industrial North-West, was responsible for development. When responsibilities were specified, the research division were deemed responsible for the inauguration of new reactor projects and for carrying them through to the stage of low-power reactor experiments. The industrial division were then responsible for carrying them through to the prototype stage. The distinction between an experimental and a prototype reactor was however unclear, and the situation was complicated by safety factors (implying geographical decisions) and resource constraints. In practice decisions were dominated by four factors: the political rule of a London based chairman, controlling the rival directors by giving way to each in turn; the use made of this procedure by the divisions (e.g. by putting up artificial proposals immediately before serious ones); the recommendations of a small and ill-informed group in the London office, determined largely by the interactions of their own subculture with those of the divisions; and the effective power of veto wielded by the industrial group, who could always find reasons not to pursue any project they wished beyond the experimental stage.

Of the remaining factors, two involved technology, but only indirectly. Developments in America, whenever they became known about, always exerted an influence on decision making in Britain, the presumption being that anything the Americans liked must be promising. American intelligence was however incomplete and unsystematic, and its effect bore little relation to the underlying state of affairs in the American programme. The technical preferences of key individuals and groups within the divisions, based largely on their own selective experience, were also significant. Engineers who had experienced the difficulties of working with high pressures tended to favour unpressurized systems using liquid coolants, while those with experience of corrosion problems preferred the use of relatively inert gases at higher temperatures. Within the research division, each reactor type found its sponsors, typically, from within the scientific discipline most crucial for its analysis: there was, in effect, a physicists' reactor, a metallurgists' reactor, and a chemists' reactor. A fourth significant factor was political activity within the divisions, in particular the activities of a group within the industrial division but unsympathetic to its culture and preferences. A fifth was international politics. European cooperation on nuclear matters was a major political issue, and the crucial marketing issue of whether Britain was to develop reactors for her own use only, or reactors for export as well, was severely complicated by international political pressures.

That these factors could assume the importance they did was facilitated by a widespread but rarely noticed feature of development programmes, namely their tendency to operate in cycles of rapid advance and stagnation, optimism and pessimism. In the case of nuclear reactor development the high points tended to come with the completion of a feasibility study and the actual construction of an experiment or prototype. The low points came in the early stages of each development phase when the technical problems, always considerable, rather than the possibilities or achievements were dominant. The outcome of any project comparison was strongly dependent on the relative states of the projects being compared, and this was a major source of both intended and unintended priority decisions.

Finally, the whole decision making process was strongly conditioned by a set of supposedly technological classifications that were, once established, maintained socially beyond the point where they had any technological relevance. In particular the reactor types were persistently classified into liquid cooled versus gas cooled on one hand, and "fast" versus "thermal" (relating to the speed of the neutrons in the reactor core) on the other. Both dichotomies made technological sense when first made, as the fast reactor was in the 1940s the only reactor type likely to be self-sustaining in fissile material (a breeder reactor), while the early liquid and gas-cooled designs had very different requirements in terms of their needs of fissile material, then in very short supply. By the time the key decisions were made in the 1950s, however, both had ceased to be relevant. Several of the designs under consideration were thermal breeders, and the differences between the fissile material needs of gas and water cooled reactors were no longer either significant or consistent. The classifications continued to dominate choice procedures, however, with the effect, for example, that the fast reactor was never critically evaluated against competing breeder reactors, and retained its place in the programme more or less by default.

The factors influencing design decisions within the individual projects were very similar. Individual or group preferences arising out of specific experience, inter- and intra-divisional politics, and personal rivalry and antagonisms were again prominent. In a situation where, typically, each of the available options entailed major development uncertainties the relative risks of which could not be objectively evaluated, decisions had to rely on guesswork as to the time scale in which problems could be solved and the extent to which they could be overcome, and while the majority of design decisions reflected some sort of consensus, many of the most significant ones did not.

Both at the project and at the corporate levels, of course, many decisions were made as a result of straight-forward technical evaluations. But the important thing is that many were not, and could not be. Rival technical opinions had therefore to compete in a political framework, in which such devices as the manipulation of committees, the use of paper projects to put down other ones, the use of multiple proposals to get one proposal through, the setting up of projects to divert participants from the point of attack, and even the attribution of papers to authors who had no knowledge of their contents, were all adopted at one time or another.

A national nuclear reactor development programme may seem a long way removed from the innovation problems of an industrial corporation. But while Graham's account of RCA and the videodisc reveals little of the underhand politics of the AEA, the determinants of the development process are nevertheless very similar in kind.

The period of videoplayer development in RCA (roughly 1963-1981) was one of considerable turmoil for the company as a whole, and executive responsibilities and organizational structures changed frequently. Broadly speaking, however, the development process involved the

Corporate Research Centre laboratories, the Consumer Electronics Division, the Records Division, and Corporate Headquarters, each with its own culture and priorities. And it involved four major videoplayer technologies: magnetic tape, holographic tape, advanced coated discs using electron-beam recording and capacitance pick-up, and more traditional discs using electromechanical recording methods. The videoplayer project as a whole came to the fore when the laboratories were reorganized along end-product lines, with their own New Business and Research Evaluation group. A few years later, in 1968-9, a major corporate reorganization drastically reduced the independence of the laboratories from the operating divisions and introduced a strong corporate marketing department and advanced product planning organization. Major priority decisions were taken out of the hands of the laboratories themselves.

Each of the four main technologies had its advantages and drawbacks, and each encountered major development problems, but as for nuclear reactors in Britain none was objectively superior from a technological viewpoint, or from a combined technical-marketing viewpoint. As in the nuclear case too, the development of each project tended to be cyclical. If things were progressing rapidly, funds were committed, confidence and enthusiasm soared and so did results. This tended, however, to lead to over-optimistic expectations from outside the project, and to high project visibility, often resulting in severe disruption, and a failure to meet targets. Doubts would then set in, funds be withdrawn, and morale and progress decline. Moreover, two of the four technologies were sponsored by the laboratories, one by the Consumer Electronics Division, and one by the Record division. And within the R&D structure too, several of the key figures had their own pet projects.

In these circumstances, theoretical priority decisions appear to have been dominated by three forces: the implications for RCA's public image in the face of successive product announcements by their competitors; the source from which information was solicited; and within the laboratories the state of the fluctuating political battle between
the fundamental research school of thought which had dominated in the 1950s and early 1960s, and the applications school which had dominated before the war and was enjoying something of a revival in the period concerned. The practical outcomes were dominated by the political balance between the divisions, and by the prevailing mood in the laboratories.

The holographic tape, employing state-of-the-art laser technology, was always a laboratory favourite, but did not have the support of a powerful R&D champion. It was developed as a low priority, and was indeed seen by some as no more than an attempt to appease the "scientists" who had been threatened by the laboratory reorganization. But in the wake of the new aggressive marketing image introduced in 1968, of the announcement of a videoplayer project by RCA's arch broadcasting rivals CBS, and of the failure by RCA to win a prestigious contract for a colour television camera for Apollo 11, corporate headquarters decided on the need for an urgent new product launch, and holographic tape was the only project capable of being developed to the demonstration stage in the timescale specified. This was not because it was more advanced, but because its problems lay in cost reduction and production facilities rather than in meeting a performance specification. The marketing people were quickly taken in by their own rhetoric, however, and it became the subject of a major development and launch programme, only to flounder when the operating divisions found that it was not so far advanced as they had been led to believe and the laboratories, who had had to stop real development work in the interests of the demonstration, had no ready response to their critics. The artificially generate optimism increased the political vulnerability of the project, which its opponents in the divisions and the laboratories (who each had their own preferred alternatives) were soon able to axe altogether.

In contrast to holographic tape, magnetic tape was seen in the laboratories as an old hat technology with little scope for development. But RCA had a strong tradition in magnetic tape technology, and the project soon found a sponsor in the Consumer Electronics Division, where development continued at first in isolation from the main videoplayer effort and later in competition with holographic tape. The project was eventually run down in 1974 as a result of coordinating problems with Bell and Howell, who had been commissioned to produce the tape transport mechanisms, the removal of the overall videoplayer project coordinating team from headquarters to the division, from where they were unable to secure the cooperation of other parts of the organization, and the commissioning by headquarters of a report from the Vice-President, Research and Engineering, who was a long-time opponent of magnetic tape. It was eventually axed altogether when Sony demonstrated their betamax, which was too far in advance of the RCA project to be seriously challenged, and in 1977 the division began marketing the Matsushita VHS magnetic tape system.

The more technically sophisticated of the disc systems originated from one of the more applied groups in the laboratories, but being too conservative for the scientists and too scientifically demanding for the inventors it at first found little support. The electron-beam recording it adopted was originally chosen as a research tool, because it left open crucial issues on which the team could not make up their minds, but it found an influential champion in the Vice-President, Research and Engineering, and was able to survive without really getting anywhere until the debacle over holographic tape opened up all options. As the least well developed of the available options it then received substantial funding to enable it to catch up so that proper comparisons could be made, and this naturally produced high morale and results. When a decision was made between disc and holographic tape projects, the momentum of the former compared with the stagnation of the latter effectively determined the outcome, even though these states were quite artificially produced. Problems arose for the disc project when, as effectively the sole remaining videoplayer project, it began to be transferred to the operating divisions. After its previous experiences, especially with magnetic tape, Consumer Electronics Division was internally divided and in no mood to take on anybody's new project. (It also had its hands full with television developments.) Records division, who would be responsible for the disc production process, resisted strongly the loading of all the main problems - electron-beam recording, triple-coated discs and capacitance pick-up - into their ball-park after minimal previous consultation, and argued strongly for their abandonment in favour of a more traditional electro-mechanical system, closer to that with which they were familiar in audio recording. Development of the original project was held up sufficiently to force adoption of the more traditional alternative as the only way of getting out a product fast enough to meet the emerging competition. In 1981 a pre-recorded videoplayer using electromechanically produced vinyl discs was launched-and flopped.

The AGR, fast reactor and RCA videodisc were expensive product failures, but that is not the point to be made here. In the case of RCA in particular the failure can be attributed to corporate problems arising from a preceding failure in the emerging computer business, and to a marketing error (the choice of a player with no recording facilities, which would generate income through the sale of pre-recorded programs, rather than of a more versatile tape recorder) that was shared by many of its competitors, without recourse to the features on which we have focused here. The point we wish to make is that these features were pervasive and persistent, that they are to some extent characteristic of any development process, and that when looking at the general efficiency of such a process they are extremely significant.

The politics of innovation

The image of the development process that

is revealed by the above studies is overwhelmingly a political one. The choice of the AGR and fast reactor was determined neither by technological nor by economic imperatives, nor indeed by any combination of the two, but by a process of political negotiation based on the rivalry between different cultural subgroups within the organization. The technological preferences of the different interest groups were to a large extent socially created and were certainly socially maintained, reflecting the values, objectives and experiences of the groups and, where appropriate, their political structures in terms of subgroups. The choices of successive videoplayer projects at RCA were likewise the result of political processes involving competing cultures and interest groups. In both cases, moreover, attempts to manage the processes by the imposition of controls resulted, almost inevitably, in a destructive backlash as the interest groups concerned exerted their powers of veto or found ways of manipulating the control process. In a political framework the powers of coercion are always limited, and both cases illustrate this well. The problem rather is to somehow free people from their habitual cultural, political and cognitive constraints, and so to make possible a genuine dialogue.

Of course, the two cases studied here may be quite exceptional. Since we know of no other studies of comparable depth we cannot say. But they do suggest strongly that the problem of innovation might profitably be approached from the existing literature on the political and cultural aspects of organizations, and especially on the problem of implementing change in organizations; and that the literature on the management of innovation might profitably be interpreted from a political perspective.

If we look at the literature on the cultural and political aspects of organizational change we find much that is relevant to out present discussion. For example Riley (1983) bases her structurationist analysis of organizations on the argument that an organization should be viewed not as a single unified culture, as popular accounts and prescriptions for the management of innovation would have it, but as a system of politically integrated subcultures. A similar perspective is also adopted by Thompson and Wildavsky (1984) in their study of the cultural basis of information rejection and distortion mechanisms in organizations, and placed on an empirical footing by Gregory (1983) and van Maanen and Barley (1985). A wide range of authors have drawn attention to the powerful psychological (Mitroff, 1983; Mitroff and Mason, 1982; Johnson, 1987), cultural (Lorsch, 1976; Schein, 1985)), or political (Guth and MacMillan, 1986; Mintzberg, 1985; Greiner, 1986) barriers to the implementation of strategic change. In a series of detailed studies of organizational change processes Mumford and Pettigrew (1975) and Pettigrew (1973,1985) have presented these processes throughout as political ones. Hickson and others (1986) have emphasized the political character of strategic decision making as revealed in a large sample of case histories. Of particular significance in our present context, Wilson (1981) has described some political aspects of technological decision making in a chemical company. And Pfeffer (1981) has offered a detailed analysis of political processes in organizations which incorporates many of the factors highlighted in our two case studies (Hendry, 1989).

But if both the product development process and the change processes which might be introduced to influence it are fundamentally political in nature, then this nature must surely be recognised in any practicable prescriptive model for the management of innovation. It is scarcely, surprising if structural prescriptions such as those for matrix or project based organizations are not in themselves sufficient. And while the more complex culturally-oriented models, based as they are on observed best practice, naturally come closer to reality in this respect, they too are apt to be sterile without some explicit analysis of the political significance of the measures they recommend, and some explicit guidance as to how the

politics of their implementation is to be managed.

The academic discussion of these sorts of issues has been conducted not so much in terms of politics (the massive literature on power in organizations has rarely ventured into the analysis of process), but in terms of corporate culture, and it is in these terms that the recipes for innovation success may be related to our analysis.

Despite the immense popularity of "corporate culture" in recent years, many people remain skeptical of it as a useful concept. Some people have questioned whether a concept drawn from the anthropology of small, simple and primitive societies can possibly be applied to the complexities of modern multinational businesses (see Morey and Luthans, 1985). Others have questioned the feasibility of changing or imposing cultural norms, which are almost by definition very deeply-based and historically rooted (Weick, 1983; Siehl, 1985; Lundberg, 1985; and see Pascale, 1985; Ray, 1986). The confusion arising in these areas is largely removed, however, when we remember first, that the problem with which we are faced concerns the dynamic interaction between rival subcultures in the firm rather than the transformation of a single monolithic culture; and secondly, that while all corporate cultures and subcultures are certainly complex, the great majority of that complexity lies within the common cultural characteristics of Western industrial society. The deviations from this common culture to be found in organizations and their subgroups are not in general complex. And as Pascale (1985) has observed the process of socialization to prescribed cultural norms takes place all the time, indeed every time a new recruit is inducted into an organization. The removal of cultural barriers or constraints, or the wholesale introduction of a new "company spirit" are more problematic, but they are political processes like any other and have direct counterparts in society at large (see e.g. Soeters, 1986).

From the political viewpoint the chief characteristic of the innovation process is that it involves collaboration between rival interest groups. Usually this will include interest groups with generally similar cultural backgrounds (and operating within the same functional divisions), but with different personal or social values or goals, different professional backgrounds, or competing political interests. Almost always it will include groups with contrasting cultural backgrounds, radically differing experiences, and different status and reward environments. One way of managing such collaborations is by political compromise, keeping the interest groups at arms length and resolving differences by negotiation or when all else fails by arbitrary dictat. To do this, however, is to effectively ignore the external environment, communication with which is in general split between the interest groups rather than concentrated at the centre, and this is scarcely a recipe for commercial success. The alternative is to manage by consensus, not necessarily in the organization as a whole but in some way at least across the principal political divisions. If a project or venture team is to be assembled, for example, the commitment to the project, or to the firm, must be sufficient to override the conflict automatically engendered by bringing the rival interest groups into close contact.

One way to approach this problem is to focus on the glue binding teams together, and it would appear to be this approach that underlies the success of the recent prescriptions for managing innovation. A strong corporate image binds people together. So does a perceived commitment on behalf of top management to the innovation process. A preparedness to allow project teams to form spontaneously and the encouragement of competition between teams both serve to strengthen team bonding. Indeed the encouragement of conflict between groups (i.e. between project teams) is probably the fastest and most effective way of reducing conflict within them (i.e. between functions). And while it imposes its own problems, especially in terms of the management of failure, these are at least manageable. So long as the structure of political conflict separates vital elements of expertise, such

as those held by the research and marketing specialists, nothing is manageable for there is nothing to manage.

These binding effects are important. But they are also limited. A strongly proclaimed set of corporate cultural norms informs people what is expected of them, and provides a foundation for bonding in terms of shared perceptions. But it can only act as an effective unifier if it is specific enough to direct people's behaviour, and that brings us back to our original problems. Unless there is some other means of coordinating research and marketing, for example, corporate culture must favour one or the other, or be irrelevant to the innovation process. Within the framework of the existing prescriptions a corporate commitment to innovation per se can only work in conjunction with the use of autonomous and competing project teams, and these raise the issues of control we discussed earlier. Any organization needs some form of control over its activities, and if this is not to be operated through a tight corporate structure there must be some overriding discipline, be it financially or more broadly marketing based, which will again upset the balance of the innovation process. Or else an organization must be prepared to take genuine risks. Of the exemplary companies used as the basis for existing prescriptions, many are actually market-led, and while this approach is reaping short-term harvests, its long-term viability remains open to question (see also Quinn and McGrath, 1985). Others are actually risk-takers, but while it may be necessary to take risks in order to optimize the chances of survival this is an approach that is unlikely to be widely imitated, at least so long as there appear to be more comfortable options.

The use of corporate glue to overcome the sources of conflict would appear, then, to be valuable but limited in its scope. There is, however, a second possible approach which has the considerable virtue of striking to the heart of the matter, and that is to seek the actual reduction of the sources of conflict. This approach is virtually absent from the existing prescriptions, but if our image of the development process is a valid one it would appear to have a major and significant role to play.

How can conflict, and in particular that endemic between marketing and R&D groups, be reduced? There is of course a vast literature on conflict in organizations, but relatively little of it concerns the conflict between departments or professional groups. Even that which does (Blake and Mouton, 1964; Walton and Dutton, 1969; Seiler, 1963; Dutton and Walton, 1966; LaPorte, 1967; Walton and others, 1969; Lawrence and Lorsch, 1967; Souder, 1977, 1987, 1988; and see Katz and Kahn, 1978) has for the most part very little to offer on the subject of conflict resolution. Indeed the only significant contribution on this theme would seem to be that of Souder (1987, 1988), who offers a range of "guidelines for promoting harmony", some (though not all) of which are practicably applicable as conflict reduction measures. Following Walton and others (1969), Souder (1977, 1987, 1988) also advocates the development of integrating lateral relationships within an organizational development setting, giving some evidence in support of a procedure which involves alternating periods of nominal (side by side) and interacting (face to face) group activities.

The literature is meagre, but this would seem largely to be due to the fact that while one group of writers have been more interested in the conflict than its resolution, the other has confused the manifestations of conflict removal with their causes. If one takes care to avoid this confusion, there are in fact some relatively obvious ways of going about the reduction of conflict, especially through the use of training programmes, and through the introduction of what Souder terms "dyadic relationships", strong personal links between individuals in the different functions which serve as channels of communication, understanding and collaboration.

1. Group development programmes such

as that proposed by Souder, in which the timing and extent of integration and retreat can be managed by development experts, have an obvious part to play.

2. Common socialization processes, and in particular common training programmes for marketing and R&D recruits, should serve both to strengthen the glue of an overriding corporate culture and to reduce conflict through the provision of shared experience.

3. The recruitment of science and engineering graduates to the marketing function, either directly or through a period in the R&D function, should help to overcome one of the major communication barriers between the two functions, and with it a large element of mistrust and suspicion.

4. Job rotation programmes or similar schemes, if sufficiently widespread, should further strengthen interdepartmental understanding, both through shared experiences and through the building of personal linkages.

5. Strong social and recreational programmes have a part to play not only in enhancing corporate belonging but also in encouraging personal cross-functional links.

6. Common status and reward systems should also remove a major source of conflict. For an organization starting with a mixture of systems (by research ability, management ability, seniority, market shortage, etc), this will inevitably entail costs as some groups are paid over the previous "going rate", and may also entail some staff losses. But the costs should be mitigated by improvements in quality and should be substantially outweighed by the benefits. Moreover, since reward systems provide one of the most visible demonstrations of the values of the organization the careful management of relative rewards should anyway be a top organizational priority.

7. Of crucial importance, but rarely discussed, is the role played by the design function. In some firms the presence of a design department serves merely to complicate the political situation, while in others it is virtually an irrelevance, ignored so far as possible by both marketing and R&D. But given the appropriate authority it can play an important coordinating role, and indeed must do so if the product design process is to be successful. As Hendry and Dumas (1988) have argued, an autonomous design department, independent of the marketing function and with sufficient internal authority not to be ignored by that function can serve both to improve end product design and to speed up and facilitate the collaborative new product development process. This is also an area in which external consultants can be used to good effect, their freedom from the organizational structure allowing them to create communication channels and bonds between the different functions.

8. More ambitiously, but not necessarily impracticably so, a range of specific training and organizational development programmes might be used to change the very nature of the functions themselves, and particularly of the marketing function.

Leaving aside the last point for a moment, there is nothing radically new in these suggestions. All are already implemented to some extent in some firms. But they do not form part of the established recipes for innovative success. Do they work? It is too early to give a definitive answer. It is a striking observation, however, that they are all characteristic of successful Japanese technology-based firms, without

being in any way specific to a Japanese culture (Imae and others, 1984; Ohmae, 1985; Pascale and Athos, 1981). Job rotation and common reward systems are in some respects easier to operate in that culture, but they are also found, in different forms, in Western firms. The Japanese education system also simplifies the recruitment of scientifically trained marketing and operations staff and the use of the R&D function as a staff resource pool on which other functions can draw. But again there is nothing in principle to prevent Western corporations from adopting similar policies.

What all this points to is a form of organization that is marketing centred, but is nevertheless technologically literate, and more specifically design-literate, through and through. Picking up on point (8) above, this suggests a new role for the marketing function. In a recent paper, Miles and Snow (1986) claim to identify the emergence of a new form of organizational structure designed to cope with the increasingly competitive and rapidly changing markets and technologies characteristic of the present era. These "dynamic networks" are characterised by vertical disaggregation, with market mechanisms and full information disclosure systems taking the place of the close linkages and trust characteristic of more traditional organizational forms: a move from hierarchies to internal markets. The key figures in these structures are "brokers", dealing as in a market place with the four separate constituencies of suppliers, producers, designers and distributors.

How representative, and indeed how desirable, this model is open to question, but it does provide a provocative extreme representation of an organization in which interfunctional linkages and trust cannot be relied upon, as is often the case in the technology-based firm. And it prompts the question: who are the brokers? They can only be the marketing function, and if that function is to play the central role in a disaggregated organization, it should perhaps do so also in the more closely knit firm to which we are aspiring here. Leonard-Barton and Kraus (1985) and Simmonds (1986) have both argued strongly for an internal as well as an external role for the marketing function, and such a role would provide a natural organizational setting for that most crucial of ingredients for innovation success, the product champion. It would seem in many respects to be precisely what is needed for the management of innovation.

As we have already noted, there are many advocates of a marketing-led approach to innovation, but these generally assume a traditional externally-oriented marketing function using its knowledge of the external market to specify development targets. An internal marketing role implies a knowledge of the interior of the organization, including the R&D and operating functions, equal to that of the external environment. It implies, in particular, a detailed knowledge of the technological capabilities, preferences and trajectories existing in the organization, as well as of their cultural settings and political structuring. This in turn would require radically new forms of training and avenues of recruitment for marketing personnel. If the function is to exercise properly the powers it is being afforded in contemporary organizations, however, such changes may well be necessary.

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