THE TECHNOLOGY PARTNERSHIP

COMPETING THROUGH PRODUCT INNOVATION:

LESSONS FROM GLOBAL BEST PRACTICE

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THE TECHNOLOGY PARTNERSHIP PLC

Since its formation in 1988, The Technology Partnership has grown to become Europe's leading innovation business, with revenues in 1996/7 of £30 million. The majority of this comes from developing innovative products for companies in a wide range of industrial sectors. They include Black & Decker, NEC, Hitachi, AEG, Bosch, Bayer, NCR, GlaxoWellcome and Fisher Price. TTP also provides consulting advice on innovation management, new business development and technology strategy.

A key feature of The Technology Partnership's own strategy is the creation of subsidiary manufacturing and licensing businesses with their own portfolio of products. These include hardware and software components for GSM mobile phones, which are marketed in partnership with Hitachi and Analog Devices, and high technology drug discovery and manufacturing equipment for the pharmaceutical industry. Myriad™, a new automated chemical synthesis business, is being developed in partnership with seven of the world's major pharmaceutical companies.

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1. THE INNOVATION CHALLENGE

The advanced economies are under pressure as never before. Global communications and the ready availability of an able management elite, as well as a disciplined educated labour force in some of the poorest countries in the world, mean that Western companies cannot be cost competitive at manufacturing for a widening range of products. The accelerating pace of competition is making product life-cycles shorter and markets are globalising and maturing faster.

In a world dominated by global companies, instantaneous communications and international finance, the competitiveness of the advanced industrial nations is more and more dependent on innovation. Whatever advantage a company has today will be imitated by others within a few years. Today's cash cow is tomorrow's dog. Success is therefore not just about how good a company is at what it does, it is also about how good it is at changing what it does before the competition.

Much of the restructuring and downsizing that companies have undergone during the last five years has been a delayed response to the pressure of increasing global competition – a desperate struggle to re-establish the competitiveness of businesses that had been allowed to become too fat, or had tried for too long to fight competitors with wage costs that were a fraction of their own.

In many cases these very businesses had been built up largely through a process of acquisition. Cute deal-making, the stripping out of duplicated corporate overheads and the creation of global marketing networks have provided a simple strategic recipe which has enabled companies to remain competitive as their markets matured.

And the whole process has been reinforced by the growth of "business tubism", the creation of independent business fiefdoms under an overall corporate structure. Under this philosophy, the sole task of each business' management team was to deliver against ever tighter financial targets, with strong incentives for doing so and severe penalties for failing.

As a formula for business success, this approach has by and large succeeded – for a time at least. But you cannot go on downsizing and cutting costs for ever. As you look across the industrial canvas, you see the great acquisitive conglomerates of the 1980s de-merging and refocusing on individual industry sectors. And at long last we see the public recognition, by

some of the strongest advocates of re-engineering, that you cannot save your way to prosperity.

> *'For years I have extolled the virtues of what appeared to be a productivity-led recovery... Unfortunately this restructuring has a dark side, one that has prompted my second thoughts... The dynamics of competition insist that success be determined by pushing the envelope at the high end of the value chain – by uncovering new markets, new technologies, new products and new concepts. And that doesn't happen by downsizing. Instead, it requires investment in both human capital and innovation...'*
>
> Stephen S Roach
> Chief Economist and Director
> Morgan Stanley
> *'The Hollow Ring of the Productivity Revival'*, *Harvard Business Review*, Nov-Dec 1996

> *'The real point .... is longer-term growth on the revenue side. It's not so much getting rid of people. It's getting more out of people.'*
>
> Dr Michael Hammer as quoted in the *Wall Street Journal*,
> 26 November 1996

If the primary means of increasing shareholder value in the 1980s was acquisition, and in the 1990s re-engineering, growth in the next decade will see a rediscovery of the importance of innovation.

Of course, it would be wrong to say that companies have ignored innovation over the last 15 years. One of the world's largest companies in terms of shareholder value, Intel, is built on a technology which did not exist 40 years ago. Reuters, the world number one supplier of electronic information to the global financial community, has increased revenues by over 500% in a decade, spending 7% on system and product development. Canon tripled revenue in a decade, most of its growth coming from businesses in which it was not involved 20 years ago. Canon now files more patents in the US than any other company except IBM. In pharmaceuticals, all the major companies have embraced biotechnology and are investing up to 15% of revenues in research and development (R&D). Technology developments have been breathtaking and there is much more to come. For most companies the problem is not a shortage of technology, but how to use it to build competitive advantage.

The point is that, in many sectors of industry, managing innovation has taken second place to managing costs. Where attention **has** been devoted to improving innovation management, the same drivers have often dictated the actions taken. Two strategies typify the response. The first has been to break up large central R&D organisations and partition resources between business units. Often this has been accompanied by significant headcount reductions. The second has been the introduction of formalised product development processes, sometimes as a part of a broader quality or re-engineering initiative.

The rationale for both approaches has been the same – to ensure that development efforts were more aligned to business needs and to increase the "bang per R&D buck".

Both have usually paid off. R&D is extremely difficult to integrate with the business it serves and can easily become slow and flabby. Giving business units more direct responsibility for their R&D and introducing standard processes to encourage cross-functional teamwork has had a positive impact on most companies that have followed this path.

But, all too often, there has been a downside. R&D has become *too* focused on the *short-term* needs of its customers. Because of pressure for short-term results, business managers in turn have had insufficient time or incentive to consider longer-term strategies and more innovative business development opportunities. Furthermore, the growth of business tubism, and reduction in corporate business development resources that has usually accompanied it, means that many of the best opportunities for business growth – those that lie in the "white space" between businesses or involve partnerships with external companies – have been ignored.

In our discussions with business leaders throughout Europe and North America, we find the same message repeated again and again. Whilst changes in approach to R&D management have led to incremental innovation becoming more efficient, it has become much more difficult to undertake radical innovations with the higher rewards (and higher risks) that this offers. The search for best practice in product innovation continues.

The purpose of this report is to examine how companies with a history of success in innovation go about the product development process and to describe the key elements of a *"Strategic Innovation Management System"* which companies will need to remain competitive in the twenty-first century. In preparing it we have drawn on three main sources of information. First we draw on the results of an extensive study of new product development processes which The Technology Partnership has carried out for this report. Altogether we visited 22 companies in Europe, the United States and Japan, including industry leaders like

Canon, IBM and DuPont. We are deeply grateful to these companies for sharing their experience of managing product innovation with us.

Secondly, we have drawn on our own experience, as consultants, of advising major companies on innovation and technology management. It is only when you try to introduce new ways of thinking or managing into a company that you realise why things were as they were. The generic lessons we have learned and approaches we have developed to overcome the natural barriers to innovation that exist in any large organisation are incorporated in this report.

Finally, we have drawn on the experience of The Technology Partnership as a product innovation business in its own right. Over 80% of our revenue comes from creating innovative products for clients, and over the last decade we have developed approaches that enable us both to manage creativity and to achieve very fast product development times. A key issue for large companies is to what extent the entrepreneurial dynamism and culture of a small business like The Technology Partnership can be replicated within a large company environment. We found some that had achieved just that.

In the next chapter we report on the results of a study of product innovation involving companies from Europe, the United States and Japan. Its primary focus is on the total quality management "stage-gate" based approach to product development, whose adoption by many large companies represents the most important change in approach to product innovation of the last five years. We discuss the benefits it has delivered to those companies that have implemented it, and highlight important shortcomings.

In Chapter 3 we step back from this analysis and paint a broader picture of the innovation process, examining how it works in practice and the barriers which often get in the way.

Together with the research findings and our own practical experience of product innovation, this provides the basis for an approach to Managing the Overall Innovation Process which is presented in Chapter 4. This offers an integrated approach to innovation management, drawing on the many different techniques and approaches used by the companies we interviewed, as well as those of others whose innovation performance we admire, and our own experience as practitioners.

BOC Gases: Responding to the Forces of Globalisation

The BOC Group is a portfolio of four businesses – gases, healthcare, vacuum technology and distribution services. BOC Gases manufactures industrial and special gases in 60 countries and supplies some two million customers worldwide. These gases are used in the manufacture of a vast array of products in many different industries, including semiconductors, plastics, steel, frozen food and light bulbs.

Although a major international business, BOC's structure has evolved to emphasise national and regional profit centres, with great emphasis placed on serving local markets through close customer relationships. International co-ordination of technology has enabled commercial intelligence to be progressively built up to overlay this dominant geographical structure.

The emergence of truly global customers was first identified in the electronics market, where BOC supplies high purity gases to semiconductor fabrication plants. In the semiconductor industry, economies of scale in R&D and production are vital to ensure competitive pricing and the supply of semiconductors has become dominated by a handful of companies. BOC therefore found itself serving the same customers irrespective of geographical location, and coming up against the same competitors.

This trend has extended to more and more industrial gas applications and, combined with the competitive pressures in these markets, has stimulated a wave of innovation amongst industrial gas suppliers, particularly with regard to applications and service development.

To serve these markets better, BOC set up a series of Global Market Sector Teams covering Food, Chemicals and Petroleum, Electronics and several other application markets. Staffed with a mixture of full-time and part-time members from around the world, they act as virtual teams to drive innovation and support marketing in their particular sectors. Each team has a Technology Director, who acts as Programme Manager for the innovation projects serving his sector.

The Programme Manager's role includes identifying opportunities for innovation projects, managing the project portfolio and ensuring that each project is structured and managed to deliver maximum benefits to BOC's regional businesses. The teams involved in each innovation project are often dispersed geographically and, to aid project management, BOC has introduced a tailored stage-gate type Innovation Project Management Process (IPMP).

Our research shows that the stage-gate approach provides only a partial solution to companies wishing to increase their innovation effectiveness. For some types of development it can actually **increase** time-to-market, and it has little to offer companies seeking to improve the "front end", concept generation part of the overall innovation process. We outline the various other tools and techniques that can be used and show how they relate to different types of project and different stages in the overall innovation process.

Finally, for companies seeking to make fundamental improvements in their innovation effectiveness, in Chapter 5 we describe the key steps needed to design an appropriate Strategic Innovation Management Programme and make the changes stick.

2. THE PROCESS APPROACH TO THE MANAGEMENT OF PRODUCT INNOVATION: A STUDY OF BEST PRACTICE

2.1 Study Objectives and Companies Interviewed

Between September 1996 and April 1997, the Strategy Division of The Technology Partnership carried out a global study of how new product development was undertaken within major companies in Europe, USA and Japan. The companies interviewed are listed below and the Appendix shows their key characteristics in terms of location, size and business activity. The scope was deliberately broad, including companies in the chemicals, materials, pharmaceuticals, healthcare, office automation, electronics and computing industries.

Table 2.1: Companies interviewed

Europe	North America	Japan
ICI	BOC	Canon
Esselte	DuPont	Fuji Photo Film
Zeneca	Bayer	Daicel
DSM	Johnson & Johnson	Kaneka
IBM	Bausch & Lomb	Zebra
Glaxo Wellcome	Analog Devices	Nippon Shokubai
NCR		
Dynacast		
Smith & Nephew		
Northern Telecom		

The most important change in the management of product development over the last five years has been the introduction of formalised "**stage-gate**" systems. Roughly half of the companies in our samples used some form of stage-gate process and one of the key starting points of our study was to assess the impact of these. What had been the benefits? Did they have any shortcomings? What constitutes best practice in terms of designing and implementing such systems?

Table 2.2: Companies interviewed employing stage-gate type new product development processes

ICI	– *Chemicals*
IBM	– *Computers and IT services*
NCR	– *Automatic teller machines (ATMs)*
Northern Telecom	– *Telecommunications equipment*
BOC	– *Industrial gases*
DuPont	– *Chemicals*
Bayer Diagnostics	– *Medical equipment*
Johnson & Johnson	– *Healthcare, pharmaceuticals and consumer products*
Bausch & Lomb	– *Eye-care*
Analog Devices	– *Semiconductors*
Canon	– *Business machines, cameras and optical products*

Note: Some of the other companies interviewed practised stage-gate approaches in other parts of their businesses.

However, before answering these questions, we summarise the key features of the stage-gate approach.

2.2 The Stage-Gate Approach

The adoption of a *process approach* to new product development is based on the belief that new product development is a core business process (along with manufacturing or purchasing) and that quality management techniques are therefore equally applicable.

Three academics have been particularly influential in conceptualising the approach, Carter and Wheelwright[1] from Harvard Business School and Cooper[2] at McMaster University in Hamilton, Ontario. A number of the companies we interviewed had been strongly influenced by their thinking and some consulting organisations have developed proprietary products around the same basic philosophy.

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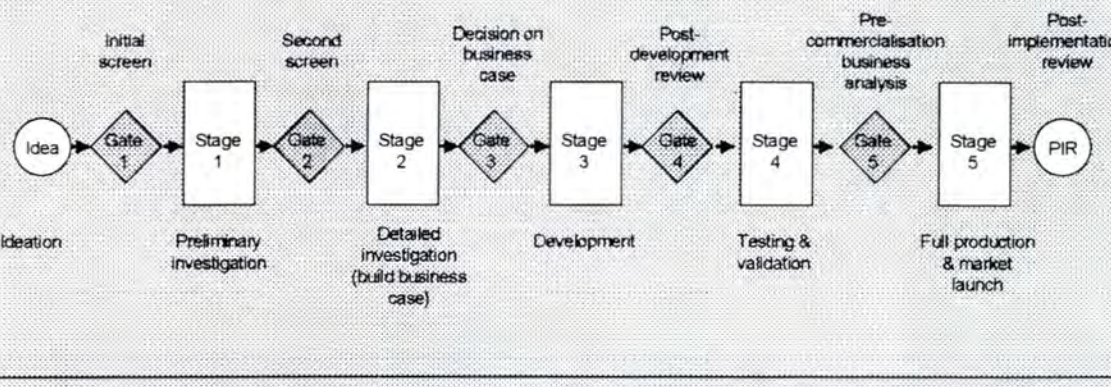
[1] *Revolutionizing Product Development*, Steven C Wheelwright and Kim B Clark, New York: Free Press, 1992

[2] *Winning at New Products*, Robert G Cooper, Addison Wesley, 1993

Figure 2.1: A generic stage-gate new product process



The central idea is that the product development process can be broken down into a pre-determined set of stages, each stage consisting of a set of prescribed, multifunctional and parallel activities. The entrance to each stage is a gate which acts as a quality control checkpoint and enables Go/No Go decisions to be made. If a company's entire portfolio of projects is managed under this regime, it should be possible to progressively focus resources on those projects offering the best commercial potential.

Typical stages in the process are:

- ***Preliminary investigation*** – A quick investigation and scoping of the project.
- ***Building the business case*** – A more detailed investigation leading to a business case for the new product development, including project definition, justification and a project plan.
- ***Development*** – The physical design and development of the new product.
- ***Validation*** – Tests or trials, both in the lab and market-place, to verify the technical and commercial viability of the new product.

- ***Commercialisation*** – Beginnings of full production and launch onto the market-place[3].

There is an additional stage, sometimes referred to as Stage Zero, known as idea generation or ideation. Idea generation is a vital activity since it acts as a trigger to the rest of the new product process.

2.3 Key Elements of the Approach

Stage-gate systems incorporate five key elements:

- ***Risk management*** – By breaking the product development process into a series of key stages, with each stage usually costing more than the previous one, it is possible to focus effort on reducing key uncertainties (technical, commercial or strategic) before development costs increase. At the start of the project, an overall game plan is produced covering the work to be undertaken at each stage. At each subsequent stage more detailed plans are provided, taking into account the information already collected and changing circumstances.

- ***Gate reviews*** – Gates provide formal review points at which the achievement of milestone targets can be checked and deliverables established for the next stage. This enables new information to be taken into account as projects progress. Poor projects can be killed off early and resources can be focused on the most promising ones. Most importantly, stage-gate reviews are *event* based, rather than calendar based. Decision making is based around the evaluation of predetermined deliverables and can therefore be given more teeth. The most important feature of the stage-gate philosophy is that a positive decision must be made to provide resources for the next stage of work. The default is stop. As Cooper puts it, *'a single no (against a predetermined list of "must meet" criteria) signals a kill decision and brings the meeting to a quick end'*.

- ***Multifunctional teams*** – Stage-gate aims for the active involvement and commitment of representatives of the different functions within an organisation (R&D, Marketing, Manufacturing and so on). If achieved, this improves decision making and, by ensuring "ownership" of projects, speeds implementation.

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[3] This is essentially the generic model as described by Cooper in *Winning at New Products*

- ***Parallel processing*** – Technical, commercial and manufacturing issues are all addressed in parallel within each stage so that the overall project risk is reduced in a managed fashion.

- ***Market-driven bias*** – Stage-gate systems provide a market-pull as opposed to technology-push bias to the new product process, with all projects being evaluated from the perspective of the customer, even if the idea originated in R&D. As one R&D manager interviewed put it: *'Our job is to come up with the ideas, but Marketing must prioritise what projects we should work on'.*

2.4 The Gate Review Process

The gate review process lies at the centre of the stage-gate approach. If this does not work well, the whole process falls down.

Gate reviews have three main objectives:

- to decide on whether or not a project should proceed, stop or be redirected
- to decide the project's priority with respect to others in the portfolio
- to agree the work programme and resourcing arrangements for the next phase and define the deliverables for the gate review at the end of it.

Typically, the project manager will submit a report to the gate review team some days in advance of the gate review meeting. Then on the day, he or she will make a short presentation.

A Go/No Go decision is reached at, or shortly after, the end of the gate review meeting. Alternatively, the gatekeepers may elect to refer the project back to the previous stage in order to address certain targets which have not been met. A "Go" decision implies the commitment of resources to enable the project to proceed to the next stage. As total R&D funding is usually fixed, this requires a priority to be put against the project compared with others in the portfolio and represents one of the most difficult aspects of the stage-gate approach to manage in practice.

Bayer Diagnostics: Revitalising the New Product Development Process

Bayer Diagnostics, the US-based healthcare business group of the German chemicals and pharmaceuticals giant, Bayer AG, manufacturers and markets diagnostic products which serve the urology, diabetes, haematology, immunochemistry and clinical chemistry markets. Its revenues in 1995 were DM1.5 billion.

One of the Diabetes Business Unit's core products is home blood-glucose testing kits. Advances in technology, increased competitive pressures and a changing healthcare market resulted in Bayer losing market share in its diabetes market and it was forced to license-in a new biosensor technology to complement the more traditional technologies that were being developed in-house.

In parallel with this, Bayer's senior management set about addressing the fundamental problems of an out-dated technology base and the lack of a clear methodology for executing new product development projects. There were two important strands to its strategy. The first involved investing heavily in building up an in-house biosensor capability and entailed changes in key staff and a re-organisation of the R&D function.

To ensure that this investment in R&D would lead to success in the market-place, the company also sought to apply a set of "best practices" in new product development. The essential elements of the new stage-gate type processes introduced are:

- the establishment of a cross-functional Product Approval Committee (PAC) to conduct event-based gate reviews throughout the new product development process. This PAC is made up of the heads of the functions represented within the business (for example: Vice-President Marketing)
- the use of multifunctional core teams to execute projects. These core teams are formed at the outset of the project and stay together until the product is launched
- a structured development process defining the five key stages of "concept", "feasibility", "development", "trial" and "launch".

Two projects were selected as pilots and consultants worked alongside Bayer's management to facilitate implementation throughout the business. Two managers were trained as programme managers for the two principal sites and, within a year, a total of 12 projects had been brought under the new system.

To date, the new process has delivered reductions in time-to-market of up to 40%. This has been achieved through:

- *Agreement of common goals and objectives* – The Product Design Requirements (PDR) document identifies product features and communicates these to all functions.

- *Input to the new product development process from all functions at an early stage* – This "buys" commitment and avoids complications later on in manufacturing and commercialisation.
- *Forced decision making from senior management* – The PAC provides the mechanism for decisions to be taken on the relative priorities of different projects and their future development path.

Selection of gatekeepers

For the gatekeeping role to be executed effectively, gatekeepers must:

- have the authority to make decisions and *approve* or *divert* resources for the next stage
- represent the "sponsors" of the project, that is: the key functions involved (such as Marketing, R&D, Manufacturing) or, in the case of a multi-business company, the management of an individual business unit
- bring a high degree of *continuity* to decision making between and within projects.

In practice, this means gatekeepers must constitute (or at least include) a small senior group of directors or managers with both authority and the commitment that derives from real self-interest. Where we found stage-gate processes at their weakest was when these criteria were not met.

2.5 Reasons for Introducing Stage-Gate

Of the 22 companies interviewed as part of this study, 11 had implemented a stage-gate type new product development system (see *Table* 2.2). With the exception of Canon, those companies employing stage-gate type systems were either UK- or US-owned. Canon's New Product Development Flow (NPDF) establishes basic procedures to be carried out at different stages in the development of a new product, but offers a high degree of flexibility in the way it is interpreted from business to business.

From this and discussions with many other companies, it is clear that US companies are several years ahead of European ones in terms of the introduction of stage-gate management. A summary of the prime motivations for firms adopting the stage-gate approach is presented in *Table* 2.3.

Table 2.3. Reasons for implementing stage-gate type processes

Reason	Key contribution of stage-gate	Importance
Increase return on R&D	Elimination of flagging projects	OOO
Reduce time-to-market	Multifunctional teams and clear decision making process	OOO
Improve risk management	Early identification of both technical and commercial risk	OO
Improve quality management	Documented process provides basis for ISO 9001 registration	OO
Technological innovation	Legitimises innovation	O
Globalisation	Integrated process	O

Key: OOO = 50% of firms interviewed quoted as key driver
OO = 33% of firms interviewed quoted as key driver
O = 10% of firms interviewed quoted as key driver

Increased return on research and development – 50% of companies interviewed that had stage-gate systems quoted inadequate return on R&D as the major reason for introducing it; though, surprisingly, none was able to quantify its current performance in terms of return on R&D investment.

The key concern was that overall return on new product development was pulled down by too many flagging projects being allowed to continue. As a result, "star" projects were starved of key resources.

Reduced time-to-market – As important as overall return on R&D was time-to-market. One major chemical company had carried out a benchmarking study which concluded that its time-to-market was double that of the best-in-class in its industry.

Improved risk management – This is important in large complex development projects involving new technologies or markets. The original motivation behind Northern Telecom's implementation of its gate process was to improve the management of software development for its telecommunications switch – a product for which reliability is absolutely essential.

Improved quality management – Many of the participating firms' stage-gate initiatives coincided with company-wide quality initiatives. For example, Bayer was able to achieve ISO 9001 registration within months of implementing its stage-gate process.

Increased strategic role of technological innovation – BOC Gases recognised that technology based innovation was becoming a major source of competitive advantage in the global supply of industrial gases. The objective of BOC's Innovation Project Management Process (IPMP) was to ensure that innovation projects with the greatest potential strategic impact on the business were optimally resourced and managed.

Globalisation – As companies become more global, product development teams are often based in widely separated geographical locations. The rigour and discipline of a well defined product development process aids communication and decision making. BOC Gases' IPMP system provides a case in point, helping it to manage projects involving work in up to five different geographic locations.

2.6 Design of Stage-Gate Systems

The stage-gate methodology is a set of generic principles which can be customised to suit specific company requirements – although most companies try to impose a standard framework on each business – thus ensuring that key disciplines cannot be ducked. The precise design needs to take account of:

- the organisational structure of the business in which it is to work
- the type of product development projects that will be executed within the process (such as product line enhancements, new product lines and radical product innovations)
- the nature of the business, for example, branded consumer products or bulk chemical processes.

Table 2.4 summarises the individual designs of the processes reviewed. The number of stages employed varies from four, in the case of ICI, to seven in the case of Northern Telecom (the latter includes four optional gates). Bausch & Lomb uses four gates, two of which are optional at the Programme Manager's discretion. The two mandatory gates are to decide on development from feasibility and to decide on whether to move from scale up to product launch. BOC are considering streamlining their stage-gate process and adopting a "two-tiered" approach to gatekeeping, thus reducing the number of reviews involving high-level, cross-functional gatekeeping teams. Johnson & Johnson Consumer Products' system includes

two launch stages, reflecting its strategy of launching new products in a pilot, local market before launching globally.

Table 2.4: Design of stage-gate systems

Company	Name of stage-gate system	Number of stages	Number of gates	Gatekeeper	Application
ICI	PDQuest	4	4	R&D Managers + Business Team Managers	Global product development
IBM	Integrated Product Development (IPD)	5	4	Cross-functional team (6-off)	All hardware and software development
NCR	Product and Cycle-time Excellence (PACE)	5	4	*Product Approval Committee	Incremental products and new platform products
Northern Telecom	Gate Process	7	8*	Technology, Marketing and Manufacturing Managers	Incremental products
BOC	Innovation Project Management Process (IPMP)	6	6	Business Sponsor + member of Technical Steering Committee	Top 20 priority projects worldwide initially, followed by further key projects
DuPont	Product and Cycle Time Excellence (PACE)	5	4	Team of business and functional managers	70% of business units; product line enhancement and new product lines
Bayer Diagnostics	Product and Cycle Time Excellence (PACE)	5	4	VPs for R&D, Marketing, Manufacturing/ Sales	All new product development in Diagnostics Business
Johnson & Johnson Consumer Products	Product Development Process	5	4	Business, Country and R&D Managers	New product lines only

Table 2.4: Design of stage-gate systems

Company	Name of stage-gate system	Number of stages	Number of gates	Gatekeeper	Application
Bausch & Lomb	Product Development Management Process (PDMP)	5	4**	*Programme Managers, Functional Managers and Directors	Eyeware and vision care businesses
Analog Devices	Product Specification Management Process (PSMP)	3	4	Product line Director, VP Division, Design Manager, Strategy/ Marketing Manager	All products

* = Includes four optional gate review points
** = Includes two optional gate review points

All the stage-gate systems reviewed emulated some form of cross-functional gatekeeping, though the selection of gatekeepers depended on the precise organisational structure of the business. Companies employing complex matrix-type structures found it harder than those with simple functional organisations to identify appropriate gatekeepers. The issue was usually resolved by identifying who were the key "stakeholders" in the project, including both the commercial project sponsor and the "owners" of the key resources needed for the project's execution.

2.7 Benefits of Stage-Gate

Companies highlighted seven main benefits from introducing stage-gate processes:

- reduced time-to-market
- more "goal orientated" project management
- more effective portfolio management
- better risk management
- increased cross-functional commitment
- increased "market-pull"
- better decision making.

Reduced time-to-market – Many of the firms interviewed claimed significant reductions in time-to-market for product development. Bayer have achieved 40% reduction to date,

DuPont between 40 and 60% reduction across the business. NCR have cut their development times by an estimated 30%.

Goal orientated project management – Stage-gate encourages a focus on results and deliverables, not simply milestones. Furthermore, the multifunctional team-working approach ensures *common* goals and objectives across functions. Bayer Diagnostics has found its Product Design Requirements (PDR) procedure a vital tool in agreeing and communicating product features.

More effective portfolio management – Whilst advocates of stage-gate argue that it enables funding and resource decisions on individual projects to be taken in the context of the overall development portfolio, only one or two companies interviewed found that the introduction of stage-gate had helped them achieve this in practice.

Better risk management – The stage-gate methodology forces the early identification of key market and technical risks *before* large resources are committed. For example, DuPont has found that the discipline of stage-gate has helped its engineers and scientists take a more commercial view early in a project's life.

Increased cross-functional commitment - Probably the most significant benefit of stage-gate is the discipline it imposes on cross-functional team-work, thus achieving better buy-in from non-technical functions and avoiding downstream problems such as poor design for manufacture. Bayer particularly highlighted the role of its Product Approval Committee in achieving this. Of course, multifunctional team-work and parallel working have long been accepted as best practice in new product development. The key point is that the ultra-strong stage-gate discipline, with *"stop"* as the default decision at each gate, concentrates the minds of managers, for whom product innovation may be a relatively low priority compared with other more urgent problems, and turns good intentions into actions.

Increased market pull – The emphasis on strategic and commercial justification in the early stages of the stage-gate approach helps ensure a firm's product innovation programme fits closely with its overall business strategy. As one manager put it, *'the aim is to develop what we can sell, not sell what we can develop'*. This is not to say that all new product ideas have to originate from the customer, or Marketing function. R&D may well be the main source of ideas but, by requiring the business case to be constructed with input from all functions, the concept is seen from the perspective of the market.

Better decision making – The ability to force tough Go/No Go decisions was one of the principal reasons companies had implemented stage-gate. Whilst the stage-gate discipline sharpened up the decision process, where project resources and budgetary control were spread across many individuals, many companies continued to find it hard to take the tough decisions required. One of the companies we interviewed noted that the formality of the process exposed those managers who actually find decision making uncomfortable.

2.8 Weaknesses of Stage-Gate Processes

Whilst all firms introducing stage-gate management had found it yielded important benefits, three significant limitations were noted by many companies:

- poor integration with portfolio management
- lack of a "front end" innovation process
- lack of relevance to all types of innovation projects and processes.

Poor integration with portfolio management – Whilst in theory "stage-gate" should provide much of the information needed to manage the overall *portfolio* of innovation projects, in practice most companies had found it difficult to use it in this way. Partly this reflects the difficulty of co-ordinating decision making across multiple projects, often involving many different gatekeepers. However, perhaps as important is the difficulty companies experienced in genuinely moving away from the annual budgeting cycle. If funds and resources have already been allocated to a particular work programme, it is hard in practice for gate review teams to stop projects or shift resources.

To overcome this limitation, higher level portfolio and "programme management" processes such as those developed by BOC must be adopted and adjustments made to improve project accounting. Funding processes often also need to be changed to permit gate reviews to operate with real bite.

Lack of a front end innovation process - The stage-gate approach does little or nothing to improve the quantity and quality of new product ideas being generated at the front end of the innovation process. It is essentially about "doing things right" rather than "doing the right things". It offers no mechanism to ensure that innovation is focused on the key strategic issues facing an organisation or that good ideas are generated and captured.

The lack of an effective "front end" is the most important weakness companies identified in the stage-gate approach and we therefore outline a more comprehensive approach to innovation in Chapter 4.

2.9 The Type of Innovation Projects for which Stage-Gate is Appropriate

The interviews suggest that stage-gate has been used most successfully for developments involving only a "moderate" level of innovation. For simple product enhancements, the standard methodology is often too cumbersome and can actually increase development times. The effectiveness of stage-gate in reducing time-to-market is also questioned by companies faced with predetermined product launch dates; for example, dictated by the need to have new products ready for an annual trade show.

One of the world's leading consumer durable products companies for whom TTP carries out development work has recently dropped the standard stage-gate approach for this reason, whilst another accepts that in certain circumstances, outsourcing can achieve far faster development times than are possible under its regulated internal stage-gate process. This latter company also found that after introducing formal stage-gate disciplines, it put far fewer prototype products to customers for user trials. It now accepts that to have something "90% right", but on time, is often more important than product perfection. It is planning to introduce a modified process for product developments where time-to-market is critical.

At the other extreme, where a high degree of innovation is involved or the development represents markets which are new to the company, stage-gate may be too inflexible. For example, Northern Telecom decided to run a mobile phone handset development using a "stripped down" gate process, more suitable for a high volume, rapidly changing product. Zeneca Specialties does not attempt to use stage-gate for "strategic research programmes", though it is the norm for business unit R&D.

The absence of formal stage-gate process methodologies amongst Japanese companies is also noticeable. The consensus management culture, which is the norm in Japan, seems to obviate the need for formal "processes" to enforce good practice. What is also striking is the much greater emphasis placed on competence building and the incremental development of new businesses. The Daicel, Canon and Fuji Photo Film case studies in this report provide examples of this kind of strategic thinking at work.

It is clear therefore that, whilst stage-gate has brought important benefits to many companies, it is not a panacea. The detailed design and mode of implementation must be linked to the precise requirements of the business. In some situations, stage-gate may be quite inappropriate. We return to this topic in Chapter 4.

2.10 Implementation of Stage-Gate Systems

Design of Implementation Programme

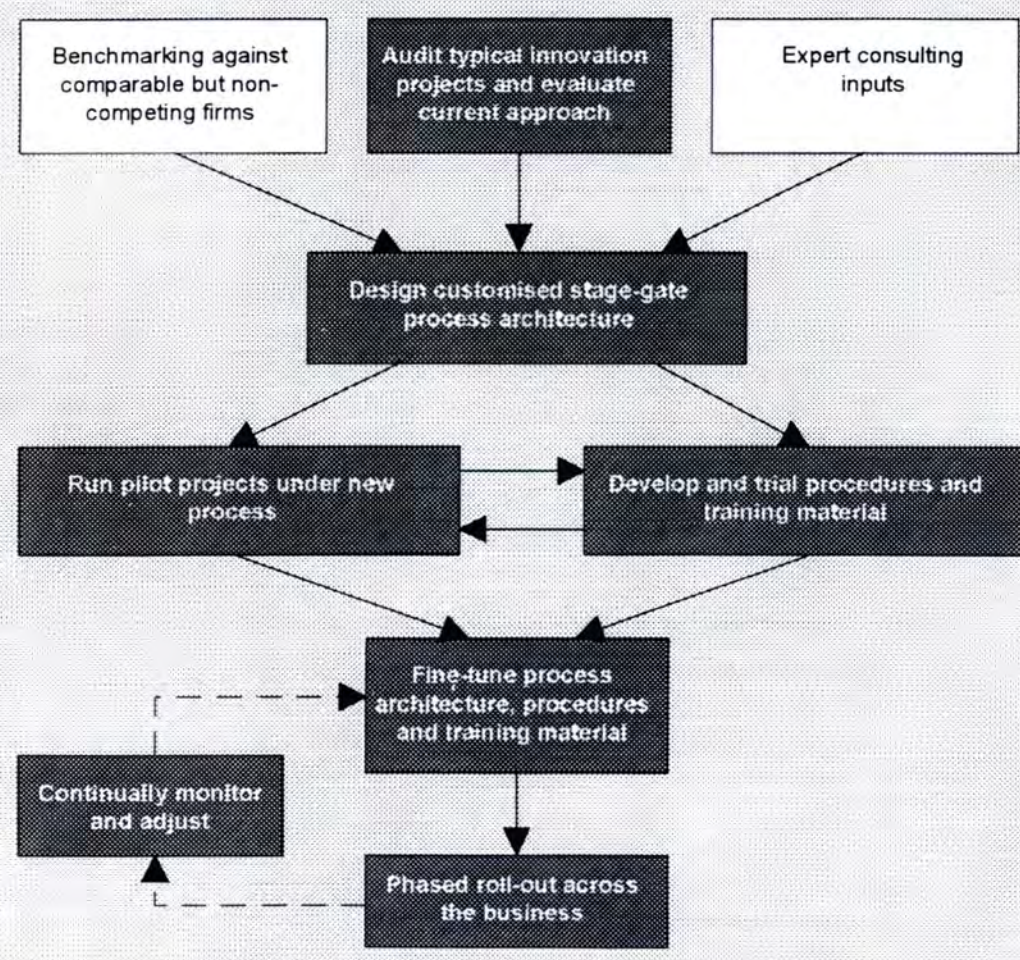
Most companies had put a great deal of planning and thought into implementing stage-gate. Those achieving the most successful outcome had followed the kind of programme shown in Figure 2.2 with three key phases as follows:

Phase 1:	Audit of existing innovation processes and typical projects, and design of stage-gate architecture.
Phase 2:	Introduction in pilot projects.
Phase 3:	Phased roll-out across the business.

It is important to remember that stage-gate management cuts right across the organisation. All management disciplines need to be involved and to be effective it usually requires important changes in management attitudes and decision making processes. The investment required to achieve this is therefore significant and a full-time internal team supported by external consultants is usually involved.

Most companies found it essential to use an external consulting resource to design and help drive through the implementation programme, and to ensure that best practice rather than compromise was the end result. In the case of IBM's Integrated Product Development (IPD) programme, briefing seminars were held regularly to share pilot programme experience between businesses from different countries. After attending training sessions, managers were required to sit a written examination to qualify as a team leader.

Figure 2.2: Implementation of stage-gate processes: Typical approach adopted by successful firms



The success of the stage-gate process depends critically on the quality of gatekeeping. Gatekeeper training is therefore essential, even though the directors and managers involved may hold very senior positions. DuPont trains gatekeepers by having them participate in a "mock" gate review using a fictitious project.

A pilot programme is essential and will usually reveal weaknesses in the architecture or related aspects of the company's management processes or culture. In one case it highlighted the need to totally revamp the organisation's approach to funding R&D to break the

stranglehold of the annual budgeting cycle and make those responsible for setting strategy more responsible for controlling funding. Further fine tuning may be required during full scale implementation.

Most successful stage-gate programmes have a full-time programme manager to ensure the necessary disciplines are maintained and to train new people. DuPont maintains a corporate team of internal consultants to implement the stage-gate process in businesses throughout the corporation. The ownership of the process is transferred from the consultant to a process owner in the business for continuous improvement.

The interviews showed that Board-level support and involvement is essential for effective implementation of stage-gate systems. In one case, where the initial idea for stage-gate had been promoted upwards from within the R&D function, insufficient resources were devoted to training and facilitation and problems with important parts of the overall architecture were unresolved. The main Board had approved the implementation programme without taking a high degree of ownership during the early stages. As a result, problems were experienced in the pilot programme.

Implementation difficulties

Besides the fundamental limitations of stage-gate management discussed above, there were also three important practical implementation difficulties experienced by the firms interviewed, particularly with regard to the operation of gate reviews and decision making:

- logistics of gate review meetings
- timing of gate reviews
- quality of decision making.

Logistics of gate review meetings

Arranging meetings of gatekeepers was often enormously difficult, especially for those companies operating a global matrix management structure. The problem is exacerbated by the need for gatekeepers to be able to look across different projects and make prioritisation decisions. Video-conferencing and other technical solutions could be and were used, but to limited effect when large numbers of people were involved. As a result, compromises often had to be made in gatekeeper selection.

DuPont: Implementing Stage-Gate

DuPont is the world's largest chemicals company and has a long history of successful innovation. Among its best known brands are Teflon®, Lycra® fibres and Kevlar® aramid fibres.

DuPont places great emphasis on investing in R&D to support growth and spends over US$1 billion annually in R&D, 25% of which is targeted at breakthrough platforms for new products and complete new businesses. As Joseph A Miller, Senior Vice President, Research & Development, points out: *'In 1995, more than 30% of DuPont's revenues came from products introduced in the last four years. We face a renewed challenge to bring forward major new ideas that can create US$1 billion businesses and entire new industries in eight or 10 years.'*

As part of a renewed focus on R&D effectiveness and efficiency in the early 1990s, DuPont carried out a detailed review of its new product development process, and benchmarked practice and performance against best-in-class companies in other industries. The stage-gate methodology was identified as best practice and DuPont set about designing and implementing an appropriate system across its different businesses. The key elements were to be:

- multifunctional core project teams
- phase reviews conducted by a Product Approval Committee comprising senior executives from Marketing, Sales, R&D and Manufacturing
- a structured development process.

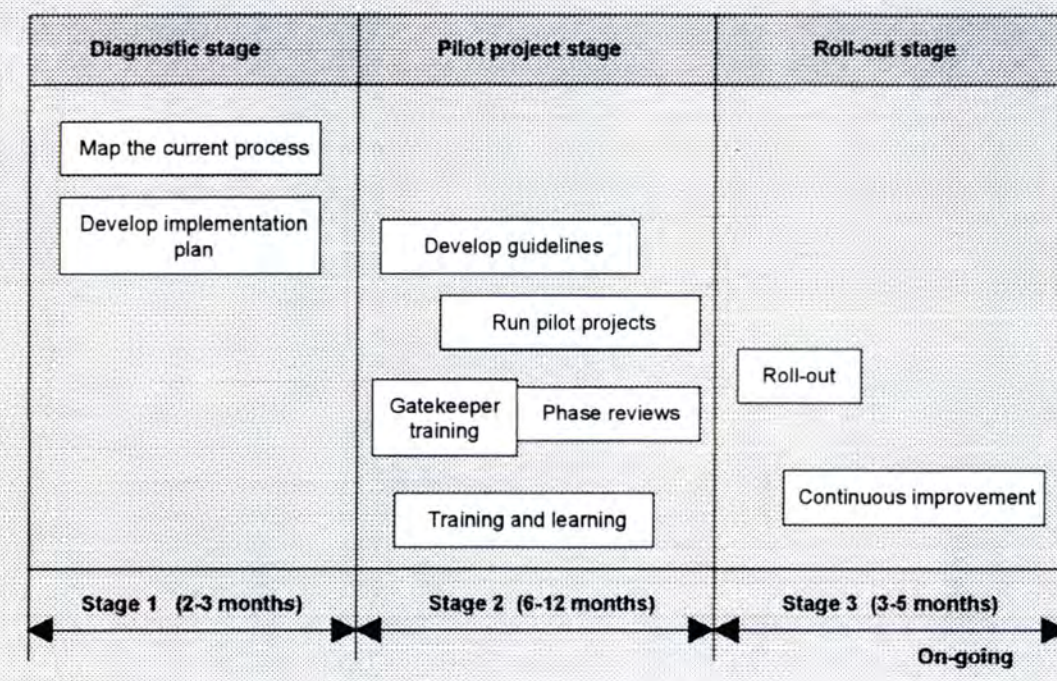
DuPont initially appointed a team of consultants to help implement the new process in four of its businesses. This in turn enabled internal "consultants" to be trained so that they could carry through implementation into DuPont's other businesses. A three stage approach is involved, typically taking 12 to 18 months to complete per business:

Stage 1 (Diagnostic Stage): Current product development practices are mapped and analysed through interviews. This provides the baseline metrics for setting improvement targets.

Stage 2 (Pilot Project Stage): A design team is put in place to identify and document those areas of the process which need to be customised for that business. Pilot projects are selected and people are tracked to test the process with actual product development projects. In addition, the Product Approval Committee is established and trained using "mock" phase reviews.

Stage 3 (Roll Out): The customised stage-gate process is rolled out through the business to encompass all product development projects. Awareness and training is vital to ensure that all "stakeholders" in the process understand its objective, principles and execution.

DuPont's Stage-Gate Implementation Process



DuPont recognises that whilst stage-gate plays a powerful role in managing project "execution", other processes are needed to encourage idea generation and new venture development. It uses a range of complementary management techniques and mechanisms to manage the overall innovation process.

To date, nearly three-quarters of DuPont's businesses have implemented a stage-gate type new product development process. On average, they claim a 40-60% reduction in time-to-market has been achieved. By 1995, 30% of revenues came from products launched in the previous four years.

Timing of gate reviews – The basic philosophy of all stage-gate processes is that reviews are event based and not calendar based. However, to facilitate active portfolio analysis and the diversion of funds from poorly performing projects to successful ones, some degree of synchronisation between gate reviews needs to be achieved. This is difficult to reconcile with the basic philosophy of stage-gate as an "event-driven process", with decisions linked to real deliverables. To deal with this paradox, companies sometimes found it necessary to relax this requirement so that gate reviews for a series of projects could be held on the same date.

Quality of decision making

The ability of gatekeepers to make Go/No Go decisions with confidence on the basis of the information presented at gate reviews is absolutely essential to the workings of stage-gate. A number of firms interviewed revealed that senior managers had found this difficult, preferring to keep all projects alive by spreading resources thinly.

The keys to really effective decision making are process design and gatekeeper training and the involvement of people who are close enough to all aspects of the decision to make informed judgements. They must also be senior enough for decisions to stick.

Despite these problems, most organisations have seen significant benefits as a result of introducing stage-gate type processes, in particular through the impact they have on the quality of communication between different functions and the resulting improvement in project planning and risk management. However, the gap between "best" and "average" new product development performers remains a large one and some companies have found the text book methodologies far more difficult than they expected to implement in their own particular industry or business environment.

More important, stage-gate methodologies are essentially about doing things smarter, not about doing smarter things. Properly structured and implemented, they represent an ideal mechanism for managing projects with reasonable technical and some market uncertainty. They are perhaps overly bureaucratic for incremental product development and put insufficient emphasis on the entrepreneurship needed to carry through very radical ones. They also have little to contribute to the management of investments in underpinning technology – so vital to the long-term strategic development of any company. Most important of all, they provide very little help with the generation of product ideas. They are essentially about "execution", rather than innovation.

For companies seeking to use innovation as a major plank of their future strategy, stage-gate provides only part of the story. Such companies must base their strategies on a much more sophisticated model of the overall product innovation process and they require a more diverse and creative set of management approaches to foster and harness it. In the next chapter, we examine in more detail how the innovation process works in practice.

3. THE BARRIERS TO INNOVATION IN LARGE ORGANISATIONS

3.1 A Simple Model of the Innovation Process

Before any organisation can begin a programme to improve its innovation effectiveness, it is essential to establish a shared understanding at senior level of how the innovation process works, together with the barriers that inhibit it, particularly in large organisations. *Figure 3.1* represents a simple schematic model of the process by which an innovation is conceived and brought to fruition.

In essence it consists of three types of activity:

Activity 1	Problem recognition and idea generation.
Activity 2	Concept refinement and experimentation.
Activity 3	Execution.

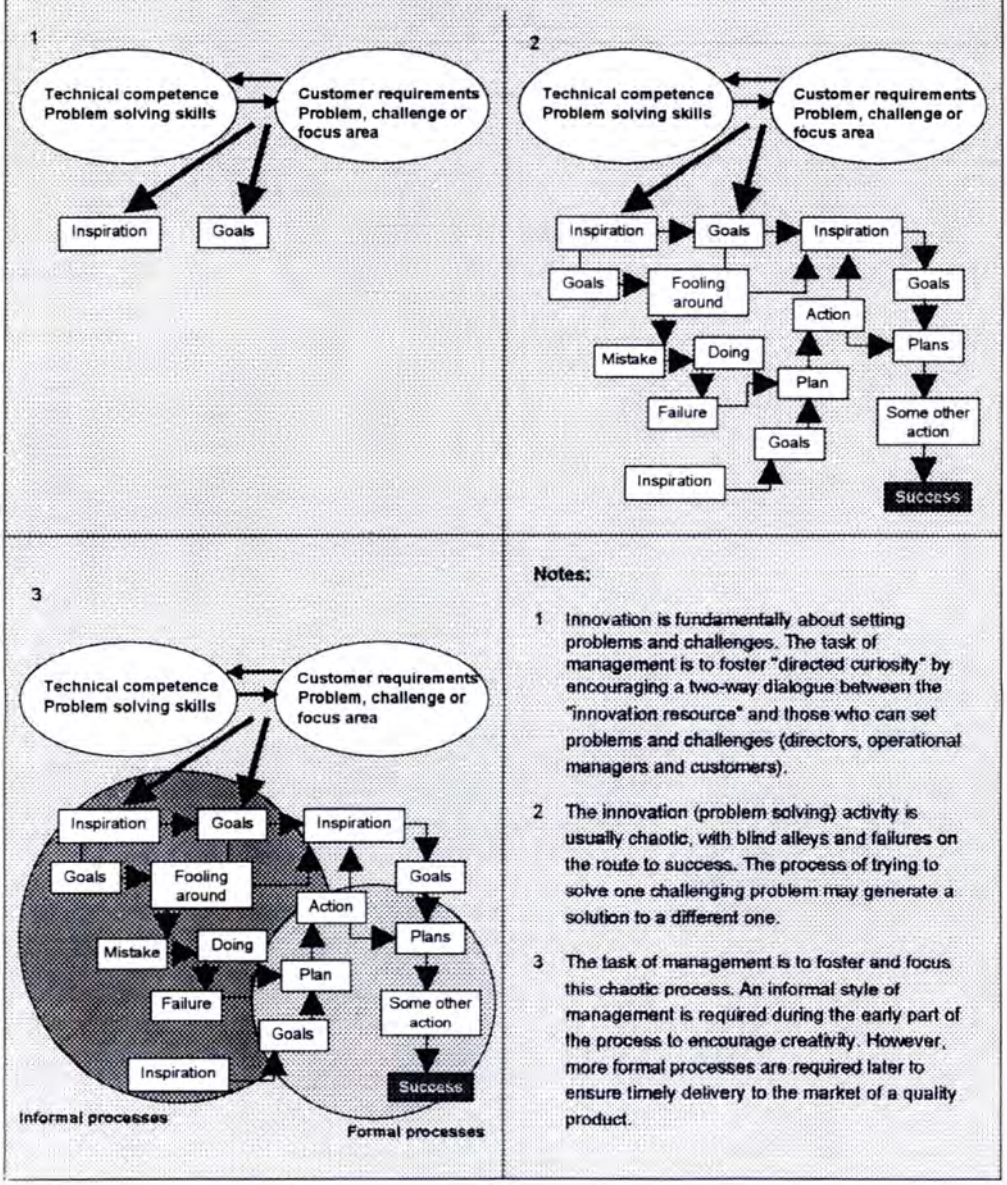
Activity 1: Problem Recognition and Idea Generation

When asked where his ideas came from, Barnes Wallis, inventor of the swing-wing aircraft and many other innovations, said *'I have never had an idea in my life. I find solutions to problems.'* At The Technology Partnership we see innovation in exactly the same way.

The first part in the innovation process is therefore about putting people with good technical and problem solving skills alongside customers or colleagues with real problems that need solving. Providing the dialogue is effective, this leads to the setting of specific innovation goals. The process can also be stimulated by setting "forcing" targets (for example, how do we achieve a 50% reduction in manufacturing costs) or focus areas (how do we exploit the Internet).

All human beings are good at solving problems to a greater or lesser degree. Where outstanding innovators differ is that they set their own problems. The result is not so much a "goal" as an "inspiration". The Sony Walkman is the classic example in the consumer goods field. Who before had conceived of the idea of listening to music in private while walking through a busy street?

Figure 3.1: How innovation works in practice



3M's paint masking tape is a good example in the industrial products arena. The inventor stumbled on the need when visiting a US motor manufacturer's paint shop to test a new type of sandpaper. During the visit he noticed the problems painters were having removing the current masking material (the industry standard) and realised how much easier their job would be if they had a type that was less sticky. Both met "hidden" needs which customers

could not voice because they could not conceive a solution. Both improve the "in-use economics" of customers, enabling them to improve their quality of life (in the case of the Walkman) or productivity (in the case of masking tape).

Activity 2: Concept Refinement and Experimentation

The second stage of the innovation process is one of experimentation. As the detailed flow chart in *Figure 3.1* illustrates, the early development of any radical innovation is always very messy, with a lot of blind alleys, false starts and the occasional lucky break. Success depends as much on creativity as on systematic thinking, and tight project management is as likely to impede progress as to promote it. Informal processes, championship, discretionary funding and openness to outside ideas and technologies are critical to success. The incubation of new ideas can be a long and painful process.

Activity 3: Execution

Good ideas people and experimenters only rarely have the skills needed to complete development and bring a new product to market. Tight project management is *de rigueur* during the execution phase and it is essential to freeze the design before moving into this final phase. Many companies fail to manage the transition from experimentation to execution effectively, leading to expensive and time-consuming design iterations.

3.2 Maximising Innovation Potential

More than perhaps any other aspect of business management, innovation has resisted attempts to produce a systematic formula for success. A better place to start is to consider three simple premises:

(i) all human beings are natural innovators; the key task is to set them real, and challenging, problems to work on
(ii) a few people are outstandingly creative (in a good R&D group the proportion would probably be 2–3%); maximising their innovation potential depends on recognising this and putting them into teams of people with complementary skills and resources
(iii) there are many natural barriers to innovation in large organisations; a company that can understand these and put in place mechanisms to overcome them gives itself the best choice of maximising its innovation performance.

3.3 Barriers to Innovation

There are many barriers to innovation in large organisations. The key ones are:

- the dominance of existing businesses and operational issues
- the momentum of traditional ways of doing things
- "not invented here" and other psychological barriers
- difficulty in constructing balanced innovation teams
- inadequate resources/prioritisation problems
- biased decision making processes
- lack of familiarity with the management of innovation.

Dominance of Existing Businesses and Operational Issues

Any large company usually consists of a series of business units: some large ones responsible for the bulk of the company's costs and hopefully profits; some medium-sized, growing ones drawing in cash to generate future profit streams; and some smaller ones with greater or lesser potential.

It is inevitable that the majority of top managers' time will be devoted to the first two categories of business. The impact of making the wrong investment and management decisions with regard to these businesses is immeasurably greater than that of successfully investing in the smaller businesses or embryonic ideas – at least in the short- to medium-term. The result is that the development of innovative new businesses is usually at the bottom of the agenda at Board meetings. If, as is frequently the case in large companies, there are unexpected issues to deal with, it drops off altogether.

Virtually anyone who has tried to get Board approval for a new venture investment or more radical innovation proposal will recognise the phenomenon, and these same priorities usually percolate right down the organisation.

The Momentum of Traditional Ways of Doing Things

Academic studies of innovation[4] have repeatedly shown that the radical innovations in any industry are more likely to come from outside individuals and organisations or from smaller industry players rather than the dominant suppliers of the time.

Partly this reflects the fact that no organisation has a monopoly on good ideas and that creative entrepreneurs are often more comfortable working outside large companies. However, there are also huge costs of change associated with implementing any major innovation. And, perhaps as important, there are usually many people whose personal positions and reputations have been built around the traditional technology or business approach. Any "threat" to their employment or standing will stimulate "defensive" innovations and probably other tactics to protect their turf.

Not Invented Here and Other Psychological Barriers

"Not invented here" is a disease we all suffer from. Indeed in many ways it is a corollary of corporate pride. Any organisation which instils its people with the idea that they "do things best" makes it hard for them to recognise that there may be a way that is even better.

This is not just about how to fight prejudice, it is also about how to stimulate "out-of-the-box" thinking. We have all found ourselves at some time in our lives trying to solve, for example, a mathematics problem and again and again going over the same impeccable logic, only to get the same wrong answer. The same phenomenon inhibits innovation in businesses. For most people, a powerful external stimulus is required before most people can think "out-of-the-box".

Difficulty in Constructing Balanced Innovation Teams

Everyone today knows about the role of high performing teams. The problem with innovation is that the team members required for success are usually scattered throughout the organisation and their key attributes cannot be found in any job description or organisation chart.

First, teams must involve individuals with the ability and motivation to play different roles. Key areas include:

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[4] See '*Mastering the Dynamics of Innovation*', James M Utterback, Harvard Business School Press 1994

Creativity – To solve seemingly intractable problems and to inject technical or marketing novelty into a concept.

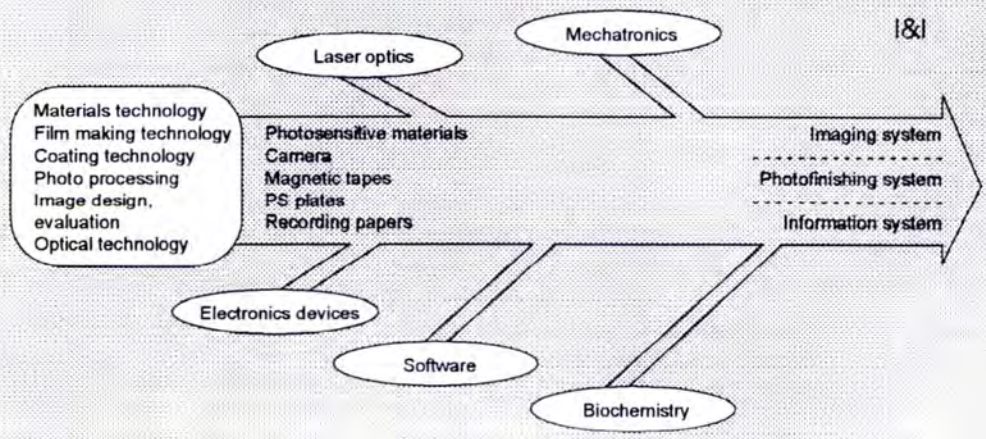
Fuji Photo Film: Applying Digital Technology to Traditional Photography

Fuji Photo Film's origins lie in the production of black and white photographic film. This capability was complemented by the acquisition of overseas technologies throughout the 1950s and 1960s. Colour film was introduced in the 1950s.

Fuji's first product diversification came in the 1960s with the development of magnetic tape recording media, first for audio and then for video formats. By 1976, with the introduction of their FII-400 photographic film, Fuji executives believed that they had accomplished their initial target of matching the technical competences of Eastman Kodak.

The 1980s saw Fuji develop new competences in electronics, mechatronics and optoelectronics through acquisitions, joint ventures and internal research programmes (by now four corporate research laboratories had been established.)

Fuji now defines its business as "Imaging and Information". Imaging refers to the development of technology to record images. Information represents the challenge of processing and adapting the captured image in order to serve a variety of end users. This philosophy is supported by Fuji's competence base (see below) which enables it to meet the challenge of the new world of imaging and information. Innovation is achieved through the combination of these competences in creative ways to deliver benefits to customers.



In the consumer market, Fuji's product offer has shifted from merely supplying photographic film to providing "technologies to capture human emotions". Examples of new products incorporating digital technology include its 'Frontier' photo-printing system, and its Advanced Photo System (APS).

In the 'Frontier' photo-printing system, conventionally-captured photographic images are scanned and digitised to provide pictures with wider tone rendition and sharper definition than conventionally-processed ones. Although the cost of the 'Frontier' processing system is approximately three times that of conventional processing, it enables customers to benefit from the advantages of digital technology without having to buy a new camera.

The Advanced Photo System is a new photographic system with a film format that has been developed in collaboration with four other companies in the photographic industry. In-cartridge processed film is returned to the customer with thumb-nail index prints. The use of a low cost ($300) in-home image scanner enables the customer to convert the image stored on the in-cartridge processed film to digital data. This digital data can then be loaded onto a PC, displayed on a TV, or printed out as hard copy. By providing the user with a captured image rather than a photograph, the APS gives him flexibility to reproduce that image on a variety of different media.

Championship – To vigorously drive the concept to fruition despite all obstacles and promote it formally and informally at every appropriate (and probably inappropriate) occasion.

Project Management – The rigorous application of "processes", "design tools" and good man management practices to assure delivery.

Sponsorship – To provide support for the champion and his ideas at high levels in the organisation without trying to dictate detailed work programmes.

The attributes needed to discharge these different functions are rarely to be found in any one individual, and there may be only a handful of people able to play each of these pivotal roles in any large organisation.

Often the most creative people are the most difficult to manage. They might argue all the time, have as many stupid ideas as sensible ones, or find it difficult to win the confidence of more career-minded colleagues. Finding a way to identify these key individuals and harness their talents is an essential task for any CEO trying to encourage innovation in his company. The chances are they will have not just the occasional good idea, but many. As the busy CEO of a division of one major Swiss chemical company put it to us, *'I have 200 R&D people, of which, I guess, seven or eight are real innovators, and I know who all of them are.'*

IBM Hursley Services & Technology: A Solutions Approach to Product Development

With the commoditisation of the traditional computer hardware and systems business, IBM has been putting increasing emphasis on the supply of services and solutions based products. By 1995, its computing services business accounted for 18% of the corporation's total US$72 billion revenues and was achieving growth rates of over 30% per annum.

In recent years, IBM has adopted a strongly process driven style of management and throughout 1996 it undertook a company-wide initiative to implement a formal New Product Development process based on stage-gate ideas.

However, some parts of the business are also pursuing a softer, more opportunistic approach based on "skunk works" principles and IBM Hursley Services & Technology (HS&T), based near Southampton in the UK, has pioneered this approach. With a staff of 130 highly qualified consultants, its mission is to provide advanced technology based solutions to customers' data and knowledge management needs which cannot be met through IBM's existing major divisions.

HS&T obtains its revenue directly from development and consultancy contracts for external organisations. It has a strongly customer driven culture, and a highly flexible approach to operating and recruitment.

HS&T has developed specific expertise in a range of advanced software and communications technologies. These include broadband networks, virtual reality, data-mining and interactive digital media. The integrating rationale is that solutions to client data and knowledge management problems need:

- some form of a database
- a way of processing the data
- a way of moving data both within and across different media so that information can be extracted in a form most readily understood by the user.

Whilst HS&T has made important seedcorn investment in new technologies, rather than trying to perfect and market predetermined "products", the approach is to work closely with a lead customer in the target market, on a revenue earning basis, at a very early stage in development. Such pilot projects ensure the development is focused on customer needs and enables HS&T to build up new competences by solving challenging real world problems. Pilot projects also help the team to identify other market-related opportunities.

HS&T's approach to data-mining illustrates this "strategic opportunism" approach to new business development. By examining huge volumes of current and historical data, data-mining techniques make it possible for companies to gain detailed insights into the attributes and purchasing patterns of different customer segments. This helps companies both to improve the effectiveness with which current products are marketed and to evaluate future product potential.

In May 1995, HS&T initiated a pilot data-mining project with a major UK insurance company. This led to further data-mining business in adjacent markets, including the finance, travel and retail sectors. The application of HS&T's proprietary data mining algorithms to these companies reveals unexpected relationships, customer characteristics and buying habits over time, and there is a substantial market for the tools and techniques developed in many other companies with large, under-exploited customer databases.

The key elements of HS&T's approach are incremental development, strategic opportunism and early customer-based projects; an approach which IBM has found is often more powerful than structured stage-gate processes for developing new services and solution based products.

A good diagnostic test for any CEO is to ask yourself: "Do I know who are my most creative people? Does the company support them with the complementary innovation skills needed to harness these talents effectively?"

Equally important, manufacturing, marketing and other management disciplines must be involved throughout the project life; and this despite the fact that each and every manager has his own responsibilities and reports day-to-day to a line boss who may have very different priorities. Participating in product innovation meetings and stage-gate reviews may be seen as a highly desirable activity, but not nearly such a desirable one as meeting a sales target or keeping the manufacturing process running.

As a result of all these problems, in practice the composition of innovation teams and the commitment of individual members often fall far short of the ideal.

Inadequate Resources/Prioritisation Problems

Speak to anyone involved in R&D or new business development and the chances are they will tell you they don't have enough resources. However, you have to hear the same

message from a whole series of project leaders in a company before it becomes clear that the real problem is not one of resources, but of prioritisation.

As a general rule of thumb, the closer a project is to completion, the more resources it requires. To take any project through to completion you therefore have to curtail others half way through the process.

In reality this is very difficult. Executives often lack information or experience to make good prioritisation decisions. Decisions taken at, say, a technical level may be overruled later, and the managers and engineers whose projects are axed may feel that their jobs are likely to follow. As a senior manager of one of our clients said: *'It is considered career damaging to be associated with a new product initiative that does not proceed to completion'.*

The result is that prioritisation decisions are fudged and the R&D pipeline suffers from terminal constipation, as even the best projects are under-resourced and fail to complete on time.

As the vast majority of developments at The Technology Partnership are funded by clients in stages, and we are continually restocking the pipeline with new challenging concepts, prioritisation is largely self regulating. Projects stop when clients decide they don't want to pay for the next stage – because, for example, manufacturing costs look too high or the market too small, or because their own internal priorities have changed. Whatever the reason, and though they may be disappointed, the engineers and scientists involved soon find they are engaged in equally stimulating projects which (because they are client funded) have more chance of reaching the market-place. Equally, because client funds are usually awarded in discrete amounts linked to the achievement of specific deliverables, deadlines and performance goals, there is an enormous incentive to achieve results, even if resources are stretched. The personal commitment of team members is reinforced by their role in defining deliverables and drawing up the project plan.

The challenge for large non-consulting companies is to imitate this customer/contractor relationship within their internal organisation and create a culture of commitment, excitement and delivery, whilst at the same time promoting integrated multifunctional teamwork across organisational boundaries.

Biased Decision Making Processes

Much attention has been devoted over the last five years to flattened organisation structures. Reducing the number of approvals required for any major innovation should inevitably have a beneficial effect on a company's ability to innovate. However, all too often the incentive structure is unchanged. The reality is that, for most middle managers, there is far more to be lost by backing an innovation that fails than there is to be gained from backing one that succeeds. Indeed, the **best** he may be able to expect is that he does not end up with egg on his face.

The frequent management changes that take place in many large organisations exacerbate the problem. Management is far more likely to put effort into downsizing or re-engineering initiatives with high visibility and the potential to deliver results in two to three years, than into a major product or business development innovation that may take five or ten.

Furthermore, all the benefits of increased business "ownership" of new product development that are engineered by stage-gate management disappear overnight if the commercial managers involved change jobs before the product launch.

There is an inevitability about these pressures. CEOs that want to make their organisations more innovative must implement a culture that deliberately counterbalances these factors.

Lack of Familiarity with the Management of Innovation

As if all these problems were not enough, most innovation teams are largely staffed, managed and sponsored by people who are on new territory. Once they have been successful they probably find themselves promoted to a new position. The result is that the organisation as a whole keeps making the same mistakes. This is particularly the case with innovations entailing the creation of an entirely new business, where "strategic opportunism", a style of management very different to the careful, detailed planning needed for large established activities, is required. The death by suffocation of Exxon's major new business creation programme of the 1970s was brilliantly documented by Hollister Sykes, the programme's manager in 1986[5]. Yet many large company ventures suffer just as badly from "business planitis" today.

[5] Hollister B Sykes, '*Exxon: Lessons from a New Ventures Program*', Harvard Business Review, May-June 1986

Managing the process of "innovation" is as technical and demanding a job as managing a nitroglycerine factory. Yet the majority of those that do it are inevitably amateurs. The task of the next chapter is to help them become more professional.

4. MANAGING THE OVERALL INNOVATION PROCESS

As we have seen, the innovation process is complex, diffuse and difficult to manage. The quality management, stage-gate systems adopted by many companies in recent years have primarily been deployed as tactical tools for improving the quality of communication between technical, marketing and manufacturing managers. The key benefits claimed have been reduced time-to-market. Stage-gate processes do not *create* innovative products *per se*.

Nor do they represent the only way of managing innovative projects. In some situations, stage-gate is an inappropriate technique. In this chapter we describe other project management approaches that have a role to play.

Figure 4.1 describes the total innovation process which an organisation must set out to manage. It illustrates the process as it relates to a company's overall portfolio of innovation projects, rather than from the perspective of a single concept or product development, as shown in *Figure 3.1*.

There are four main phases, each requiring different management philosophies and tools:

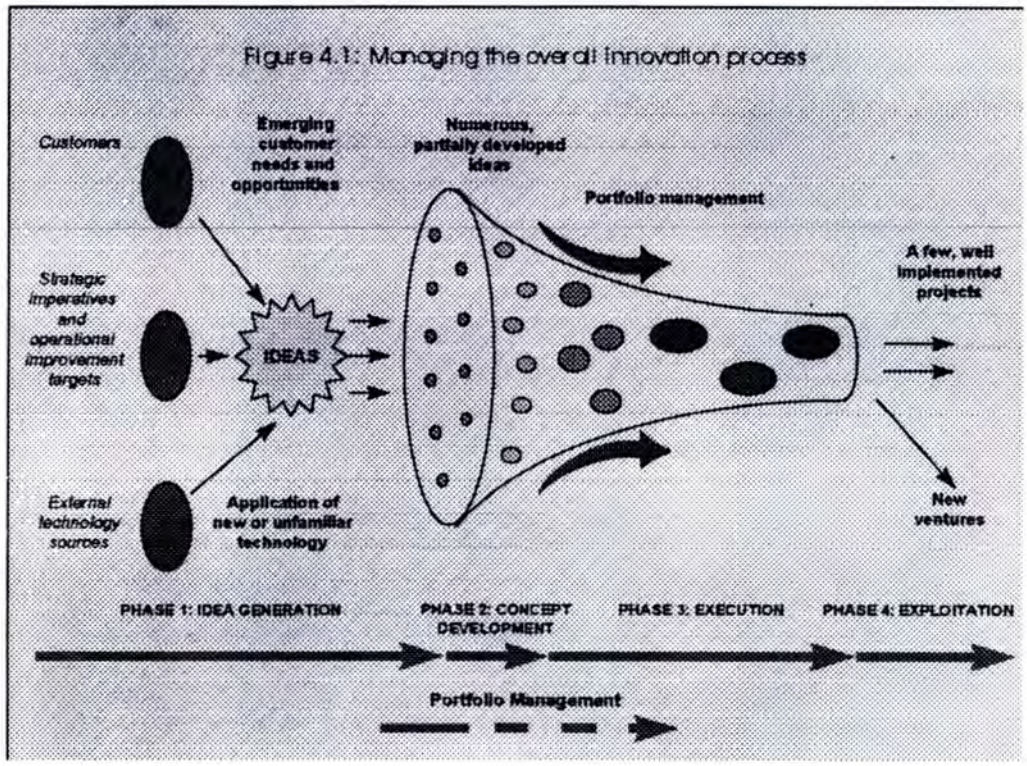
Phase 1: Idea Generation – This is concerned with identification of customer needs and challenges and the creation of raw ideas for projects which *might* have the potential to deliver growth or competitiveness benefits.

Phase 2: Concept Development – Concerned with turning raw ideas into simple, but as yet unvalidated, concepts suitable for discussion and possible development funding.

Phase 3: Execution – The more systematic development, design and validation activities required to bring the innovation to full commercialisation or implementation.

Phase 4: Exploitation – The activities required to maximise commercial impact of the innovation during and after the product launch, or through the creation of a new business venture.

Overlapping all of these phases is **Portfolio Management**: the balancing of resources against conflicting demands so that effort is continually refocused on those projects that can best maximise the strategic and commercial impact of the overall innovation activity. We deal with each phase in detail below.



4.1 Phase 1: Problem Recognition and Idea Generation

We described in Chapter 3 how innovation is really about problem solving. The first challenge for management is to ensure a steady flow of relevant problems and challenges. These come from three main sources:

(i) exploratory marketing to existing and potential customers
(ii) strategic imperatives and operational improvement targets
(iii) external technology sources, approaches and ideas.

4.2 Exploratory Marketing

The first source of problems and challenges is customers. Customers are a primary source of innovative ideas in many industrial and commercial markets. However, the challenge here is not recognising the needs the customer **knows he has** (any successful company must have a process for capturing these), but the ones **he does not know he has** or has not yet been able to articulate clearly. In industrial and commercial markets, uncovering these requires getting

to know customers' (and potential customers') businesses in depth. This is an activity we call *exploratory marketing;* a process of open ended discussion around the customer's business and the challenges facing him. What are **his** plans and ambitions? How do the economics of **his** business work? How could **he** differentiate his business compared with his competitors? How could **he** use his managers' time or physical assets more cost-effectively? How could **his** business sell more or make larger profits?

One company, Akzo Nobel Coatings, has brilliantly captured this thinking in the mission statement of its car refinishes business - *'to be the people who are best at enabling body shop profitability'*. Restating the relationships with customers and marketing channels in this way leads to a complete rethink of how innovation can be used to support and further develop them.

The kind of dialogue described above rarely takes place naturally between sales people and their customers' purchasing managers. Indeed, we have found many managers in large companies reluctant to engage in these kinds of open-ended discussions. Instead they seek the comfort of, say, a new product brochure around which to structure the conversation and prefer to consult existing contacts rather than make more appropriate new ones. Moreover, normal sales contacts may be inappropriate, especially if they are with customers' purchasing managers, for whom price and delivery may be the only variables of interest.

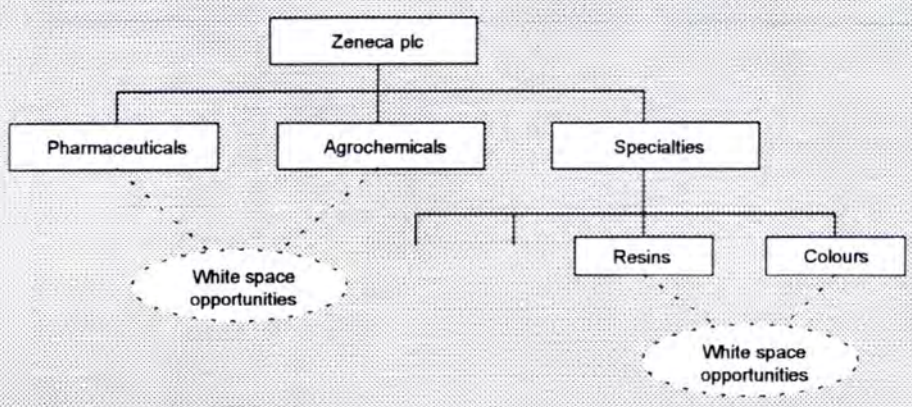
This was no more apparent than when The Technology Partnership was undertaking a project for a client whose businesses included selling fine chemicals to the semiconductor industry. As device geometries shrank with each generation of chip, the requirements for chemical purity became progressively tougher. During most of the 1980s, competition revolved around price and speed of delivery to local semiconductor factories. Suppliers were able to respond quickly to tighter purity specifications with better techniques for filtering out impurities.

By 1991, such simple solutions were no longer possible. As a result, our client found itself outmanoeuvred by competitors who had developed close ties with the semiconductor manufacturers' R&D labs and had been able to invest in innovative process developments in parallel with their customers' research and development programmes.

Challenging the security of existing sales and marketing relationships requires regular "exploratory marketing" campaigns, involving in-depth consultations with customers structured around industry trends or potential new product or service concepts. Consultants play a role which can rarely be effectively discharged by insiders.

Zeneca Specialties: Exploiting the White Space Between Existing Businesses

Zeneca plc was formed in 1993 following the de-merger from ICI, and is organised around three Strategic Business Units – Pharmaceuticals, Agrochemicals and Specialties.



With a turnover of some £700 million, Specialties accounts for some 15% of group revenue and consists of Resins, Colours and a number of other semi-autonomous profit responsible businesses.

One of the challenges facing companies with this kind of structure is how to exploit "white space opportunities" lying between the business units. Such opportunities often offer some of the best growth opportunities facing the company but, due to divided responsibilities, can be the most difficult to exploit in practice. To support innovative developments offering significant opportunities which are not of immediate interest to the business units, Specialties has established a centrally funded Strategic Research Programme (SRP). Colourable Resins for Stereolithography is one of the projects funded under the SRP.

Stereolithography is a new technology for the building of prototype models of products and components. The technology uses a laser to selectively cure a light-sensitive resin enabling a three-dimensional model to be built up layer by layer. Since its introduction in the late 1980s, the technology has been widely adopted for rapid prototyping in the aerospace, automotive, electronics and medical device industries.

Zeneca uses stage-gate processes within its existing Strategic Business Units structure, though this approach to project management is not thought appropriate for the longer-term strategic research area. Once the "concept" has moved to a more formal project stage, gate management is adopted however.

Zeneca Specialties identified the opportunity to develop colourable resins for use in stereolithographic models. This would enable the selective colouring of defined three-dimensional regions and Dr Kevin McAloon, the project's "champion", believed it might offer particular benefits in medical applications. For example, by using the technology in conjunction with hospital CT or MRI scanners, it is possible to produce three-dimensional models of diseased organs and tissue in which the cancerous regions are identified by colour coding. This in turn would enable surgeons to practise removing difficult tumours prior to an operation.

In order to exploit this market opportunity, the competences of two Specialties businesses – resin formulation and colour ink chemistry – had to be combined. To gain access to external competences and develop a total systems approach, a collaborative research programme was also established with Siemens Medical (medical scanning techniques), Materialise (model building and software) and the University Hospital in Leuven (surgery).

Zeneca Specialties has now secured a strong intellectual property rights (IPR) position in this technology, being the first to develop a commercially viable resin capable of giving selectively coloured stereolithography models. Market reaction has been very favourable. In October 1995, the European 3D Systems Users Group awarded the Stereolithography Users Group Award for innovation to the project.

Lead customers – those with the most demanding requirements or creative managers – offer particularly important insights on new trends or innovation opportunities. Companies must be sure to build close relationships with these businesses or individuals.

In the consumer field, panel discussions and other established market research mechanisms perform a similar role; though often the only way to expose an unmet need is to provide people with drawings, three-dimensional models or functional demonstrators of specific concepts. "Looks like, works like" demonstrators provide a further level of realism.

4.3 Strategic Imperatives and Operational Improvement Targets

The second way in which a company can identify innovation challenges is by looking internally. Properly structured and managed, the strategy development process should throw up regular innovation targets, both in the form of high level product and technology requirements, and in the form of business "imperatives" for which there *could* be an

innovation response. It is usually possible to put numbers on these targets, such as "We need to reduce unit costs by 15% a year for the next five years"; "We need to find £500 million of new business revenues by 2002". The task then is to ensure these are used as triggers to stimulate creative thinking and generate innovative solutions.

Surprisingly, this connection between setting the "business challenge" and the creative part of the innovation process is rarely made effectively, whereas history shows again and again how organisations can rise to seemingly impossible challenges in a do-or-die situation. The ability of Japanese companies to reduce manufacturing costs to compensate for the rise of the Yen in the 1980s (Endaka) and the history of Swatch provide examples.

4.4 External Technology Sources, Approaches and Ideas

As important as looking internally at what a business thinks are the key challenges and opportunities facing it, is to look at new technologies, products and business concepts being developed **outside** the organisation. No company has a monopoly on good ideas; suppliers, academics, small entrepreneurial companies and competitors can all provide the stimulus for new product concepts. This is the third key source of innovation ideas. The task of top management is threefold:

(i) to ensure there are effective mechanisms to capture intelligence on external developments
(ii) to stimulate internal debate around the question "how could we use this technology or concept to benefit the organisation?"
(iii) to ensure that *overall* business strategy is influenced by major opportunities uncovered in this way.

Possible stimuli include reverse engineering, foresight studies, new technology scans, best in class benchmarking and strategic partnering.

Reverse engineering

Reverse engineering involves regularly examining the products of competitors or role model companies in non-competing fields to see how they are made and what can be learnt from them.

Swatch: Using Challenging Targets to Stimulate Creative Thinking

Despite the strength of its national brand image, the Swiss watch industry faced crisis in the mid-1970s, with exports down from 50% to 12% of the world market. The industry had, it seemed, failed to capitalise on advances in technology which had made the manufacture of accurate, low-cost watches for the mass market a commercial reality. Despite the Swiss being the first to develop the quartz wrist watch, its major companies insisted on sticking to traditional technologies and mechanical movements aimed primarily at up-market, luxury timepieces.

The crisis led to the merger of the two major players to form the Swiss Corporation for Microelectronics and Watchmaking Industries Ltd (SMH) and Nicholas G Hayek, Chairman and CEO of SMH, outlined the new company's prime objectives as follows:

(i) To retain Switzerland as its main production centre based on the belief that rationalisation, new product development and new management would enable it to bring costs down to Far East levels.

(ii) To launch a large-scale attack on the lower price market segments.

Tough development targets were set which could not be met using conventional manufacturing approaches. SMH would have to redefine its competence base and manufacturing technologies around the marketing objective.

The Swatch design reduced the number of parts from 150 to 51, thus markedly improving reliability and robustness. This reduction was achieved by using an injection moulded case as the mounting plate. Unlike conventional watch manufacture, the Swatch design called for a single, fully integrated manufacturing process.

Three years after starting the project, the team had developed a waterproof, shock-resistant, accurate watch in synthetic material that could be mass produced at low-cost in an attractive range of colours. Although the basic shape and construction of the core product remained the same, five elements (colour, dial, hands, date display and strap) were variable and open to free interpretation by designers. This flexibility permitted "mass customisation", a central feature of Swatch's marketing strategy.

Today, Swatch has 50% of the world watch market and has built up enormous brand awareness. The company has also pursued a strategy of developing products for which the same brand values can be applied, including sunglasses, telephones, pagers and even an environmentally friendly car.

Foresight studies

Foresight studies involve groups of managers thinking beyond the current markets and competences of the firm and examining the social, economic and technological drivers of the industry in which their organisation competes. Typical themes include:

- the *ageing population* and its impact on the healthcare industry
- the impact of *digital electronics* on communication and the resulting opportunities for the broadcasting industry
- the trend towards *mass customisation* and its impact on the packaging industry.

Simple creative tools are available to explore product opportunities that might exist as a result of these trends.

New technology scans

New technology scans entail taking an area of technology, like sensors or microdevices, and carrying out a systematic worldwide search for new developments and applications. The process usually uncovers unexpected developments in organisations, industries and countries quite outside the reach of normal discussions, and provides vital triggers for the creative process of generating new or improved product concepts which use them. There is a simple rule in innovation: the new technologies with the greatest potential to transform any industry usually come from outside it. The purpose of technology scanning is to get there first.

Many companies regard the technology scanning process as a normal part of the day-to-day responsibilities of its scientists and engineers. However, practice shows that high profile scanning "campaigns" are required to break the patterns of conventional thinking.

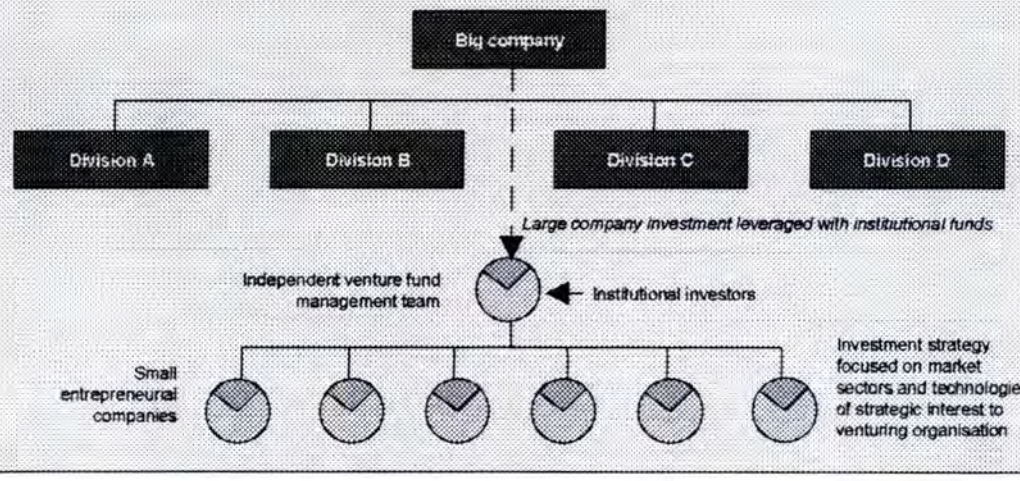
Best in class benchmarking

Best in class benchmarking has a similar aim – to study companies in other industries who have a particularly well developed approach to an aspect of their business from which your own organisation can learn. So if you want to improve brand management, study Unilever or Coca Cola, if you are interested in database marketing, study Readers Digest or American Express.

Strategic partnerships and collaborations

Strategic partnerships and collaborations can provide a powerful mechanism for improving an organisation's understanding of new technologies and market opportunities that currently lie outside its core business. Corporate venturing and academic collaborations demand particular mention.

Figure 4.2: Using corporate venturing to gain a window on new business and technology opportunities



Corporate venturing, the systematic taking of minority equity stakes in small and medium-sized businesses started by external entrepreneurs, can play a particularly powerful role. Corporate venturing is best carried out in conjunction with an external venture fund manager, and it can provide intelligence on a whole range of emerging scientific and market opportunities of relevance to the investing organisation. This comes not just through the companies invested in, but also through the wider "deal flow" to which the fund manager is exposed. Whilst a corporate venturing programme may lead to, say, six investments a year, the sponsoring organisation may see a further three or four hundred technologies or business concepts in which no venture capital investment is made. Some of these will offer collaboration, acquisition or recruitment opportunities, not to mention an insight into emerging technologies, market trends and a stimulus for creative thinking more generally.

Daicel Chemical Industries: Applying Existing Competences in New Markets

Company Origins

Daicel Chemical Industries, originally called the Dainippon Celluloid Company, was formed in 1919 through the merger of eight Japanese chemical companies. Daicel's traditional business centred around the manufacture of celluloid from nitrocellulose.

In an early venture, Daicel developed a capability in photographic film production which was spun-out in 1934 to form the now famous Fuji Photo Film.

During the 1930s Daicel expanded further into the production of organic chemicals, initially with the manufacture of acetic acid and derivatives. This led Daicel into the field of fine chemicals, producing intermediates and bulk compounds for the pharmaceutical and agrochemical industries.

In 1996 Daicel reported net sales of US$2.2 billion. The company is organised around the core businesses of cellulose derivatives, organic chemicals, plastics and films, and propulsion systems.

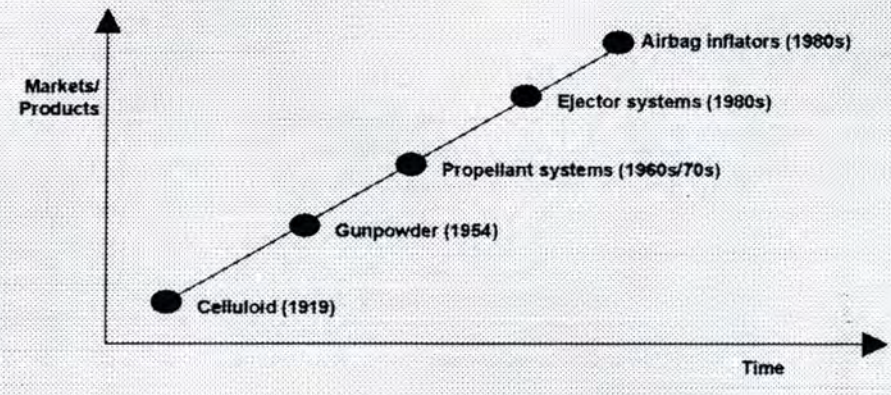
Incremental Product Development: The move into automotive airbag inflators

In recent years Daicel has actively pursued a business development strategy aimed at delivering end-products to high value-added markets. Daicel's approach to new business development is demonstrated by its successful incubation of a business to manufacture inflator systems for the automotive industry. This venture is based on Daicel's origins in nitrocellulose, from which gunpowder was produced. Since its establishment of a gunpowder production facility in 1954, Daicel has built up expertise in organic synthesis, polymer chemistry, plastic moulding and assembly from which a series of products, including composite propellants, rocket motors for missiles and pyrotechnic devices, was developed. The combination of these skills and technologies enabled Daicel to supply emergency pilot ejection systems to the Japanese air force, a venture which also required it to develop competences in mechanical and electronic assembly.

In the early 1980s, a foresight exercise carried out by the central business planning department identified the consensus amongst automotive industry experts that driver and passenger safety were likely to be of increasing importance over the next 10 to 15 years. The study also recognised that Daicel possessed the core technologies needed to produce airbag inflator systems based on its propulsion systems expertise and experience of supplying ejector systems to the Japanese air force.

In 1988 Daicel formed Daicel Safety Systems and set about establishing a production system to manufacture and supply assembled inflator systems on a just-in-time basis to automotive OEMs. Daicel has since developed two types of inflator in collaboration with a lead customer.

The Evolution of Competence Based Product Development at Daicel



Daicel today

Daicel Safety Systems is now established as a leader in the manufacture of automotive airbag inflator systems. In the year 1995/6 sales grew by 30%, reflecting Daicel's penetration of the domestic market and exports to the USA and Europe. Production capacity stands at two million units per year compared to a total car production of five million (1996) in Japan.

Corporate venturing is widely used as an innovation strategy by major US corporations as well as by some continental European and Japanese companies. However, it has so far found little favour as a strategy in the UK. Properly structured and integrated into the broader "front end" innovation processes described in this report, it can have a powerful impact on a company's ability to respond to new opportunities. The average financial returns on venture capital fund investment are significantly greater than those available to large companies on mainstream investments, so it is also an approach to innovation which should be self funding.

Academic collaborations provide another important source of external technology. However, many companies use this mechanism rather poorly, setting up numerous research contracts and retainers, sometimes involving hundreds of different academics. The problem with this approach is the management time it takes for the sponsoring organisation to take advantage of the academic knowledge and research findings it has financed. Instead, companies are now focusing increasingly on setting up much closer "cohabitive" R&D collaborations with a handful of international centres of excellence. Cohabitive R&D collaborations involve placing the sponsoring organisation's own scientists in a laboratory alongside the academic team. This encourages both formal and informal communications and allows the organisation's scientists to develop capabilities which can ultimately be brought back into the parent company. The creation of an effective "receptor team" is a vital part of any collaboration strategy of this kind.

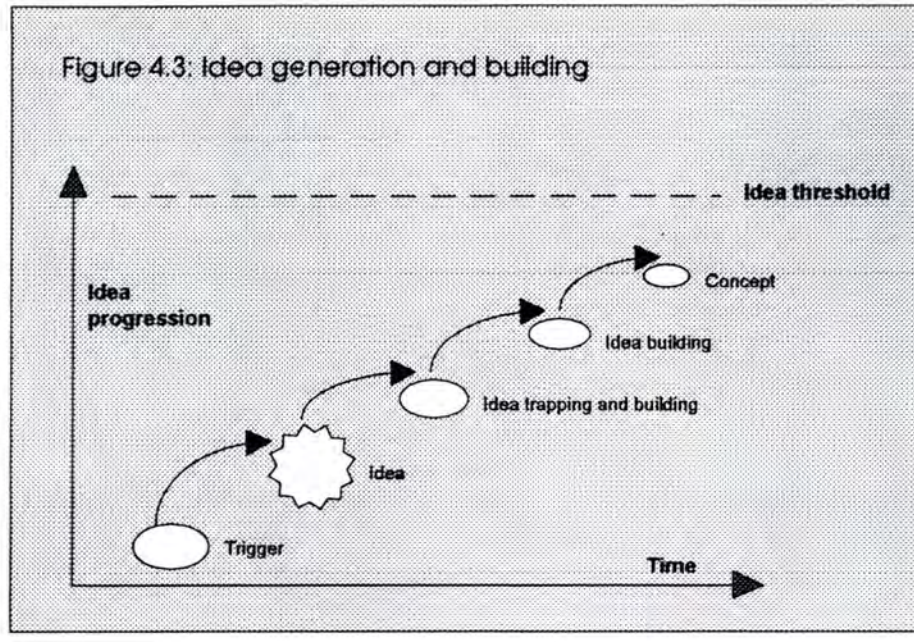
Monsanto, the US-based chemical company, provides one of the best case studies of these processes at work. Starting in 1976, Monsanto's use of corporate venturing and cohabitive academic collaborations to gain access to biotechnology provided a pivotal role in its eventual transformation from a commodity chemical company to a life sciences business. Today it is the undisputed world leader in the application of biotechnology to the agrochemical industry.

4.5 Idea Generation

There are many well established techniques for running creative thinking sessions, of which "brainstorming" is the best known. Typically these produce perhaps a hundred ideas which then have to be grouped, refined and prioritised. However, in reality the best ideas often occur when you are least expecting them – walking the dog, or chatting to someone in a bar. This does not mean that formal creative thinking sessions are a waste of time, merely that they serve to focus and stimulate the search for solutions, not necessarily to produce an instantaneous result. Furthermore, most organisations have many ideas lying around in filing cabinets, or unvoiced by managers for fear of criticism. Formal creative thinking processes serve to bring them to the surface.

Successful idea generation depends on:

- setting the right problems or challenges
- having in place a mechanism for trapping, debating and building ideas, wherever and whenever they arise.



It is important to note that the use of screens at a very early point in the idea generation stage can discourage innovation. Partially developed ideas that do not merit progression in their own right can act as triggers for other, better ideas. For example, the idea of a welding gas that smells nice seems trivial at first, until it triggers another idea for welding gases that emit fewer noxious fumes which improves health and safety at work. Ideas need to be given fertile ground in which to germinate and air in which to breathe, so that they can be given the chance of crossing the "idea threshold". This is the point at which they have the critical mass to warrant evaluation, screening and refinement.

Negative thinking can be applied far more readily than creative reinforcement and is, all too often, the attitude of more senior people in the organisation who have "seen and tried it all before". They can bring powerful psychological pressures to bear on less senior, perhaps more creative, minds. Special techniques such as Edward de Bono's "six hats" approach can play a useful role in structuring the discussion of new ideas to ensure that objections are treated as logical challenges to be overcome rather than overwhelming show- stoppers.

A number of companies, including ABB and Bausch & Lomb, have created formal ideas systems for managing this process. ABB, one of the world's largest and most geographically dispersed companies, has put in place a sophisticated information management system to

support its "Continuous Programme Management" approach to managing the R&D workflow.

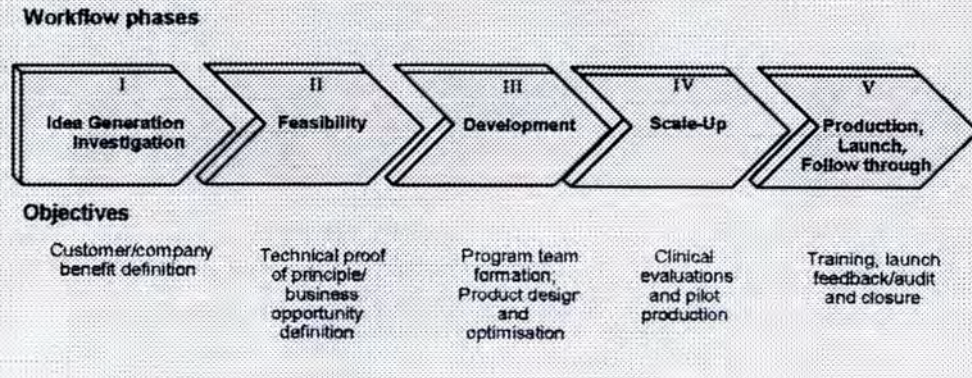
Bausch & Lomb's Global, Real-Time, Ideas Databank

Bausch & Lomb is a US$2 billion eye-care products company. Its core businesses include soft and rigid gas-permeable contact lenses, lens care products, premium sunglasses and ophthalmic pharmaceutical products. The company owns and manages the Ray-Ban brand of sunglasses. With headquarters in the USA, the company employs some 13,000 people in 35 countries. Its products are available in 100 countries around the world.

Bausch & Lomb's mission is to be a global vision care company, helping consumers *see*, *look* and *feel* better through innovative technology and design. The company recognises that developing new products to respond to consumer requirements is key to their growth.

As Jim Kaneley, former President, Personal Products Division, explains, *'Understanding consumers' expectations and then meeting or beating them has been the key to differentiating ourselves from our competitors. I firmly believe our long-term success will be determined by our ability to make the right investments in those products that will make a difference.'*

Bausch & Lomb has implemented a stage-gate type new product development process called the Product Development Management Process (PDMP). The phases and the objectives of each phase are shown below.



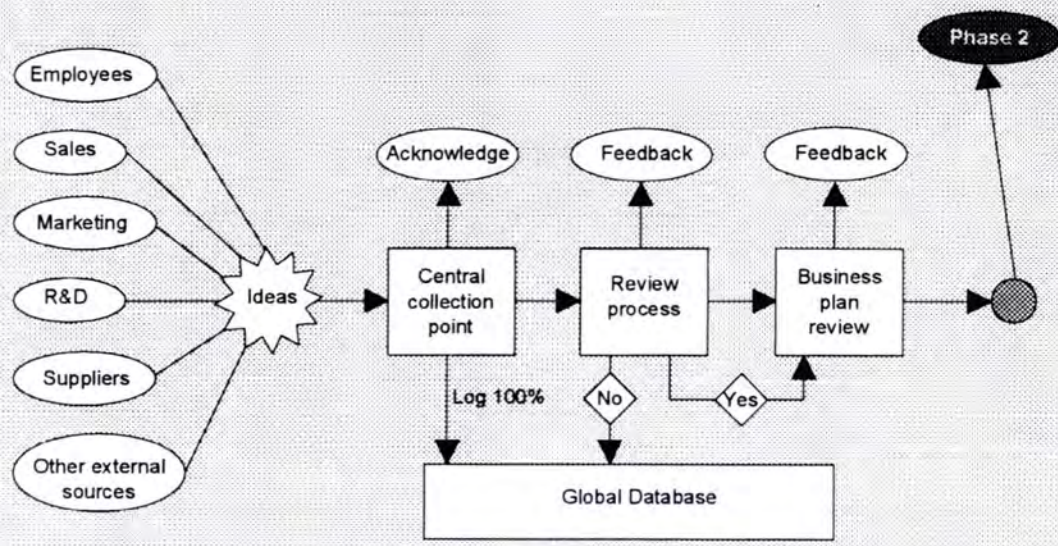
A major challenge for such a globally dispersed company is to tap into and exploit *all* sources of ideas, both internal and external. The company has identified that the key to achieving this is to have in place a mechanism which:

- centrally collects ideas
- acknowledges their receipt
- records the idea on a global database for easy access/searching

- provides feedback to the original source on the progression of the idea.

Bausch & Lomb are setting up a global, real-time, ideas databank to achieve just this and envisage that it will be an integral part of their Product Development Management Process.

Bausch & Lomb's Idea Generation and Management Process



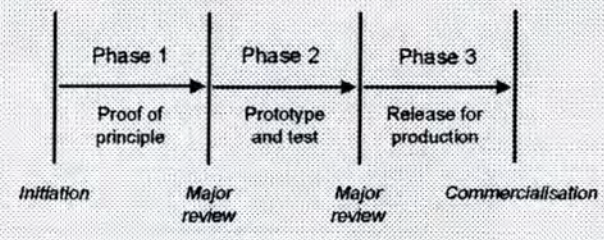
With the mnemonic PIPE (Project Idea, Planning and Execution) it has been developed using Lotus Notes to enable problems and ideas to be rapidly shared and worked on by people in different parts of the corporation. New ideas move along the PIPE, progressively requiring "support" and "acceptance" before being turned into a formal project proposal. Those that do not reach the project proposal stage are saved in an ideas databank for possible use at a later date.

4.6 Phase 2: Concept Development

The results of the first phase of the innovation process may just be one line descriptions of new product ideas. Such ideas may be generated during systematic innovation "campaigns" or as a result of day-to-day activities. Unfortunately, many ideas get no further than this point. This is because you cannot design a proper innovation project around a one line idea. Any new idea must first be turned into a concept that is sufficiently developed to merit funding. However, some funding is first required to do so. This is the Catch 22 of innovation.

The Technology Partnership's "Fast-Track Product Development" Approach

The Technology Partnership's Product Engineering Group undertakes product development projects on behalf of clients in the consumer goods, office automation and electronics industries. The competitive dynamics of these industries demand product development cycle times (from concept to production) of between 12 and 18 months and there is continuing pressure to reduce this lead time further. In response to this demand, The Technology Partnership has developed an approach to fast-track product development[6] which focuses on streamlining the stages of development, testing and validation, and full production and market launch (stages 3, 4 and 5 in Cooper's stage-gate process).



A conventional stage-gate development process includes both alpha and beta prototypes. The differences between the two is crucial. Alpha prototypes are designed with little regard to cost targets or ease of production. Only limited testing is possible since robustness is poor. The beta prototype entails significant re-design for production and is often carried out by a new project team. Between five and 15 of these models are built for extensive laboratory testing. Finally, a documentation package is released for hard tooling to be made for production. Having both alpha and beta prototypes is intended therefore to minimise changes to expensive production tooling.

The Technology Partnership's approach comprises:

Phase 1:Rapid demonstration of proof-of-principle via a simple model. "Getting into the third dimension" at an early stage is central to identifying key problem areas.

Phase 2: Production in one step of the near equivalent of a beta prototype together with a limited amount of laboratory testing.

Phase 3: Update of document package and release for tooling.

[6] The Technology Partnership Internal Document, *Fast Track Development*, March 1996

Eliminating the need for both alpha and beta prototypes significantly cuts development lead times. This enables a faster commitment to production tooling. However, this approach inevitably means that some changes need to be made at the pilot production stage. The costs of this must be balanced by the strategic advantages of faster time-to-market and earlier revenue streams.

The Technology Partnership's approach is based on the following principles:

- Replacing the "removing risk" approach of stage-gate methodologies with an approach based more on "building confidence". This relies more heavily on engineering judgement and the quality of the final product is therefore more reliant on the *people* involved as opposed to the *process*.
- Integrating manufacturing knowledge at an early stage and designing to cost targets from the outset. Stage-gate attempts to achieve this by involving representatives of the manufacturing function in the project team. The Technology Partnership's approach relies on the inherent knowledge and experience of project team members.
- Multidisciplinary teams which remain unchanged throughout the project and operate with total authority for design and control of the development budget. Decisions on expenditure (manpower or capital expenditure) do not need to be signed off by line managers.
- A "don't reinvent the wheel" philosophy. If a component or sub-assembly can be bought in from outside, then it is. This is achieved by the development of a strong network of local and global suppliers who can provide a rapid response.

In many large organisations no mechanism exists for converting internally generated ideas into concepts around which a meaningful discussion can be held. This alone is why so many companies fail to exploit good ideas. Phase 2 is where the primary blockage on innovation occurs, often exacerbated by a management process that never kills existing projects, so there are no "slack" resources to examine new concepts.

The solution comprises two main elements:

Discretionary budgets (time and materials) enabling seed funding to be awarded quickly and without bureaucracy for champions to develop their ideas into a concept. The work that needs to be undertaken typically involves initial desk work on technical and commercial

feasibility, preparation of a short concept paper and possibly some very simple experiments or customer discussions. The objective is to find out whether the idea has any merit, quickly and cheaply.

Regular meetings of a "Concepts Panel" to review, refine and recycle concepts, possibly supported by a computerised ideas databank.

Like all other aspects of the innovation process it must be driven by top management, with metrics for performance, covering, for example, number of ideas investigated and taken forward per annum.

4.7 Phase 3: Execution

The third phase in the product innovation process is Project Execution: the development, design and evaluation activities required to bring the innovation to full commercialisation or implementation.

It is easy to fall into the trap of thinking that all projects need to be executed in the same manner. In reality the challenges during the execution phase vary considerably and the approach adopted must therefore be tailored to match the critical success factors facing each organisation or project.

There are two principal variables to the equation. The first is *degree of project difficulty*. This depends on the extent of the market uncertainties and technical risks, and on the complexity of the management co-ordination task. The project management overhead involved in communication across departments or functions is usually greatly underestimated. Projects which start with unanimity on their objectives and the degree of urgency are much less difficult to manage than those where only half the team has bought in, or where there are conflicting views and priorities.

Of course, *degree of project difficulty* is a relative concept. What is easy for one organisation, team or project manager is well nigh impossible for another.

The second variable is the *speed of development*. In really fast developing technologies like mobile communications, companies now have to start product developments one and a half product life-cycles before they are launched. That is to say, they have two product generations under development at any one time. So shaving 10% off development times and

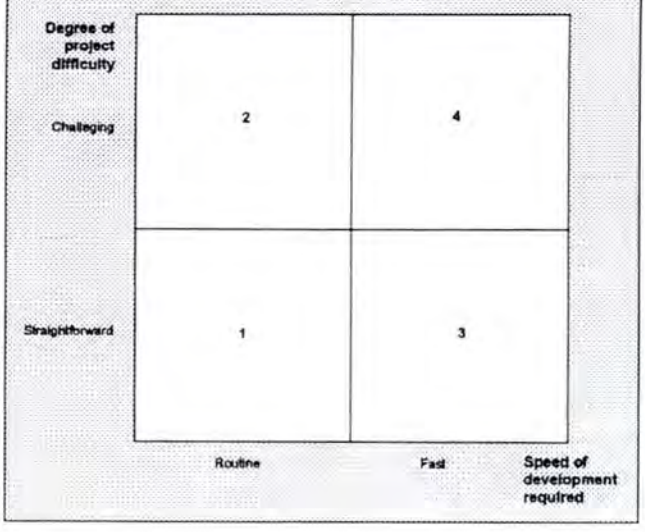
getting products to market whilst margins are at their highest can have a major impact on total product profitability. Companies selling in seasonal markets, or whose product launches need to coincide with, say, a major annual trade exhibition, face similar challenges.

At the most generic level, good project execution depends on five key ingredients:

(i) clear, agreed objectives with buy-in and involvement of all those responsible for development, manufacturing and marketing
(ii) simultaneous engineering – progressing each of these elements in parallel
(iii) good project management
(iv) an able team, whose members between them have the right skills, experience and resources, or who can get ready access to them
(v) a high level of motivation, excitement and commitment.

In reality, the best management approach will depend on where the project lies on the Project Execution Matrix shown in *Figure 4.4*:

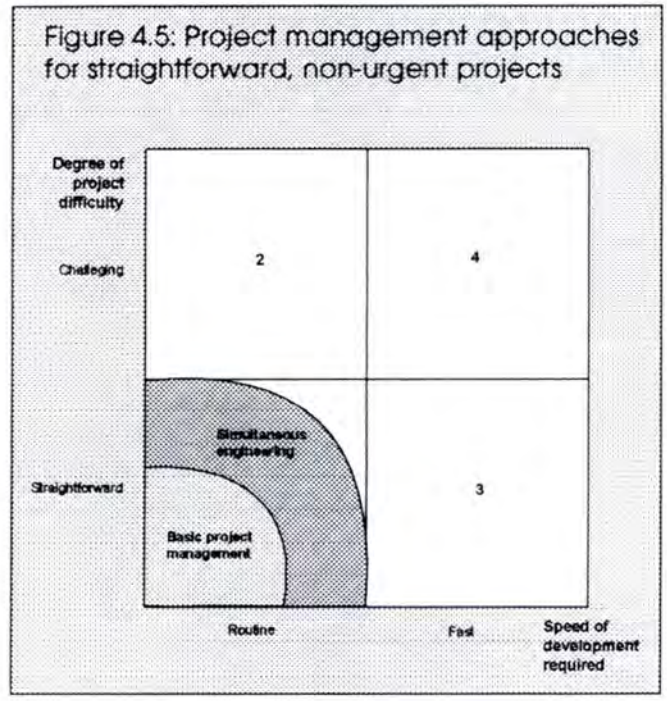
Figure 4.4: Product execution challenges



Quadrant 1: Straightforward, non-urgent projects

Projects in Quadrant 1 are neither particularly urgent, nor particularly difficult to manage. Simple project management techniques will deal with them adequately and basic

simultaneous engineering approaches will further improve project management effectiveness.



Quadrant 2: Challenging projects without a demanding deadline

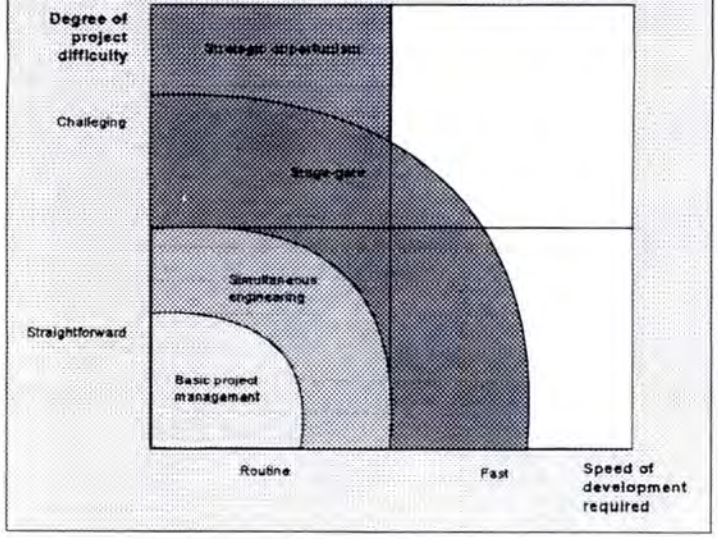
Projects in Quadrant 2 entail more difficulty or complexity than the organisation or team has been able to handle effectively in the past, but are not seen as particularly urgent. The priority they receive in terms of resource allocation will therefore depend very much on the importance attached to other projects in the portfolio. The absence of tight deadlines for completion creates a danger that they may suffer from lack of commitment by managers who are not directly involved day-to-day in their development. Those from manufacturing or marketing functions, for example, will inevitably face conflicting pressures to spend time on other, more urgent, tasks under their direct responsibility.

In managing Quadrant 2 projects, the key challenges for management are therefore twofold – to ensure good cross-functional communication, and to manage a structured, progressive reduction in risk. Companies normally have a number of developments in this category at any one time, and it may not be clear at the outset whether a given project will ultimately be technically successful or offer the returns needed to justify commercial deployment. Management needs to regularly assess progress and potential in the light of changing

circumstances. **Stage-gate** project management is admirably suited to help managers with these sorts of projects providing the degree of technical and market innovation is not exceptionally high. In doing so it will almost certainly reduce time-to-market compared with basic project management approaches; partly through the discipline it imposes on cross-functional teamwork, and partly through the assistance it provides managers seeking to manage resources across competing projects.

However, where a very high degree of innovation is involved, stage-gate may no longer be appropriate. Freedom to explore within a loosely defined field is of paramount importance if you are going to uncover the solutions or opportunities that others have missed, and the rigid Go/No Go discipline of gate reviews is too restrictive. The way in which companies have tended to manage strategic research programmes has long reflected these considerations. However, the arguments apply equally to those product developments that are so radical as to effectively involve the incubation of new businesses.

Figure 4.6: Project management for challenging, non-urgent projects



Creating a new product for a new market suffers from all the same uncertainties as research. There are likely to be many false starts and blind alleys, and the best opportunities may not be apparent until you are actually "experimenting" in the market. The strict application of large company planning and business management approaches, just like stage-gate, can easily stifle innovation. A process of "**strategic opportunism**" is far more effective. This

involves setting broad strategic goals, but being prepared to refocus rapidly as the real opportunities become apparent from market experimentation. Early participation in the development by customers is essential for these sorts of development, preferably involving a financial contribution to the costs of development and joint trials. The IBM Hursley Services Technology case study illustrates this approach.

The most important business innovations in large companies often take place by accident, outside the direct vision of top management and protected from close scrutiny by the "sponsorship" of a senior manager. Location in an overseas market, away from the corporate gaze, is surprisingly frequent.

However it does not have to be this way. CEOs who are seriously concerned with encouraging innovation must actively foster the creation of innovation teams and allow them freedom to experiment in the market-place. It is not sufficient to rely on oversight.

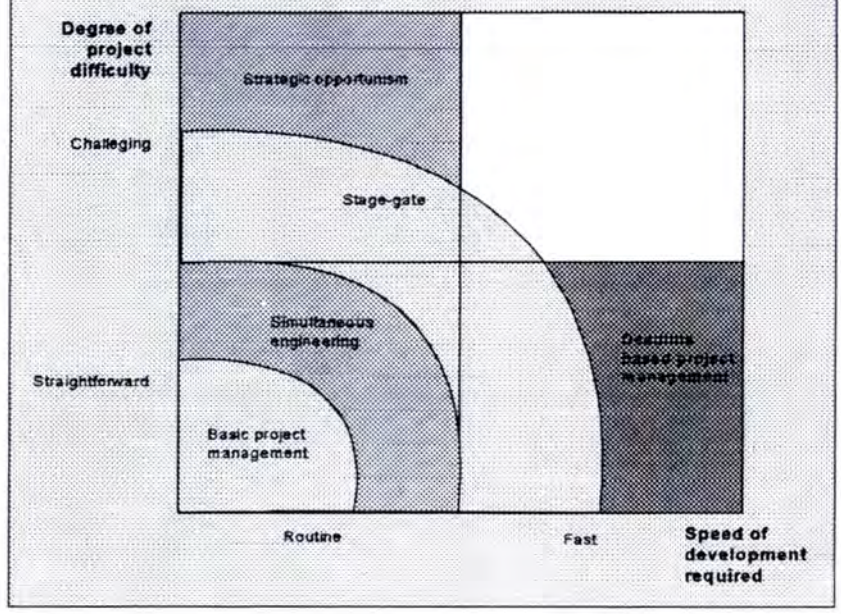
Quadrant 3: Urgent, but relatively straightforward, projects

For projects in Quadrant 3, time-to-market is critical, but the degree of project difficulty is within the team's experience and ability. Experienced project management, good teamwork, openness to external inputs and a "can do" culture can, of course, steadily increase the "degree of difficulty" which the company can deal with as "routine".

For projects in this category the key challenge is to manage the critical path. **Deadline based project management** focuses on this above other elements. Whilst isolating and dealing with key risks as early as possible, it also involves a willingness to make risky decisions where there is a chance that time-to-market will be reduced as a result. Committing to critical tooling costs before the design is finalised provides an example. Stage-gate project management, with its emphasis on meeting intermediate targets before a project is allowed through each gate to the next stage, can seriously impede effectiveness in situations where time-to-market is of paramount importance.

Deadline-based project management approaches are used by companies in industries as diverse as pharmaceuticals and consumer durables. However, because the approach depends so much on the experience of the team, only a minority of projects can be run in this way.

Figure 4.7: Project management for urgent but relatively straightforward projects



One of the tasks of top management in companies where time-to-market is *the* critical issue is to improve project team training so they can apply deadline based project management to increasingly complex or risky projects. A second is to minimise the technical and commercial risks remaining prior to commencement of the execution phase. Some of the best product development companies use deadline based project management approaches to drive through a predetermined product launch programme during the year. Each development draws in new concepts or component technologies which have already been taken through a parallel development programme, run under a stage-gate process, to investigate and reduce risks.

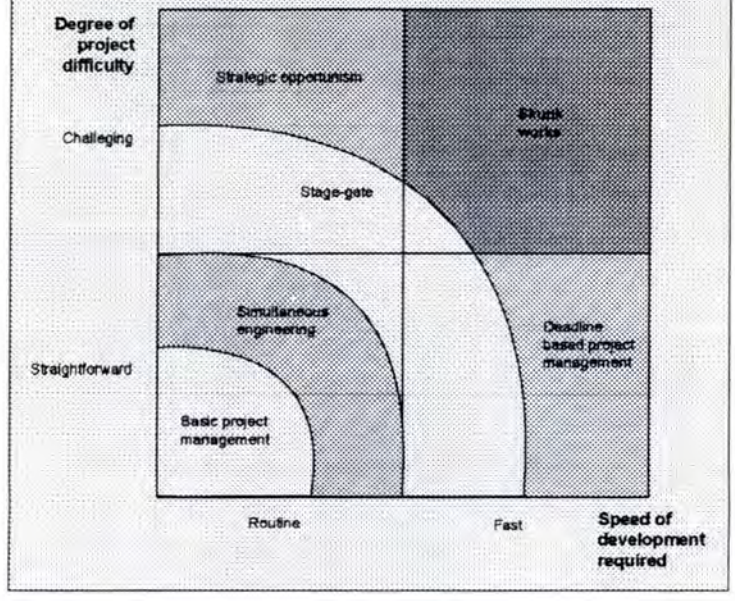
Failure to apply the right kind of project management can be disastrous. In one case, the use of deadline based project management to fast track a high risk development by one of our clients led to a product which won prizes for innovation but, in the words of the incoming Technical Director, was unmaintainable. The financial impact will be felt for years to come.

Quadrant 4: Projects which are both urgent and challenging

For projects which are both difficult and urgent, there is no substitute for putting together a highly able team and allowing them to get on with it. The term "**skunk works**" has been

coined for this approach and originated in the Lockheed Corporation during World War II. Skunk works teams are usually brought together just for the duration of the project. The approach was adopted by Land Rover to develop the Discovery and by IBM to develop the PC[7].

Figure 4.8: Project management for projects that are both challenging and urgent



Key factors for successful application of the skunk works approach include:

- setting clear goals and stretch targets
- a separate location, designed to encourage interaction and communications
- complete absence of bureaucratic "red tape"
- strong senior executive support with short managerial chains
- staffing by highly able, committed individuals with the right blend of knowledge, skills and personal attributes including:
  - (i) relevant technical, manufacturing and marketing competences
  - (ii) interpersonal skills
  - (iii) judgement

[7] For an excellent summary of the use of skunk works approaches at The Ford Motor Company, see '*Creating and Commercializing Innovation Inside a Skunk Works*', Arthur W Single & William M Spurgeon, *Research Technology Management*, Vol. 39 No. 1, January–February 1996.

(iv) management experience
(v) entrepreneurial zeal
(vi) a strong sense of urgency

- measurement by results, not internal processes.

The skunk works approach depends on taking some of an organisation's best people out of their existing jobs and asking them to perform the impossible. It is an approach to product innovation that all organisations should use from time to time, and it provides a superlative training experience for able, but less experienced, team members. However, even more than deadline-based project management, it is an approach that depends on individual and team excellence. It is not an approach that can be applied across all projects.

4.8 Outsourcing

Outsourcing to specialist organisations executing projects under contract can provide a way of bringing elements of several of these advanced project execution approaches to bear. Depending on the supplier selected, it can enable a company to tap into knowledge and experience in industries and technologies far beyond those of its own scientists and engineers. If the supplier can bring well-honed project development experience in these fields, it may be possible to speed time-to-market by adopting a deadline-based project management approach for more "difficult" projects than the company is used to handling internally.

The need to define a development "contract" and the expenditure of *real* money involved can do much to increase the rigour with which the customer organisation's managers define deliverables. The high profile received by such procurement decisions can also ensure they are agreed across all the key functions. As such it emulates elements of the stage-gate approach. Deviations from plan are, as a result, more recognisable and easier to deal with. Furthermore, the rigorous customer/contractor relationship involved provides a high level of motivation to the supplier team, thus achieving some of the objectives of the skunk works approach.

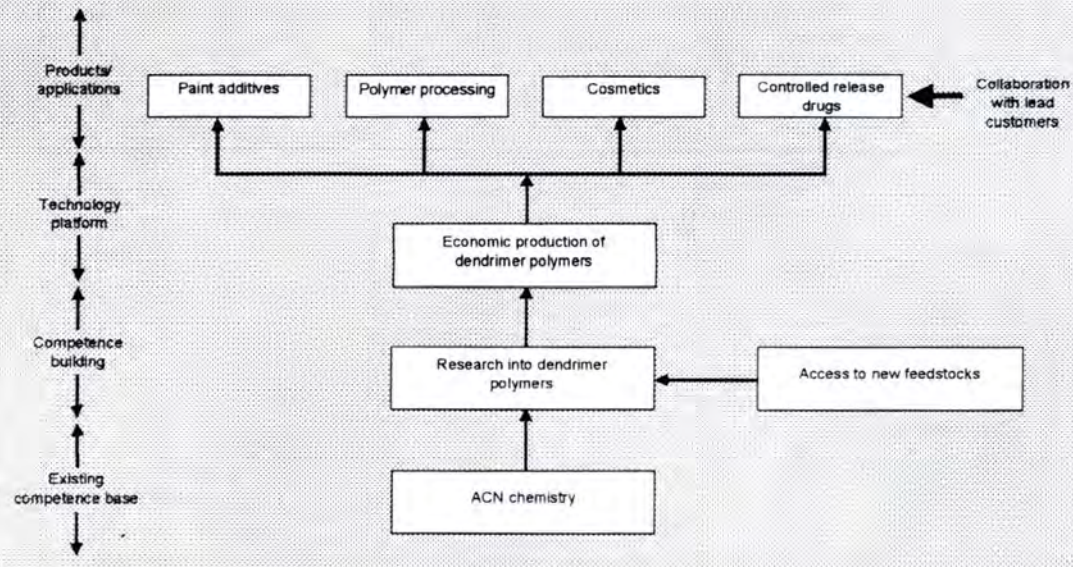
For most companies, total outsourcing of product innovation, like the skunk works approach, is inappropriate. However, both methods provide a benchmark of normal in-house product development performance – a demonstration of what can be achieved when the pressure is on and distractions eliminated. As such, they provide powerful mechanisms

for changing the overall innovation culture, as well as a "fast track" route to developing specific products.

DSM's Dendrimer Polymer Technology Platform: Commercialisation through Multiple Collaborations with Users

Dendrimer polymers are a novel type of polymer which exhibits many interesting properties. Their branch-type structure and other special characteristics, such as cavities in their molecular structure, multiple crosslinking ability and viscosity effects have relevance to a range of application markets including paints, polymer processing, cosmetics and controlled release medicines.

Research into dendrimers dates back to the 1970s. In the 1980s, Dow Chemical were the first to bring a dendrimer product to market. However, supply remained very restricted due to the limited production capacity. The price of dendrimers remained high (tens of thousands of pounds for a few grams). As a consequence, interest from the market was limited.



In 1993, DSM, the Dutch chemicals and materials company, announced a breakthrough in the production of dendrimers. DSM's knowledge of acrylonitrile (ACN) chemistry combined with access to new feedstocks enabled a new synthesis route for the economic production of these polymers. This meant that dendrimers could be produced for less than £1,000 per kg, and provided a "technology platform" with multiple application markets.

This radical improvement in production economics led to renewed interest in the market for dendrimer applications. However, development lead times were likely to be long and it will not become clear for some years which are the most important applications. In the meantime, DSM's primary business development task is market creation and "strategic opportunism". This means focusing effort on where it believes the best opportunities to be,

but retaining the flexibility to refine and accelerate its strategy as key applications are uncovered.

Recognising the potential number of applications and their high added-value, DSM's strategy has been to grant licences to lead customers who wished to develop specific application products. DSM provides a complete dendrimer technology package, including the supply of samples to enable customers to undertake their own application developments and trials.

4.9 Imitating the Small Company Approach

Small, highly motivated, dedicated teams can always be faster and more cost-effective than conventional large company organisation structures. They can also usually be more creative. This is one of the reasons why small companies play such an important role in the economy.

Some multinationals are trying to replicate elements of the small company approach in-house. Canon has set up a network of small R&D centres around the world. Its 20-man European centre in Guildford is charged, not just with research and development, but with creating entire new businesses with their own revenue streams. The 120-man Services & Technology Group based at IBM's Hursley laboratories has a similar rationale. By carrying out development projects in new areas like data-mining and virtual reality for customers keen to be the first to exploit these new technologies, it aims to build up its own capabilities in real situations and so, ultimately, to provide the basis for standard offerings.

The New Business and Special Projects Group at Philips' Eindhoven Research Laboratories, run by ex-entrepreneur David Penrose, has a similar philosophy. Its small core team of highly able scientists and engineers operates under minimum bureaucracy to develop innovative new product concepts for customers in Philips' established businesses.

A key feature of both IBM's and Philips' approach is the explicitness of the customer/contractor relationship. Significant development work can only be undertaken if the customer (internal or external) is prepared to pay – a discipline that, more than any other, ensures commitment on all sides.

Canon Inc: Using Product Innovation to Build New Competences

Founded in 1937 to manufacture cameras, Canon is now one of the world's most dynamic and best regarded technology-based companies. Between 1991 and 1995 it received more US patents than any other company except IBM. Canon maintains an investment in R&D of around 6.5% of net sales per annum and one of its guiding R&D principles is to "conduct R&D activities on a global scale and create new business activities in the country or region where the R&D takes place".

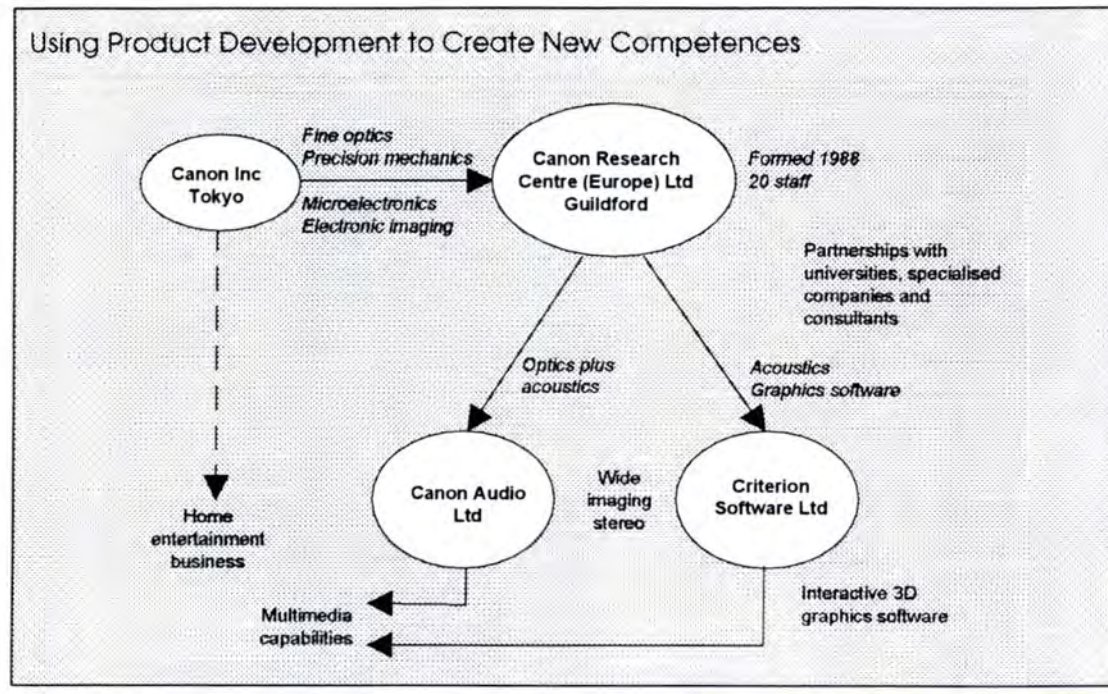
To implement this principle, Canon has established five overseas R&D centres, each focusing on accessing and applying local scientific or technological strengths. Canon Research Centre Europe (CRCE) was the first of such centres, established in Guildford in the UK in 1988. The others are in Australia, France and two in California. Unlike most companies' overseas R&D laboratories, CRCE is tasked not just with carrying out R&D, but also with creating self-standing, revenue earning businesses. Like the other centres, it also has a wider information gathering and networking role.

CRCE's location in the UK provides the impetus for the two main areas of activity. First, Canon wanted to acquire and develop capabilities in audio, an important stepping stone towards its aspirations to be a player in the emerging "home entertainment" market. This is seen as a key growth opportunity for the company in the 1990s and into the twenty-first century. Guildford provided an ideal base from which to take advantage of the UK's excellent international reputation for audio technology and to tap into its network of specialist companies, designers and academics.

By combining Canon's traditional core competence in the manipulation of optical waveforms with these skills, CRCE was able to develop a highly novel wide imaging stereo (WIS) loudspeaker which produces improved stereo sound quality over a wide area. A CRCE subsidiary, Canon Audio, was formed in 1991 to manage the manufacture and marketing of the WIS loudspeaker and, by 1996, its revenues were in the order of US$8 million.

CRCE was also tasked with filling another key competence gap perceived by Canon: that of software development. Canon's ambition as a multimedia company meant that it had to address Japan's lack of world class expertise in software development. The UK's high reputation in software development and, in particular, in 3D graphics interfaces meant that it provided a natural base for Canon's software development activities.

In 1993 a second business, Criterion Software, was spun out to exploit CRCE's 3D graphics interface technology and, in early 1996, Criterion Studios was formed as a new division of Criterion Software to develop 3D games for the PC market. This coincided with the announcement of an alliance with Virgin Interactive Entertainment (VIE) to publish selected games developed by Criterion.



4.10 Phase 4: Commercial Implementation

One of the great strengths of the stage-gate approach is that, almost by definition, it ensures all aspects of a new product development are considered from the beginning, and that the managers who will be responsible for manufacturing and marketing are fully involved. Stage-gate, therefore, maximises the probability that a new product will be effectively launched onto the market. Though, if the product is similar to existing products and cross-functional meetings to agree specifications and launch programmes happen automatically, the full rigours of the stage-gate discipline may be unnecessary once the initial decision has been made to develop and launch the product.

The other advanced approaches to project execution we have described involve the same disciplines as stage-gate, but enforced through the experience of team members or close team work rather than a "standard" business process.

Many companies encounter particular difficulties trying to commercialise new products over a wide range of international markets. Differences in climate, market preferences, standards and distribution channels can all mean that some modifications are required to make the product acceptable. "Not invented here" barriers may interfere as teams from different

national markets compete to develop what is essentially the same product. If overall development efficiency rather than time-to-market is the key issue, it makes sense to develop a single "product platform" which can then be applied in different markets.

One of the key problems of this sort of technology transfer situation is that the costs and benefits accrue to different budget holders. In this case, it is important to plan technology transfer centrally, so that those with the best knowledge of the basic product platform are made available to help managers and engineers in different markets to apply, modify, manufacture and market it.

The most difficult products to exploit commercially are those involving both new technology and new markets. Where a high degree of innovation is concerned and the product essentially forms the basis of a new business, a very different approach to commercialisation is likely to be required. A new venture must be created with a full-time team of able managers operating independently of existing businesses and prepared to rethink all elements of strategy, if necessary. For consumer products, there will need to be extensive market research and possibly a period of trial marketing before the design is finalised. For industrial products, it may not be possible to define the most important applications or customers in advance and the development activity may need to proceed in parallel with the sales activity.

As we have seen, the approach required in this situation is best described as one of strategic opportunism and is very different to the rigid disciplines imposed by stage-gate. DSM's dendrimer business and IBM Hursley Services & Technology provide good examples of this process at work.

New business development is an area with which large companies have very great difficulty, though the success of companies like Canon, IBM and others shows that it is possible to manage it well.

5. TRANSFORMING AN ORGANISATION'S INNOVATION PERFORMANCE

In this report we have focused on the management of product innovation as an integrated process and tried to identify best practice in terms of the management techniques and approaches adopted at each phase.

But this alone is not enough. For a company to operate these processes effectively, its people must be both equipped and motivated to do so. This is where "culture" comes into the picture. The reason some companies are so much better at new product development than others is that the value of innovation as an activity is repeatedly re-emphasised up and down the company. It is this continued top management attention to the role and power of innovation which ensures that efforts are focused on the organisation's key goals and strategies, and that knowledge of how to manage the innovation process flows right through the corporate bloodstream.

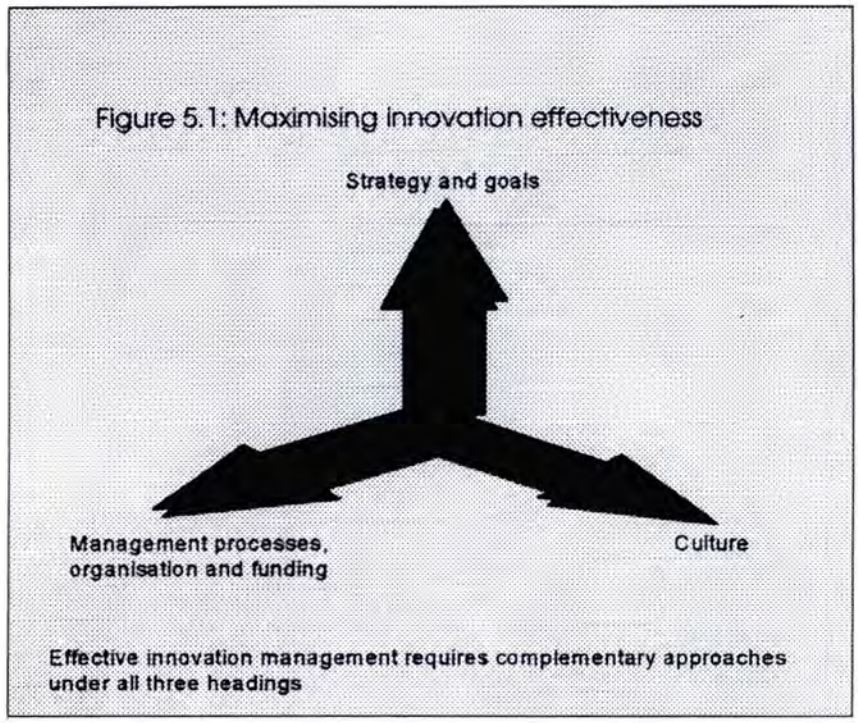
For companies where this is not the case, or where the culture appears to be dominated by short-term financial and operating pressures, achieving the cultural changes necessary may seem a daunting or impossible task. We therefore set down below the three steps which a CEO can take to transform the innovation potential of the organisation.

5.1 Step 1: Define the Innovation Gap

The first step is to map how the innovation process actually operates in your organisation and to examine how your approach compares with best practice. Organisations with a world class approach to innovation manage the activity along three distinct axes:

Strategy and goals – They have clearly articulated short-, medium- and long-term strategies, which feed down through explicit, often quantified, goals and targets to focus the search for innovation opportunities and solutions on areas with the greatest strategic and commercial importance for the organisation.

Management processes, organisation and funding – They have organisation structures, processes and funding systems which enable all parts of the "Innovation Funnel" to be managed effectively and which provide a counterbalance to the inevitable short-term, operational pressures that exist in almost any large organisation.



Culture – Their executives reinforce the importance of innovation again and again, not just in annual reports and speeches, but through everything they do to motivate people and monitor their performance. They reward innovation through awards, prizes and peer group recognition. They recognise that innovation does not exist without failure and encourage learning from mistakes whilst tolerating failure. They emphasise that innovation is everyone's responsibility and provide top level support and encouragement for the organisation's most creative talents, irrespective of rank or role. They ensure that short-term pressures never undermine the innovation message.

Each of these elements is reinforcing. Without appropriate policies and actions in each area, overall innovation performance will suffer.

5.2 Step 2: Design, Implement and Embed a Strategic Innovation Management Programme to Improve Overall Innovation Effectiveness

A programme to transform innovation performance must ensure that *all* of these elements are in place and that the key gaps revealed in Step 1 are dealt with. The precise focus and content of a transformation programme will depend on this earlier diagnosis.

Checklist for Auditing a Company's Innovation Effectiveness

- Where do ideas for innovation projects come from?
- How do you tap into external ideas and capabilities?
- How well is the innovation portfolio linked in with the company's overall strategy and goals?
- Are these used to set stretch targets and challenges to drive creative and problem-solving activities?
- Does the organisation's "culture" and overall approach to management support or impede innovation?
- What quantitative and qualitative measures are available to assess innovation effectiveness?
- What is the balance of effort between different phases of the innovation funnel and types of project?
- Which phases of the "innovation funnel" and types of project does your organisation manage best?
- What are the weakest links?
- How are projects at different parts of the funnel resourced and funded?
- How do you kill flagging projects?
- Does your budgeting system support innovation or reinforce the status quo?
- Which of the natural barriers to innovation found in large organisations are relevant to your own?
- What are the key ones and why do they exist?
- What is the potential for improvement and what are the key aspects of innovation on which an improvement programme needs to focus?

However, whatever the precise details, implementing change will involve three distinct elements:

- board-level driven cultural and organisational changes
- the design of an appropriate Strategic Innovation Management System, including targets, metrics, processes, funding mechanisms and organisational arrangements
- introducing and embedding these changes.

The last requires special mention. Innovation is an area of management where practice is infinitely more useful than theory. Old habits do not die easily and natural barriers can easily reappear. Achieving real and lasting improvement therefore requires a process of "learning by doing", with internal or external coaching to facilitate the change in behaviour and an ongoing feedback process to enable the entire organisation to learn from the experience, so that its overall approach can be further improved.

How to Create an Innovation Culture

- Set and monitor quantified targets to measure innovation performance (such as number of new product launches per annum, or percentage revenues from new products launched in the last five years).
- Ask each major business to report to the Board once a year on its innovation programme and achievements.
- Link senior managers' bonuses to innovation performance as well as to the achievement of short-term financial goals.
- Award prizes once or twice a year to the teams delivering the best innovation projects.
- Publicise innovation successes internally and externally.
- Enforce a no-blame culture. Treat failures as a learning opportunity.
- Protect budgets for long-term developments and radical innovations. Do not allow business managers to axe them or hijack them for short-term, routine projects.
- Provide discretionary funding for early stage developments and sponsor projects to generate and capture new ideas.
- Cultivate championship *and* sponsorship.
- Encourage maximum use of external technology. Focus on application, not invention.
- Keep the R&D headcount small enough to ensure use of external technologies and resources when appropriate.
- Encourage projects aimed at solving impossibly difficult problems with impossibly small teams working to impossible timetables for demanding internal or external customers.

5.3 Step 3: Continuous Top Level Commitment

The pressures on CEOs over the last five years have been enormous. They derive not just from the accelerating pace of change and increasing global competition, but also from the pressures placed on their shareholders, the investment fund managers, as a result of international capital mobility and more powerful methods of measuring and monitoring the performance of their own investment portfolio.

It is inevitable that demands for ever improving financial results are relayed down through the organisation. This puts short-term pressure on all managers to ensure that waste is eliminated and cost reduction programmes pursued vigorously. This is especially the case for organisations which have been split into semi-autonomous, profit responsible business units.

These pressures will not go away, even if a period of economic growth has, for a time at least, taken away some of the urgency.

It is precisely because these short-term pressures are so strong in today's corporation that only the CEO can ensure that innovation gets the attention it deserves. It is *his* role to ensure that the culture, strategies and processes to encourage innovation *remain* in place and work effectively, irrespective of short-term pressures and expediencies. It is *his* role to ensure that directors and managers understand how innovation and new business development work in practice, and that the issue remains high up *their* personal agendas.

The schizophrenic management style this requires is demanding, with attention to cost management in operational matters and the performance of mature businesses *matched* by continuing, visible and real encouragement for innovation and new business development.

Working out how to marry both styles is a dilemma that CEOs of more and more large organisations will have to face as we move into the next century.

APPENDIX

Background Information on Companies Interviewed

APPENDIX – BACKGROUND INFORMATION ON COMPANIES INTERVIEWED

Company	Location	Turnover	Activities	Comments
ICI	UK	£10.5 billion	Chemicals and polymers	Interviews focused on Polyesters business
Zeneca	UK	£5.3 billion	Pharmaceuticals, agrochemicals and speciality chemicals	Focus on Specialties business
DSM	The Netherlands	£3.9 billion	Chemicals and polymers	Interviews with corporate functions and Fine Chemicals business
IBM	UK	£4.6 billion	Computers and computing services	Interviews with IBM Hursley Services & Technology division
Glaxo Wellcome	UK	£7.9 billion	Pharmaceuticals and disease management	Focus on R&D
NCR	UK	£432 million	Automatic teller machines (ATMs)	Interviews with Financial Products and Systems Division
Smith & Nephew	UK	£2.4 billion	Healthcare products	Focus on R&D
Northern Telecom	UK	£6.9 billion	Telecommunications switchgear, software and mobile communications	Interviews with International Terminals Division
Dynacast	UK	£8 million	Die castings for the automotive, telecommunications and electronics industries	Part of Coats Viyella Group
Esselte	Belgium	£928 million	Office products and labelling systems	Focus on electronic label-makers for the home, office and retail markets

Company	Location	Turnover	Activities	Comments
BOC	USA	£3.5 billion	Industrial and special gases, healthcare, vacuum technology and distribution services	Focus on Gases business
DuPont	USA	£27 billion	Chemicals, fibres, polymers and diversified businesses	Interviews with central R&D experimental station
Bayer Diagnostics	USA	£500 million	Diagnostic products for the urology, diabetes, haematology, immunochemistry and clinical chemistry markets	Focus on Diabetes and Immunochemistry BUs
Johnson & Johnson	USA	£12.1 billion	Healthcare, pharmaceuticals and consumer products	Focus on Consumer Products division
Bausch & Lomb	USA	£1.3 billion	Soft and rigid gas permeable contact lenses, lens care products, sunglasses and ophthalmic pharmaceuticals	Focus on global product development and strategy
Analog Devices	USA	£606 million	Semiconductors and electronic devices	Focus on Wireless Communications division
Canon	Japan	£13.5 billion	Business machines, cameras, optical and other products	Interviews with R&D Headquarters
Fuji Photo Film	Japan	£6.3 billion	Imaging and information products, including photographic film, cameras and magnetic recording media	Focus on Technology Development and Information Division

Company	Location	Turnover	Activities	Comments
Daicel Chemical Industries	Japan	£1.4 billion	Cellulose derivatives, organic chemicals, plastics and films, propulsion systems	Focus on new business in automotive airbag inflators
Kaneka Corporation	Japan	£1.2 billion	Plastics, films and pharmaceutical intermediates	Interviews with corporate R&D managers
Zebra Pen Company	Japan	£138 million	Design and manufacture of writing instruments	Focus on novel electronic pen development
Nippon Shokubai	Japan	£750 million	Chemicals, polymers and catalyst technology	Interviews with corporate R&D managers

The effective application of Technology requires a recognition of the importance of Partnership and an understanding that any successful partnership requires an acceptance of common values and objectives, and a sharing of risks and opportunities.

Our commitment to partnership exists not simply between our own business and technological specialists, but, more importantly, between ourselves and our clients.

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