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UNIDO MANUAL ON TECHNOLOGY MANAGEMENT

Technology Management

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

UNIDO Manual on Technology Management

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INTRODUCTION

Technology has become one of the critical assets needed for creating as well as sustaining competitive edge in the global economy. Managing technology has become a critical competence in all the sectors of the economy such as agriculture, mining, manufacturing as well as services. Earlier, economics considered economic growth as an output of labour and capital. The work of Schumpeter as well as Solow clearly indicated that technology and innovation contributed to economic growth in a substantial manner. There has been a major change in business context in the late 1990s. This has enhanced the role of technology. Technology and innovation have become the major sources of competitive advantage.

Global competitive strategies are increasingly becoming technology driven. Global companies are investing across various countries and are expanding market reach at a rapid pace. Technology has become the great equalizer among companies and countries. Global firms are creating new technological capabilities and they are also leveraging technological innovation in many markets simultaneously. Technological innovation cannot be achieved without corporate management devoting considerable energy and investment to developing effective linkages between science, engineering and management. Technology management could be broadly defined as the capability to create new technologies and to exploit them for growth. Technology management is equally critical for large, medium or small enterprises, as the global business context has become intensely competitive. Firms operating in developing countries have to leverage technology to remain competitive in the context of emerging competition.

In the last ten years many new firms have come up and some established firms were not able to compete in the wake of competition. This is true of manufacturing firms as well as service firms. See box 1.1:

Box 1.1 Changing corporate landscape

- AT&T which dominated the United States telecom scene has lost its identity
- Vodafone which is a rather new entrant is operating in many new markets
- New aircraft manufacturers such as Embraer are selling airplanes to many countries across the globe
- IBM has sold its personal computing to the Chinese firm Lenovo
- The Korean semiconductor manufacturing firm Samsung is one of the largest LCD display manufacturers in the world
- A start up from the United States has licensed nanotechnology to make cotton fabric spill resistant
- Asia has become the global innovation hub
- The migration of industrial sourcing, manufacturing and service operations from high cost to low cost countries is accelerating rapidly
- Industrial clusters are becoming the major source of competitive advantage

What are the factors that made some established firms lose their identity? They were closed down or acquired. The most noteworthy of them is Cray Supercomputers. That firm was unable to meet the competitive challenges posed by emerging technology. Technology did two distinct things across the globe. It disrupted some industries and it enabled a series of new firms to come up. An Indian start-up firm, namely Impulsesoft from Bangalore, is supplying embedded software to Apple for its iPod. By leveraging technology even new entrepreneurial firms are able to create global products.

Origins and logic

Edward Roberts, David Sarnoff Professor of Management of Technology at Sloan School of Management, MIT, Boston, made a presentation in 1986 at the First International Conference on Engineering Management in which he proposed that the failures of the automotive, office equipment and electronics industries were not the result of trade, economic or political policies but the inability of the industry to implement programmes in technology management. Technology acted both as a creator and destroyer. It destroyed some of the firms that were not responsive to change. It created many new firms and opened up new business opportunies. Many new products were introduced and many new services emerged that leveraged new technology. See box 1.2

Box 1.2 New products and services

- Milk with long storage life without refrigeration
- Monoclonal antibodies to treat tumours
- Digital video disc
- Electronic commerce through the Internet
- Digital nose
- Scratch-proof nanotechnology based paints
- Fuel cell-based cars
- Stain resistant clothing based on nanotechnology
- Stem cell-based treatment for Parkinson's disease.
- Medical imaging technology
- Video through mobile telephones
- Non-glucose sweeteners such as Fructalose
- Internet banking
- Laser lithotripsy
- Microwave cooking ovens
- Mobile phones
- Digital video disc players
- Global credit cards
- Radio frequency identification chips
- Ready to eat foods

In that conference Edward Roberts emphasized that technology management involved a diverse set of activities such as:

- Integrating technology into a firm's strategic objectives.
- Taking a proactive stance in introducing new technologies, new products and new processes with a greater emphasis on cycle time.

- Increasing the productivity and performance of the firm's technical community.
- Understanding the interdisciplinary needs in project management.
- Analyzing resources and infrastructure to effectively select the technical scope of the work effort.

Global competitive strategies are becoming increasingly technology driven. Because of this, technology strategies have become the differentiator in every aspect of the business value chain. The evolution of technology management concepts into various aspects of the value chain has been progressive. The growth of technology management is schematically presented in figure 1 to indicate that technology as a concept became infused into various business functions over the years. Technology has become the great equalizer among companies and countries. Firms in developing countries, small as well as large enterprises, could use the technology management framework to enhance their internal capabilities or innovate or enhance external offerings.

Management of technology can be described as the process of integrating business unit resources and infrastructure in the fulfillment of its defined purposes, objectives, strategies and operations. The definition of the management of technology has been looked at from different perspectives namely:

- Technology is the means for accomplishing a task—it includes whatever is needed to convert resources into products or services.
- Technology encompasses the knowledge and resources that are required to achieve some critical business objectives.
- Technology is a body of scientific and engineering knowledge that can be applied to the design of products and/or processes or in the search for new knowledge.

The management of technology is a holistic perspective that connects people, processes, organizations and facilities or technical assets so that the objectives of the organization can be met. This means continuously aligning its business outcomes to meet the competitive demands of an ever-changing business context.

Why do we need technology management?

The need for managing technology at enterprise level has become critical and a number of corporations have designed their own approaches to the management of technology. Some of the major driving forces that have made technology an essential ingredient of corporate success are highlighted here:

Global competition

The intense competition that characterizes corporations requires that firms remain at the cutting edge of technology. Enterprises have to renew products and services so that they can meet customer requirements at each and every point of time. Global

firms move their resources to the most competitive location and developing countries have to ensure that firms remain competitive so that they can attract global capital flows and generate value.

Trade barriers

With the start of the World Trade Organization (WTO), trade barriers are being removed across the globe. By the end of the decade most of the barriers will have gone. This means two things. First, trade will become increasingly competitive and competitive efficiency will become critical for business survival. The rapidly growing items in world trade are mostly technology embedded. In a global economy with minimum barriers, of a firm is to grow, it has to be competitive in its own right.

Tightening intellectual property rights

The tightening of intellectual property rights requires that firms have to create and own their own intellectual property. Reverse engineering as an option will be of very little value to enterprises. Copied products cannot be sold across the globe. The ability to leverage a product in different markets will be restricted if the intellectual property rights associated with a product are not owned by the company. Also, intellectual property in the current context encompasses a number of assets such as:

- Patents
- Trademarks
- Copyrights
- Industrial designs
- Trade secrets
- Gene sequences
- Integrated circuit designs
- Geographic indicators

Because of this constraint, technology management has to focus on the patentability of new products while new products are being created.

Mobility of global capital

The global movement of capital has been increasing in the last decade. The capital will go into regions that have high productivity, both manufacturing productivity as well as service productivity so that global firms can use productivity differences to their advantage. Direct foreign investment is a major source of economic growth apart from foreign trade.

Competitive advantage shifting to low cost countries

Globalization is reshaping the industrial landscape and creating new winners and losers. For example, more than 70 per cent of footwear, 60 per cent of audio and video equipment and 45 per cent of the apparel sold in the United States have their origin in low cost Asia, Latin America or Eastern Europe and those areas are still gaining market share. This is a golden opportunity for developing countries to enhance their industrial production base. This will require managing technology in a comprehensive manner, more so by newly industrializing countries.

Digital convergence

The Internet along with mobile phones fuelled by the falling costs of communications and increasing convenience are creating new business opportunities. The outsourcing of IT and ITES is a consequence of this phenomenon. Distances are shrinking. Business value chains can be disaggregated and delivered across the globe. The tools of human interaction—images, video, sound and text can now be defined and represented in a common digital format. This allows any kind of information to be transmitted, stored, combined and manipulated in ingenious ways that are still being discovered and perfected. Commerce, telephones, entertainment, travel and design are changing dramatically as switching costs are coming down and new businesses are being created. This means that business and IT will be integrated in a manner that makes it difficult to separate them as distinct entities. Because of this many new technology-driven businesses are emerging.

Venture firms

The emergence of innovative start-ups supported by venture funds has been another major driving factor behind the rapid technology change. Start-ups have been more innovative and they are emerging as a power house innovation. Silicon Valley emerged as one of the dynamic centres that created start-ups. Opportunities for innovation from these have been increasing because of venture funding that is easily available. Industrial clusters are emerging through the starting of small innovative firms close to each other.

Environmental concerns

Global warming and pollution as well as waste generation have been another set of drivers that need to be a focus of technology management. Green design, recyclable parts, reusable products, zero emission devices, pollution control, etc., need to be designed and marketed across the globe. Companies such as Canon, Toyota, ABB, etc., have exploited green opportunities to stay ahead of competition.

These eight factors make it essential to consider technology as an element of distinctive competence that could affect business negatively or positively. Technology has to be used deliberately to enhance the competitiveness of an enterprise. Technological capability to innovate and productivity enhancements are inputs that could be

leveraged. Technology management is the ability to extract business value by using technology as a strategic variable in a business. Technology management has become one of the leading levers of business strategy. Technology management is rather an approach and it can be used in multiple ways.

Technology management perspectives

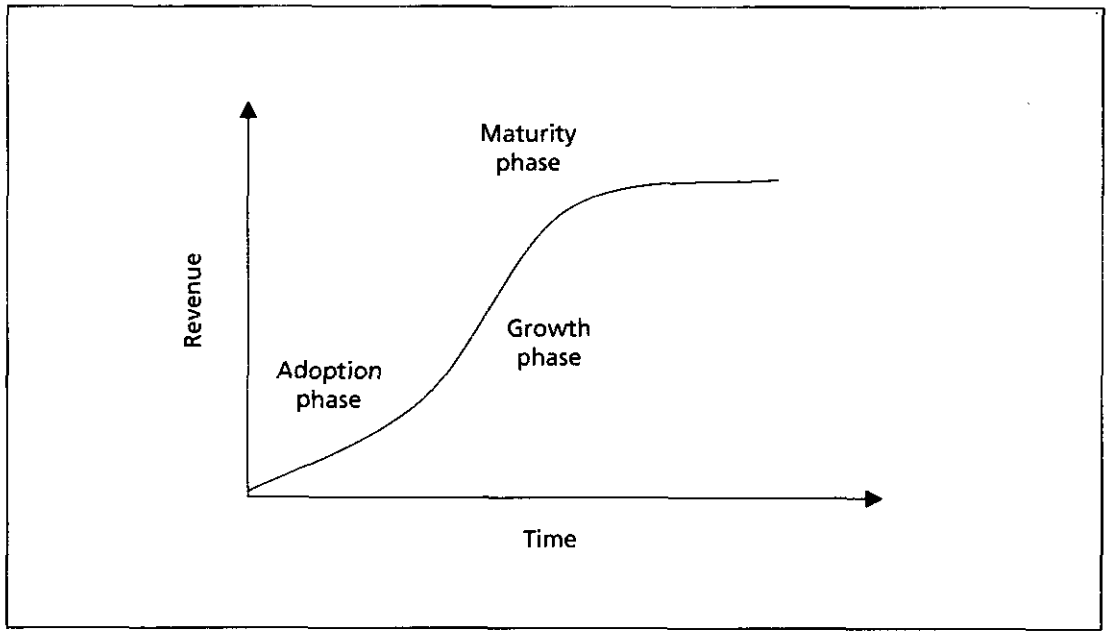
Technology management could be looked at using any one of the conceptual frameworks used in management to get new insights into what could be done better, what could be done differently and what new things could be done. Technology management tools and concepts help you to do this.

Product life cycle perspective

Any product, technology or service evolves over time in an s-shaped manner as shown in figure 1.1. Initially growth is slow and then it picks up. Then it slowly levels off. The first phase is the adoption phase in which only early adopters use a product or a service. Slowly, experience builds up as learning occurs. Then other firms enter the fray. This is the growth phase in which productivity, quality, cost efficiency and service will become critical. In the last phase, when growth declines, new technology or product renewal becomes essential. Technology management has to focus on different things during each of the phases.

During the early phase the focus is on product innovation so that the product evolves. This is the learning phase. Generally Japanese firms are very active in this phase. They

Figure 1.1 Product life cycle curve



use product feedback to ensure that all the minor hitches are eliminated. This phase is characterized by experimentation, using feedback extensively, rapid learning and cross-functional interactions. The next phase is the process innovation phase in which the source of competitiveness is improving process efficiency and process delivery. The focus is on the manufacturing process. The thrust of this phase is on improving process yield, fine-tuning the manufacturing process and eliminating some steps by innovating new ways of doing the same task. In this last phase, product growth declines. Here the focus is on marketing so that maximum potential is extracted. The thrust here is on sustaining the market, keeping investment needs to a minimum.

The product life cycle approach helps in understanding customer behaviour. New product models help forecast the way growth will pick up after the introduction of a product. This approach helps one to identity business priorities for ensuring competitiveness.

It has been observed that first mover firms need not necessarily be the winners in the market place. Xerox was the first mover in photocopiers. Canon subsequently overtook Xerox. Xerox focused on technology and product development, whereas Canon, which was a late mover, emphasized features such as service reach, retail network and service quality. It learnt from the mistakes of the first mover. Instead of entering the low volume, high value market Canon entered the low value segment offering easy to use low cost photocopiers. They reduced product development time and introduced new products into the market faster than its competitor. Slowly it penetrated the market and increased its revenue. It expanded its revenue. It expanded its market using market segmentation principles. The product life cycle approach is a lens that helps firms to identify winning strategies.

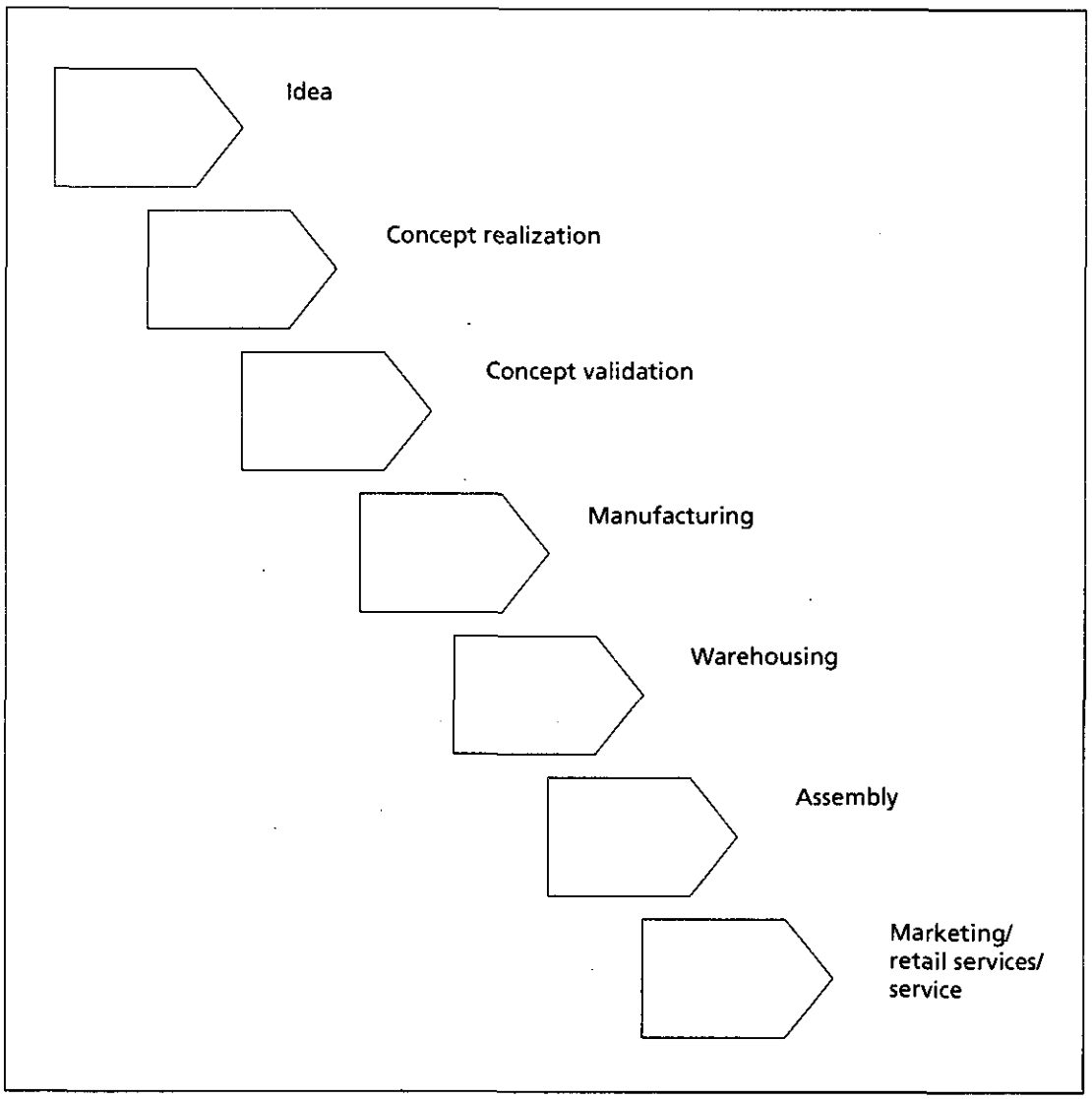
Value chain perspective

Any product, service or technology delivery can be envisaged as a bundle of activities starting with the origin of the idea. The value chain can be schematically depicted as an evolutionary chair, moving from the idea to customer service. The value chain is a set of activities that creates value for a firm, as shown in figure 1.2.

The value chain framework helps us to understand the activities that a firm has to focus upon. To remain competitive a firm has to excel in as many segments of the value chain as possible. The value chain segments what it could do elsewhere at a lesser cost and in a competitive manner what it should outsource. A firm could reconfigure its value chain to enhance its competitive advantage. For example, Boeing used digital product definition to reduce the cycle time for developing its aircraft. Instead of making physical mock-ups that are rather expensive it used computer-aided design or electronic product definition. The airplane B-777 was done digitally used "CATIA" software. It could reduce product development time as well as cost. It reduced development time by half and the cost by 50 per cent. By changing the way a product is made one could improve the competitiveness as one could reach the customer faster. Product validation can be done on line so that design productivity goes up and product redesign is also made easy.

Electronic commerce is another example of value chain reconfiguration. Using a "one click" buying process that it had patented, Amazon.com became the first firm in the world to use electronic commerce on a global scale and it became the largest bookstore in the world, overtaking "physical" bookstores such as Borders or Barnes and Noble.

Figure 1.2 Value chain perspective



The value chain perspective allows a firm to examine what part of the value chain it could reconfigure. Another successful example of value chain reconfiguration is that of Dell computers. It reduced its costs by removing the distributor by using a direct mailing approach so that it could minimize the cost of carrying inventory. The value chain perspective helps a business to visualize the value creation process so as to enhance customer value and eliminate non-critical activities.

Knowledge management perspective

There are essentially two distinct kinds of knowledge: tacit knowledge and explicit knowledge. Tacit knowledge is the embedded knowledge strands in a technology that are difficult to articulate. On the other hand, articulate knowledge is that element of knowledge that can be articulated and easily learnt.

Some of the finer aspects of a technology reside in tacit forms of knowledge. The look of a product, the external styling in an automobile, the finer colour hues of a painting etc., all reside in the tacit element of knowledge. As shown by the path-breaking work of Nonaka and Takeuchi, tacit to tacit knowledge transfer can be realized only through a process of socialization. This brings us to the important point that not everything can be learnt through articulate learning. Some things can only be learnt by doing. Process control in a traditional process such as the dyeing of a fabric is an example of this. Some technology transfer initiatives fail because of the absence of attended processes for transferring tacit elements of knowledge.

Each of these perspectives could be seen as a different sort of lens with which to look into a business in which technology plays a significant role in changing competitiveness. In consumer products, connecting with customers, distribution, packaging and retail networks seem to be important. In design intensive products such as watches, cars, scooters or cycles, it is reliable performance that matters. In durable products such as television, refrigerators, furniture, office equipment, computers etc., retail network and service quality will be the differentiating elements. Technology management has to identify the element that the customer values or uses for differentiation and then focus on that. The main value of technology management is that it helps to focus on the value adding elements of a business system.

Technology and business competitiveness

With increasing competition, the ability to differentiate between a product or service becomes the competence that is valuable. Technology can be used for differentiating a service or a product. The connection between technology, trade and competitiveness is becoming closer. This means that a firm will be able to remain competitive only by sharpening technology management capabilities as technology has become the key differentiator in competition. Competitiveness is not a static condition, but a dynamic one. A firm has to improve technological capability on a continuous basis. Nor do competitors remain static. One could learn from the principles of evolution. Competitiveness comes from the ability to monitor change, learn what to change and then adapt. Adaptability and flexibility come from technological capability. Flexible manufacturing systems help companies to customize products to meet the requirements of customers. For example, Honda used the concept of a platform to produce different variants from a unibody platform. Mass production provides for "economies of scale" whereas platform technology provides for economies of variety or "economies of scope".

Toyota and platform technology

Initially, Toyota developed and produced cars only in Japan and exported them abroad in order to ensure high quality and to maintain customer trust in the brand (Ichijo, 2006). This model of production system is not suitable in markets with different needs, for example Eastern Europe, South Africa, Latin America, etc. The global demand for cars has also been going up. Toyota changed its production logic to tailor make cars to meet local demand, to take advantage of tax breaks and to save on shipping costs. Toyota evolved to the second stage of its manufacturing model; it started to produce vehicles where the market demand is. Toyota identified BRIC countries namely, Brazil, the Russian Federation, India and China as emerging market opportunities. In these emerging markets local demand sometimes fluctuates widely or may vary greatly from that of Japan, Europe or the United States.

Toyota announced a breakthrough initiative called the "innovative multi-purpose vehicle" (IMVs) project in 2004. At its heart the model increases self-reliance on overseas manufacturing facilities in such a way as to optimize overall vehicle production worldwide especially in emerging markets, by both understanding common needs and paying sufficient attention to unique local needs (Ichijo, 2005). Toyota upgraded and expanded plants in Argentina, Thailand, Indonesia and South Africa and turned them into assembly and export bases for a line of innovative IMVs. For the first time in its history, Toyota is producing and selling cars that are not produced and sold in Japan. This is the power of platform technology, in which a uni-body platform is used to produce a number of variants in different markets. This helps the firm to use many common parts to produce products needed in different geographic locations.

The main lessons from the experience are multifold:

- Firms have to meet local needs while, at the same time, meeting the global scale to derive economies of scale.
- Firms have to use technology to exploit emerging markets.
- Firms have to penetrate the market rapidly to secure a leadership position.
- Firms have to develop products that are "local best" rather than "global best".
- Firms have to exploit a global network of overseas plants that is self-reliant and efficient.
- To be successful in a globalizing context, firms need strong human resources management that can perform in a global network.

Technology management in essence is managing technological systems to maximize their productive output as well as customer value. Technology works in conjunction with people and because of this it has become increasingly clear that technology management is about making people comfortable about technological change. It is about making people innovate and do things differently and it is about firms competing in highly contested markets by leveraging technology.

Small and medium enterprises in emerging markets are not used to competition. In a context where the operating principle is the "survival of the fittest" every firm has to focus on innovating and staying ahead of the competition. Productivity has to be maximized by plugging leaks and eliminating waste as well as enhancing the value of output or creating high value products. Productivity improvement includes all aspects of productivity, namely:

- Design productivity
- Manufacturing productivity
- Marketing productivity
- Service productivity
- Office productivity

Technology management is a way of working in which technology is used for enhancing the revenue of a firm as well as customer value. The revenue could come from a number of sources, namely:

- Improving existing products and services so that price realization is higher.
- Reducing wastage, reducing cost, improving efficiency of productive processes.
- Creating new services and products so that new revenues are generated.
- Doing things differently so that customer satisfaction is enhanced.
- Developing new manufacturing processes, new design processes so that the time to market cycle comes down.
- Learning the business process so that non-value added activities are continuously eliminated from enterprise activities.

The next chapter examines the global technology scene which is one of the major changes driving the industrial scenario.

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Chapter 2 Global technology scene

Introduction

Global technology trends

Critical technologies

Investments for technological innovation

Technology and global trade

Major initiatives

Food processing

Construction technologies

GLOBAL TECHNOLOGY SCENE

Globalization broadly refers to the globalization of markets, investments, manufacturing, technology, entertainment, financial practices and environmental standards. At the worldwide level, globalization refers to the growing economic interdependence among countries as reflected in cross border flows of goods, services, capital and know-how (Boyett, 2001). At the level of a specific country, globalization refers to the extent of interlinkages between a country's economy and the rest of the world. At the level of a specific company, globalization refers to the extent to which a company has expanded its revenue and asset base across countries and engages in cross border flows of capital goods and know-how across subsidiaries. By 2030 it is estimated that 80 per cent of the world's GDP will be produced and consumed in global markets. Between 1970 and 2003 foreign direct investments grew twice as fast as trade and the number of transnational corporations grew from 7,000 to over 50,000 (Boyett, 2001).

The overarching features of globalization could be briefly stated as below:

- Integration symbolized by the Internet and integration
- All countries are opening up, deregulating and privatizing their economies in order to make them more competitive and attractive to foreign investments
- Spread of free market capitalism
- Urban life styles intimately linked to food, entertainment and fashion trends
- Speed of commerce, travel, communication and innovation similar across markets.
- Intense competition from global players
- Moving towards global standards

Some of the specific global trends relating to technology provide us with an indication of the direction of change.

Global technology trends

Technology and finance are the two interwoven factors that work across the globe influencing the customers, suppliers, innovators, investors, consultants, designers as well as service providers. The major trends seem to indicate that technology will have an overarching influence over many economic segments. These have been highlighted by a reputed futurist, Joseph Coates (Coates, 2005).

- *Influence of technology:* Technology is becoming more systemic, that is, attentive to the total system it draws upon and relates to—from raw materials to final waste disposal. Customer acceptance occurs at the endpoint, hence technology creators need to have in-depth understanding of technology as well as the nature of customer interactions with a product or service.

- *Science and technology linkages:* The distinction between science and technology is blurring. Basic science is leading in many segments such as genetics, brain science, biology, materials and information technology.

- *Innovation:* Innovation is becoming more interdisciplinary and cross disciplinary. Most of the innovations are taking place at the interface or conjunction of two or more disciplines. Stem cell research and nanotechnology are some examples of these.

- *Global tech monitoring:* Globalization is encompassing all commercial, scientific and technological activities Companies have to monitor trends carefully and this process needs to be institutionalized.

- *Virtual activities:* Outsourcing is a big step towards demonstrating and developing the virtual corporation. There are unequivocal examples of the outsourcing of research, development, testing, evaluation, pilot activities, field research, components manufacturing, collaborative product manufacturing across many countries. Knowledge process outsourcing is also emerging as a global business opportunity. Legal and financial services are the first set of industries that are using knowledge process outsourcing.

- *Physical technologies:* Physical technologies are still dominating the innovation scene. Biological technologies are still way behind. New products are still in the domain of physical technologies. Biological technologies are moving faster.

- *Competition by substitution:* Competition by substitution is growing in all areas. The substitution ladder includes raw materials, parts, components, devices, subsystems, systems and macro societal systems.

- *Information technology diffusion:* Information technology continues to force changes on individuals, families, businesses, organizations, governments and international affairs, while improving efficiency and reliability and increasing the breadth and depth of knowledge. Information technology is enhancing efficiency in all aspects of the value chain.

- *Creativity is increasingly in demand:* "Creativity on tap" is the slogan of the day. New tools such as the Theory of Inventive Problem Solving (TRIZ) are helping problem solvers to have a structured approach to creative thinking. New product idea creation time is coming down. The Honda City is a car that came out of the use of TRIZ. Japanese firms have started using a structured approach to idea creation, idea screening and idea assessment. Forty inventive principles that could be used for creating ideas for new products are given in box 2.1.

- *Fusion of technologies:* There has been a systematic approach to the fusion of ideas. Everything is becoming 'smart'. Smart devices with magical capabilities are constantly coming up.

- *New technologies and risk:* New technologies are inherently risky. There has been a systematic attempt towards the sharing of risk. Venture capital is becoming a major instrument for risk reduction. The primary advantage of venture capital as practised across the globe is to force inventors to develop an outstanding business plan. Biotech ventures such as Genetech have their origins in venture capital.

Box 2.1 40 inventive principles: TRIZ

These 40 principles were put forward by Genrikh Altshuller based on a study of 200,000 inventive patents covering many fields. These principles could be used for problem solving in many disciplines.

Principle		*Meaning*
1.	Segmentation	Separating into smaller parts
2.	Extraction	Taking out or separating something
3.	Change local quality	Changing structure to non-uniform structure
4.	Asymmetric form	Leveraging asymmetry instead of uniform shapes
5.	Combination	Bringing together things which happen at the same time or in the same place
6.	Universality	Creating objects to perform multiple functions
7.	Nesting	Putting one thing inside another
8.	Counterweight	A deliberate change to balance out the situation by acting in the opposite direction
9.	Prior counteraction	Taking prior action to prevent undesirable situations
10.	Prior action	Taking some action beforehand to smooth and ease the event to occur
11.	Before hand cushioning	Creating conditions that prevent untoward events
12.	Equipotentiality	Minimizing movements involving high potential differences
13.	Other way round	Doing the opposite of what might seem normal
14.	Spheroidality	Considering curves in all of their various forms instead of flat surfaces
15.	Dynamicity	Creating systems which are able to cope with change and intrusions from outside it
16.	Partial action	Carrying out slightly less or slightly more action
17.	Using the other dimension	Moving dimensions by rotating the object, changing your viewpoint, or even changing the number of objects
18.	Using vibrations	Vibration is effectively a way of injecting energy into an object, which can break it away from other things or allow it to be moved easily
19.	Periodic action	Using pulsed energy bursts instead of continuous bursts
20.	Continuity of useful action	Improving efficiency by reducing the idle time of machine parts
21.	Skip	Doing things at high speed to reduce the time during which problems may occur

Box 2.1 ***(continued)***

22.	Turn harm into good	Looking at how waste can be not only recycled but also put to good use
23.	Feedback	Taking or sensing the output of a system and using this to change events which happen before
24.	Intermediary	Adding a new part or temporarily bringing in something to perform the actions that the system cannot perform.
25.	Self service	Making system self-reliant
26.	Use of copies	Rather than use the expensive, delicate or inaccessible original, use a simple copy
27.	Cheap short life options	Replacing expensive or problematic parts with something cheaper that works for the moment
28.	Mechanical replacements	Replacing physical mechanical systems with invisible effects such as magnetic and electric fields
29.	Pneumatic and hydraulic	Replacing solids with liquid or gaseous structures
30.	Flexible shells	Using thin films to separate, isolate and protect the system
31.	Porous materials	Using porous materials for separating and filtering out desired or undesirable elements
32.	Changing colour	Changing colour as an indicator
33.	Homogeneity	Making interacting objects of similar materials
34.	Rejection and regeneration of parts	Regenerating parts when needed
35.	Change parameters	Changing the physical or chemical state of a system
36.	Phase transitions	Changing the phase of use
37.	Thermal expansion	Leveraging the thermal expansion properties of substances
38.	Strong oxidizers	Using strong oxidizing materials
39.	Inert atmosphere	Providing an inert atmosphere for the process
40.	Composites	Using composite materials

Source: Y. Salamatov, *"TRIZ: The right solution at the right time"*, Insytec, Hattem, 1999

These principles are given at the website: www.triz40.com.

Altshuller had proposed that his principles should not be restricted in their use and this website is free for anyone to use.

These 11 trends are changing the competitive landscape in an evolutionary manner along with brand dominance and active market development efforts in all the major segments of the economy. Industrial trends cannot be predicted precisely as they are mostly evolutionary. They evolve through interactions of many trends. The visibility

of trends is rather low and haziness will continue to dog executives. Managers cannot predict risk but they have to generate options so that risks can be managed as and when they emerge. In view of these, countries are preparing an agenda of action on critical technologies.

Critical technologies

The United States has developed a list of critical technologies that are essential to maintain technological supremacy in commerce and defence. These are needed for many products and critical systems. The list as it existed in 2005 is given in box 2.2.

Box 2.2 Critical technologies: selected list

1. Materials	Ceramic materials
	Composites
	Electronic materials
	Photonic materials
	High energy density materials
	Super conductors
	Polymers
2. Transportation	Aerodynamics
	Avionics
	Propulsion
	Systems integration
	Human interface
3. Medical technologies	Biocompatible materials
	Functional diagnostic imaging
	Bacterial and viral detection
4. Manufacturing	Discreet product manufacturing
	Continuous materials processing
	Nanofabrication and machining
5. Computing systems	Information management
	Intelligent computer-aided systems
	Intelligent sensors
	Software kits
6. Biotechnology	Bio-processing
	Monoclonal antibodies
	Protein engineering
	Recombinant DNA
	Vaccines
	Combinatorial chemistry

Box 2.2 *(continued)*

7.	Energy	Energy efficiency Transmission Generation
8.	*Environmental quality*	*Monitoring and assessment* Pollution control Remediation
9.	Information communication	Components *Communications*

Investments for technological innovation

Global firms have been investing in research and development activities to maintain their competitive edge. Over the years these firms have built up capabilities for creating and launching new products and services. The ten firms that are in the top R&D spending list are presented in box 2.3. One could see that these firms are trying to maintain their lead by building new capabilities so that their technological lead is not lost.

Box 2.3 R&D expenditure of major global firms in 2004

Company	*R&D expenditure* (millions of US dollars)	*R&D expenditure* (as a percentage of sales)
Matsushita	6 282	7.74
Siemens	5 493	6.74
Daimler Chrysler	7 660	3.98
Ford	7 400	4.31
General Motors	6 500	3.36
Toyota	6 455	3.94
Pfizer	7 684	14.63
Glaxo SmithKlime	5 439	13.94
Sanofi	5 215	15.58
Johnson & Johnson	5 203	10.99
Microsoft	7 779	21.12
Sony	4 947	6.86
IBM	5 673	5.89
Intel	4 778	13.97
Volkswagen	4 517	4.68

Source: B. Bowonder, J. K. Racherla, N. V. Mastakar and S. Krishnan, R&D Spending patterns of global firms, Research Technology Management, vol. 48, Issue No. 5, pp. 51-59, 2005.

Many global firms are focusing on the creation of intellectual property assets. Since intellectual property rights are needed for dominating the market place, especially in information technology, chemicals, electronics, pharmaceuticals as well as biotechnology. There is a major thrust towards intellectual property creation by companies such as IBM and Canon. Box 2.4 clearly shows that these firms are able to identify patentable innovations through careful screening of opportunities. They are able to maintain the lead by "selecting the winners" or technologies that could provide them with a clear lead in the market place. Companies such as Canon were not the pioneers in inventing photocopying technology, but by working on a number of ideas they were able to capture their market share. This brings out the point that technological innovation alone will not guarantee competitiveness. Along with new technology, a firm has to clearly identify how it should deploy strategy to remain competitive over others.

Box 2.4 Top US patent recipients: 2005

Company	*Number of patents granted in 2005*
IBM	2941
Canon	1828
Hewlett Packard	1797
Matsushita	1688
Samsung	1641
Micron Technology	1561
Intel	1549
Hitachi	1271
Toshiba	1258
Fujitsu	1154

Source: www.uspto.gov

Technology and global trade

It has been shown that high technology exports are one of the dynamically growing categories in world trade. Many developed countries have been able to balance their trade by focusing on high technology products for global trade. Countries and areas such as Hong Kong SAR, Malaysia, Singapore and Taiwan Province have been able to accumulate surplus foreign reserves using technology exports. Most firms that are exporting high technology are also have high levels of foreign exchange reserves. The nexus between competitiveness and technological capability has been increasingly tight. As economies integrate with the global economy, technology needs to be managed more efficiently. Cost, quality of the service or the product, reliability, the service network, as well as global supply logistics need to be managed from a global perspective.

Major initiatives

Some of the emerging market economies such as Argentina, Brazil, China, India, Russian Federation and Thailand have very well defined initiatives for building technological capability that will help them to enhance their ability to compete in the world market apart from producing for the national market. In the United States most of the initiatives are at the firm level. The two major national initiatives are:

- Nanotechnology
- High speed Internet.

Most developed countries are making large investments in nanotechnology. This means that it is one of the emerging areas. Already a variety of new products based on nanotechnology are on the market. Some of the major products that have appeared are:

- Self-cleaning windows with dust repelling properties
- Cool and spill resistant textile fabrics
- Scratch resistant paints for automobiles
- Hard skiing surfaces with nano paints
- Nano paints
- Nano coatings with distinctive properties.

Advanced sensors are another segment that will grow in this decade. Automotive sensors, chemical sensors, fragrance sensors, aroma sensors, motion sensors, temperature sensors and bio sensors, are some of the major examples. With increased emphasis on pollution control and safety, automobiles will see the introduction of a variety of advanced sensors. The major changes are the emergence of integrated sensor systems. Radio Frequency Identification (RFID) chips are helping firms to track the movement of goods in the factory as well as outside. The Airbus 380 aircraft has 10,000 RFID chips for making many parts smart. A 380 will have passive RFID chips on removable parts such as seats, life jackets and brakes. The goal is to make maintenance easier and to reduce the time required to make aircraft inspection reports early. They are using RFID for routine checks before a flight. Airbus started using RFID on its A-400M military transport aircraft.

Most firms start with a new technology in a limited sense and slowly extend its usage. Airbus tried RFID in one or two systems and then extended the application to new areas. Pilot project, testing and validation and then extended the application to new areas.

Food processing

This is an area of opportunity for developing countries. Food processing is becoming technology intensive. Raw material preparation, processing, new preservation technologies,

new packaging technologies, etc., are areas in which advanced technologies are getting embedded. With more organic foods, ready to eat foods and long storage foods.

Box 2.5 RFID in retail business: Pantaloon

Pantaloon is a retail chain in India that used RFID. They observed that RFID could reduce logistic cycle time. Pantaloon is one of the major retail chains in India. They are in the retail textile and garment business. They used RFID chips in a retail warehouse for branded garments. Both the identification and tracking became very easy. The saving they achieved was of the order of 20 per cent of the cost. Since they found it very useful for tracking products they are extending it to other major warehouses

Box 2.6 HACCP Process

Hazard Analysis and Critical Control Point (HACCP) is a food safety programme adopted by the FDA of the United States that has now become a major requirement. Exporters of meat, poultry, fruits, dairy products, juices, fresh products, etc. have to get acquainted with HACCP if they wish to be a major player in the global food market. It was originally a food safety programme developed 30 years ago for astronauts and it is being applied to all industries dealing with food. HACCP has been endorsed by many scientific agencies. Traditionally food industry regulators have depended on spot checks of manufacturing conditions and random sampling of final products to ensure food safety through a process driven system.

HACCP principles:

1. Analyze potential hazards associated with a food and measure to control those hazards. The hazards could be biological (such as a pathogen) or physical (such as a piece of glass).
2. Identify critical control points: start from raw state to final consumption.
3. Establish preventive measures with critical limits for each control point.
4. Establish procedures to monitor the critical control points.
5. Establish corrective actions to be taken when monitoring shows that a critical limit has not been met.
6. Establish procedures to verify that the system is working properly.
7. Maintain effective records to document the proper operation of the HACCP system.

Source: FDA website.

Construction technologies

With the rapid urbanization of the population, the demand for constructed spaces is increasing. Critical new technological capabilities are emerging from the management of large engineering construction projects. Large highway projects, large retail spaces,

long suspension bridges, airports and ports are becoming complex structures built in a short time frame without any slippage or construction faults. Software technologies are helping the visualization of structures and managing the critical steps in the projects. Offshore drilling platforms, mining projects and refinery construction are areas in which hazard analysis skills are also critical. Hazards and operability studies, hazard analysis and failure analysis are the key competences needed for complex constructions. Technology management in this context is the ability to integrate very complex systems and execute them without any interface problems. These are four typical areas selected to identify that each domain of technology requires a distinct set of competences for managing it. It is necessary that firms identify the competences needed and continuously renew them to ward off the obsolescence of competences.

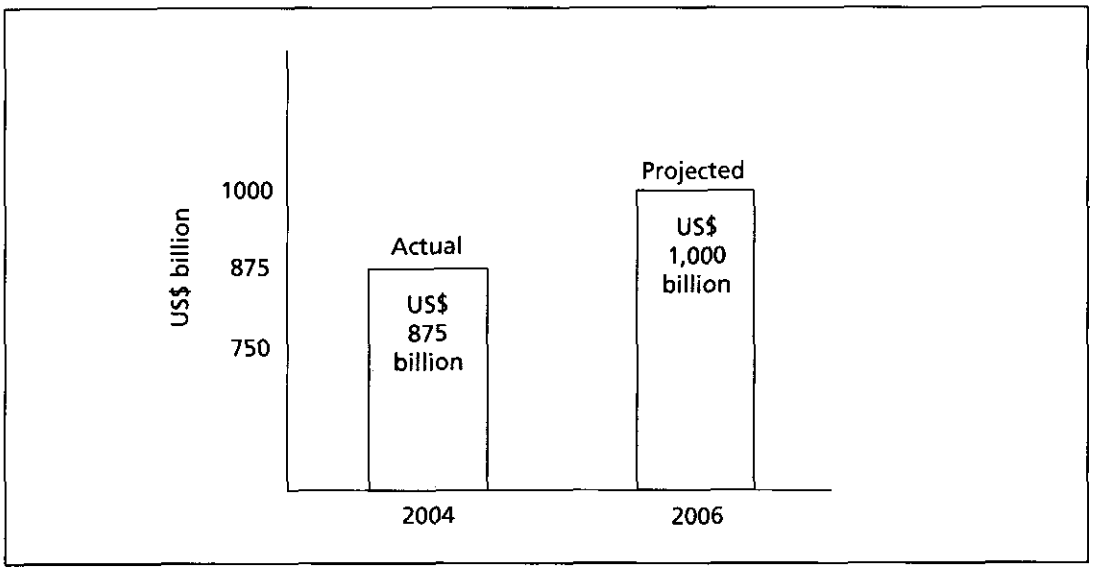
The speed of technological change has gone up because of the simultaneous action of innovation and competition. Firms operating in developing countries have to evolve systems for monitoring technological change that could affect them in the form of incremental competition or disruptive competition. The UNIDO manual on technology monitoring has explained these in detail.

Box 2.7 Innovation is becoming intensive

"Innovate or evaporate" is the dictum of the twenty-first century. Innovation is becoming intensive across the globe. It is projected that global expenditure on innovation will reach a figure of US$ 1,000 billion in 2006. It is also projected that innovation expenditure by the Asian economies will overtake US expenditure on innovation in 2006. The projected R&D expenditure by the United States in 2006 will be about US$ 375 billion compared to a figure of US$ 450 billion for Asian economies such as China, India, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore and Thailand,. Since manpower costs are lower in Asia more people will be innovating in the Asian region than in the United States or Europe. Europe jointly will be spending around US$ 240 billion in 2006. The total global R&D expenditure was around US$ 875 billion in 2004. Expenditure on innovation is likely to increase sharply and this will increase competition. Also innovation is becoming more collaborative and global. IT convergence is also catalyzing innovation initiatives. Shared networks are reducing the cycle time of product development. Innovation is being increasingly outsourced to developing countries. Firms will have to enhance their capability to innovate if they are to remain competitive. Technology and innovation will continue to drive industrial competitiveness. The new context will demand world class innovation and product development capabilities. The rule of law in the new context is the "survival of the fittest."

Source: TMT Trends: 2006, Deloitte, Jerusalem, 2006

Figure 2.1 Global expenditure on innovation



Box 2.8 Even small start-ups go global

The power of innovation is becoming evident across the world. Innovation is becoming a major driving force behind globalization, be it in global firms or small start-ups. An innovative start-up, Nano-Tex, has licensed its technology to companies across the world. This technology helps to make cotton fabrics comfortable and stain resistant.

The San Jose Mercury News reported on the top ten tech trends for 2006. One of the trends states that even small start-ups are going global by leveraging the power of innovation. Firstly, global markets are receptive to innovative products/services. Asian markets are growing at a rapid pace compared to US and European markets. Secondly, the cost of innovation is lower in start-ups and there is a boom in the growth of start-ups. Thirdly, the Silicon Valley model of nurturing start-ups is occurring at many locations. Clusters are supporting networked growth. Fourthly, larger firms are sourcing innovation from start-ups. For example, Intel has acquired or invested in innovative start-ups across the globe. These trends indicate that innovation could be leveraged across many markets and there is a huge global opportunity for the commercial use of innovative technologies.

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2. San Jose Mercury News. Top ten tech trends for 2006, December 25, 2005

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Chapter 3 Technology strategy

The purpose of strategy

Customer excitement

Competitor dominance

Portfolio enhancement

Ten sources of opportunity

Unexpected success

Unexpected failures

Unexpected external events

Process weaknesses

Market structure changes

High growth areas

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Technology strategy: caselets

TECHNOLOGY STRATEGY

The usage of strategy came from defence. Strategy in war is defined as manoeuvring forces into the most advantageous position prior to actual engagement with the enemy. Using good strategy is how you survive in a world of killer competition. What has changed in business over recent decades is the amazing proliferation of product choices in just about every category.

> "In a tough world, using strategy is how you survive."

In our over-communicated society the human mind is a totally inadequate container (Trout, 2004). Strategy has been the tool that helps us to focus on an option. Strategy is either offensive or defensive. In offensive strategy we attack and move forward and in defensive strategy we remain in the same position and do not allow the competition to move forward.

The purpose of strategy

Strategy in technological parlance is about creating new choices for business so that we remain ahead of the competition. Strategy-making starts with three questions about the business:

1. What could we do differently?

Can we do things differently so that we reduce cost, reduce cycle time, improve the process, reduce wastage, reduce work in progress, etc. The B-777 is the first passenger aircraft to use "digital product definition" to reduce cycle time and to eliminate the need for making physical mock-ups. Digital product definition allows design and validation to be done in a single step.

A brewery in India developed a new process so that it could use a continuous process for fermentation using submerged solid substrate. This firm has become one of the largest biotech firms in India. Using the continuous fermentation process, it entered into the production of "statins", a pharmaceutical product. The strategy was to transform a batch process into a continuous manufacturing process. This process was patented and used for making many other products. The company started as a small venture and through an initial public offering (IPO) it became a large pharmaceutical company. The technology strategy was to do something differently.

2. What new business opportunities should we exploit?

Using the technological capabilities a firm has at its disposal, the possibility of opting for new business opportunities is the second source of strategic opportunity. The choices a firm has could be mapped into four segments:

- Enhance the existing product share in the existing market
- Enter a new market using the existing product line or service business line
- Introduce a new product into an existing market
- Introduce a new product into a new market

Figure 3.1 Market – Product matrix

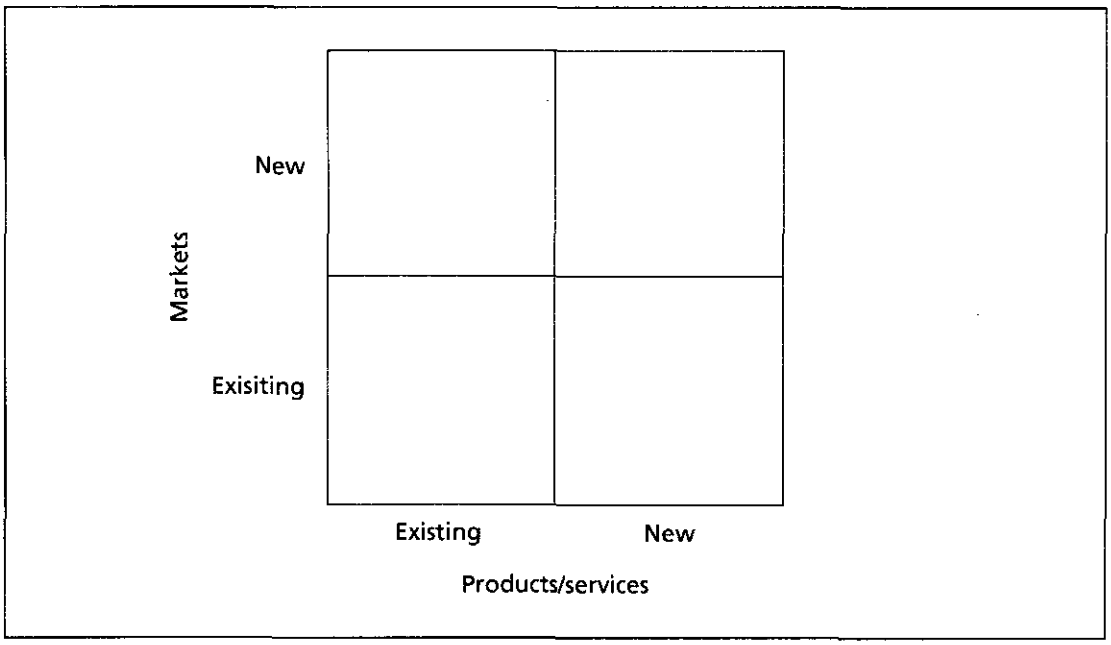
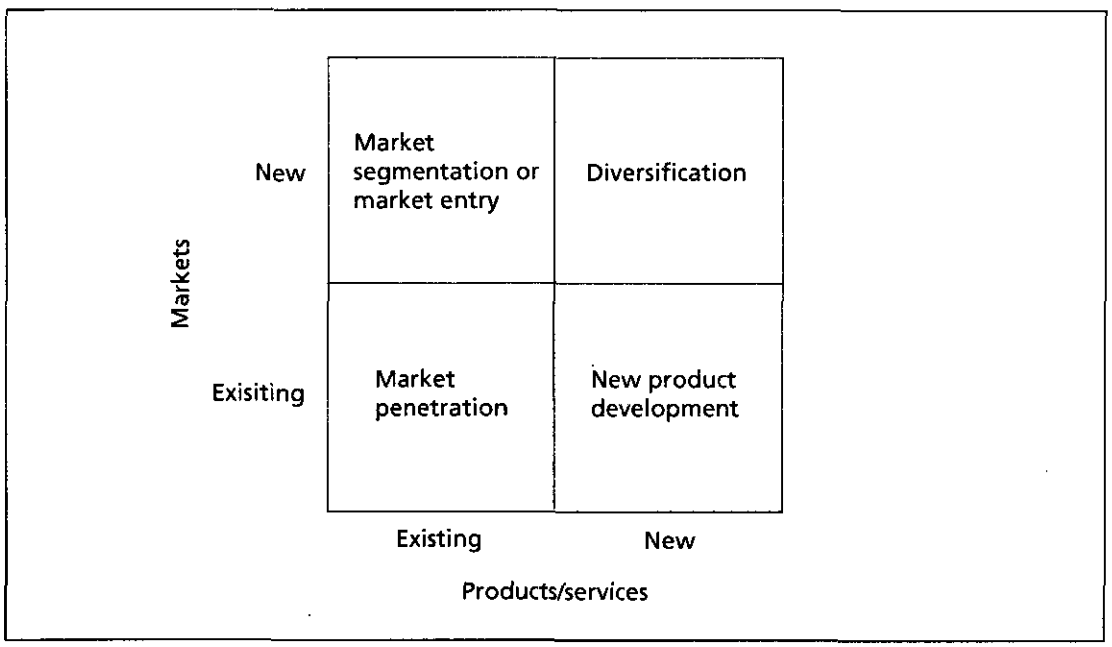


Figure 3.2 Market – Product matrix



Technology strategy is examining how technology could be deployed or leveraged for these four objectives.

3. What should we do?

This is not an extension of the present. Looking into something that does not exist today and creating something new is the essence of this strategic option. Nokia's entry into mobile telephones is an example of this strategy. Discontinuous or radical innovations come under this segment. Siemens uses a tool called "Picture of the Future" to envision something new it ought to be doing. Developing a vaccine for AIDS comes under this category.

Any firm has to continuously develop strategy so that it remains ahead of the competition. Any technology strategy should help a firm in three different ways. Strategy has to be assessed in terms of its potential business impact, and they are:

- Customer excitement
- Competitor dominance
- Portfolio enrichment

Customer excitement

A strategy has to help a firm to serve the customer in a better manner. It could be through new product features, performance improvement, cost reduction or improved service delivery time. In a competitive context any strategy that is pursued should be perceived by the customer as an improvement. For example, Canon introduced shake-free camcorders that became a market hit.

Similarly, Tetrapak introduced a technology for storing beverages/juices/milk without refrigeration for long duration. This has revolutionized the beverages market. Customers have benefited from this innovation considerably. This is used in many developing countries.

Competitor dominance

The second major business impact of technology strategy is competitor dominance. The logic of this approach is to ensure that, by using a new technology, a firm is able to dominate the market.

If business is war, the way to survive and prosper is to be better than your competitors at one thing (Trout, 2004). General Electric focused its business on medical imaging, and aircraft engines. Whether you are big or small, your chosen strategy should revolve around what is often called your "core competency" (Trout, 2004).

Asian Paints is a paint manufacturing firm in India. It developed a colour mixing technology using a computerized algorithm to reduce the number of colour mixes a paint dealer has to store. By mixing some basic colours, any shade could be easily generated

at the dealers' end. Using this technology Asian Paint dominated the Indian paint market and has entered many markets in Asia, Middle East and Africa. Leveraging technology to be ahead of the competition is the essence of this strategy.

Portfolio enhancement

Technology strategy can help a company to enhance its product range. The best example of this is Canon. Canon was a camera company that subsequently entered the camcorder and copier markets. It broadened its product range over the years to expand its business portfolio. Using the core knowledge that the company had, it created many new products and expanded its product portfolio.

In the subsequent sections, details of the strategic options a firm could use are highlighted.

Ten sources of opportunity

Opportunities exist outside the firm. Good innovators know where to look for new products or markets. There are ten specific areas of business that they have to constantly monitor for signals that could be converted into new opportunities.

Unexpected success

The unexpected success of certain businesses could be an indicator of emerging opportunities. For example, the success of Xerox made Canon get into copier market.

Unexpected failures

Failures are disliked, so people tend to defend the failure rather than try to find out what caused it to happen and how to turn it into an opportunity.

Unexpected external events

The events of 9/11 in the United States made people look for personal identification technologies. Biometric technologies evolved as a technology opportunity for personal identification. "Digital nose" technology emerged as a response to this.

Process weaknesses

Long product development cycles made people look for alternative processes. Concurrent engineering as a product creation process came out of this process weakness. Originally it took car makers 84 months to create a new generation of automobiles. Honda and Toyota reduced this to 42 months. Now Toyota has been able to reduce it to 15 months from idea to roll out of production. Innova is a Toyota vehicle that came out in a record time of 15 months.

Market structure changes

When the rules of the game are suddenly changed in an industry, changes will usually bring on turmoil, meaning threats for some but opportunity for others. For example, when the structure of the human gene was mapped, many companies jumped into the arena to exploit the opportunity. Similarly, when drug prices started going up, formulations based on traditional medicines started emerging. Chinese drug firms brought out a large number of traditional medicines based on herbal drug know-how.

High growth areas

Firms have to grow continuously and this requires identification of high growth opportunities. This is done by monitoring sectoral industry growth. For example, food processing and entertainment are currently the high growth areas across the globe. Firms could segment these and then analyze the opportunities.

Converging technologies

When two or more technology areas begin to merge or converge, the convergence is bound to produce some turmoil as well as opportunities for entry. Gene mapping of plants along with the fusing of protoplasm is emerging as a new opportunity for producing chemicals using trees or shrubs. The current trend for biodiesel is an opportunity area.

The convergence of entertainment, commerce, telecommunication and computing is helping firms to reach the customer directly. A number of products are being prepared for getting into this segment. For example, the Indian ICICI Bank Ltd. introduced a system for purchasing products through the mobile phone by working with the credit card company, Visa. It improves security, the authentication process as well as the reach of the credit card by using the mobile phone's "sms" technology.

Demographic changes

The demographics of an organization's customers are not static, and are distinctly different in different countries. The emergence of a rapidly growing middle income class is an opportunity in Argentina, Brazil, China, India, Malaysia, the Russia Federation, Slovenia as well as Thailand. Demographic changes need to be monitored and then opportunities need to be assessed. They need to ask a number of questions:

- What demographic changes are happening?
- What will be the trends in income, age groups, education and mix?
- What are the emerging product or service opportunities?

Services for higher age levels are emerging as an opportunity in Japan, Europe and the United States.

Perception changes

If you could anticipate the changes of perception that your customers have towards your products or product series, you are bound to find a new opportunity. For example, the recent hike in petroleum prices is making customers look for energy efficient products. Philips is trying to produce LED based lighting that will consume very little power. They have introduced a prototype in Nepal.

New knowledge

New knowledge means inventions, discoveries, patents, licences, designs, etc. These could be a source of opportunity. Knowledge of nanotechnology is helping people to churn out a new set of products with magical properties. For example, an SME in India produced a thin particulate board with nanoparticles that served as an excellent "sound proof" board and could be used as a room divider. It absorbs the sound that falls on the board.

Elements of technology strategy

After examining the potential opportunities, the firm could think about the technology strategy the firm could use for realizing the market opportunity. The five elements of technology strategy are:

- Product strategy
- Manufacturing strategy
- Outsourcing strategy
- Alliance strategy
- IT strategy

Product/service strategy

As a result of the search step, a firm could get a number of ideas that could be pursued. A systematic process for doing this is enumerated below. Robert (1995) has identified four areas that could help a firm in screening and sharpening a product. The first essential screening criteria that needs to be considered is cost. The variables that one has to consider are:

- Materials
- Equipment
- Research
- Marketing
- Legal
- Promotion
- Time frame

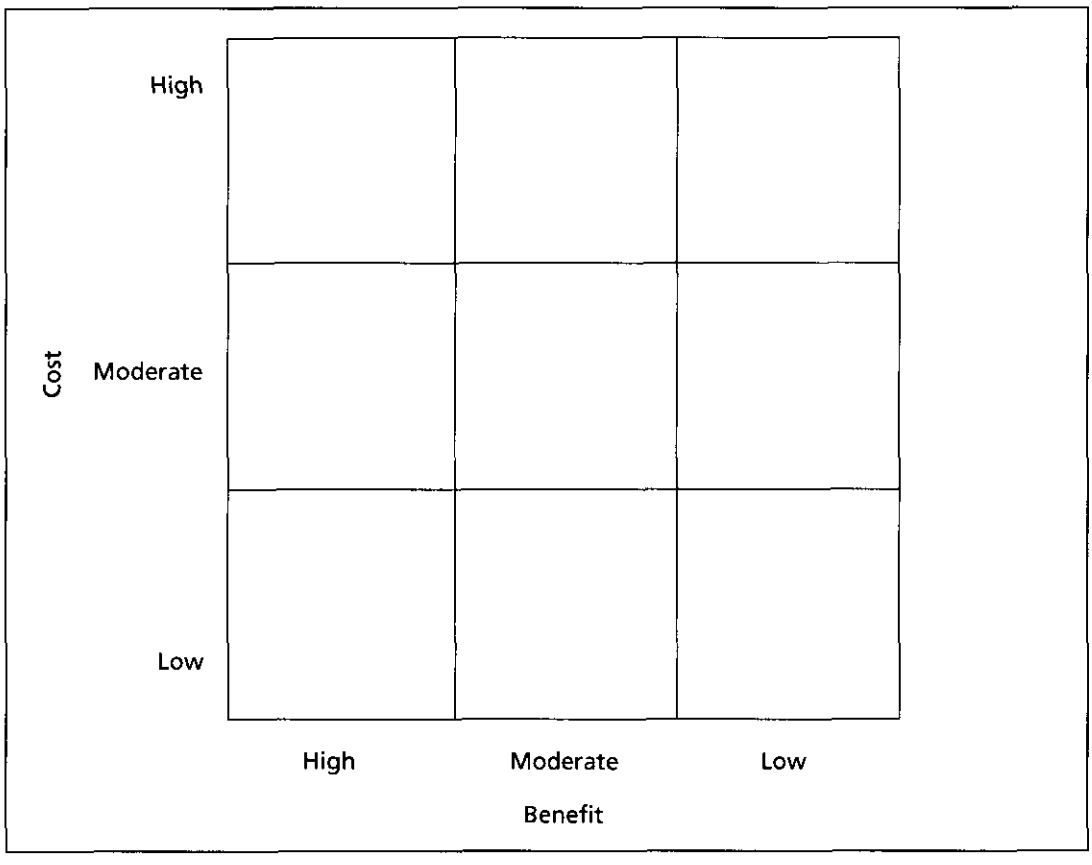
- Testing/validation
- Contingency

The opportunities are not assessed in quantitative terms but in relative terms. The second screening criteria is the potential benefit. The parameters that could be used are:

- Market share
- Return/profit
- Prestige/image
- Service/satisfaction
- Earnings/dividends
- Fallout/residuals
- Safety/security
- Quality
- Morale/motivation
- Growth/size

The opportunities are assessed by placing them in the cost-benefit assessment grid.

Figure 3.3 Cost Benefit matrix



Opportunities in the right lower end of the matrix are the ones a firm could pursue. The ones on the upper left are costly options with lower benefits, as shown in figure 3.3

The third screening criteria that could be used is the implementation difficulty. The parameters that are used for assessing this are:

- Organization structure
- Processes and or systems
- Skills and/or talents
- Manufacturing methods
- Selling and/or marketing methods
- Distribution/or delivery methods
- Technologies
- Capital and financing
- Legal and regulatory issues
- Compensation systems
- Raw materials
- Customer services
- Corporate culture

The fourth screening criteria is the strategic fit of the proposed idea and the strategic benefit of the proposed action. The parameters that determine the fit are:

- Compatibility with existing product/service base
- Customer base
- Market served
- Technology/know-how
- Production capacity/capability
- Method of sales/marketing
- Distribution method or system
- Natural resources
- Size/growth
- Return/profit

Figure 3.4 Implementation – Strategic fit matrix

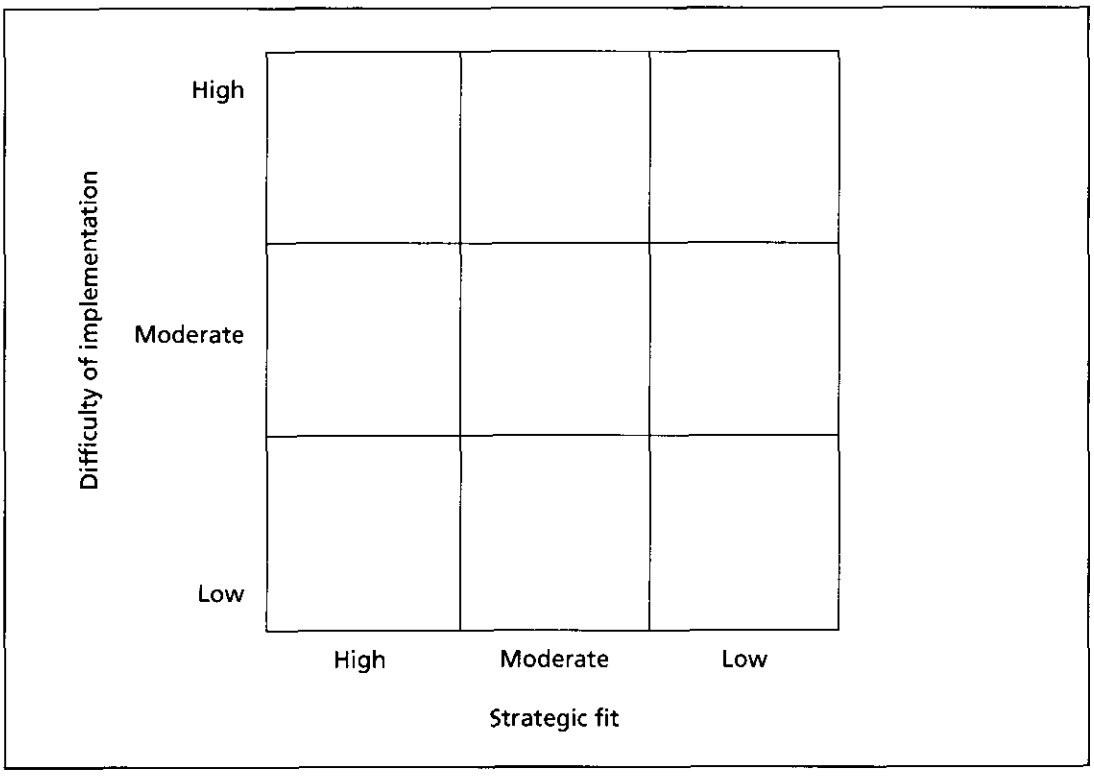
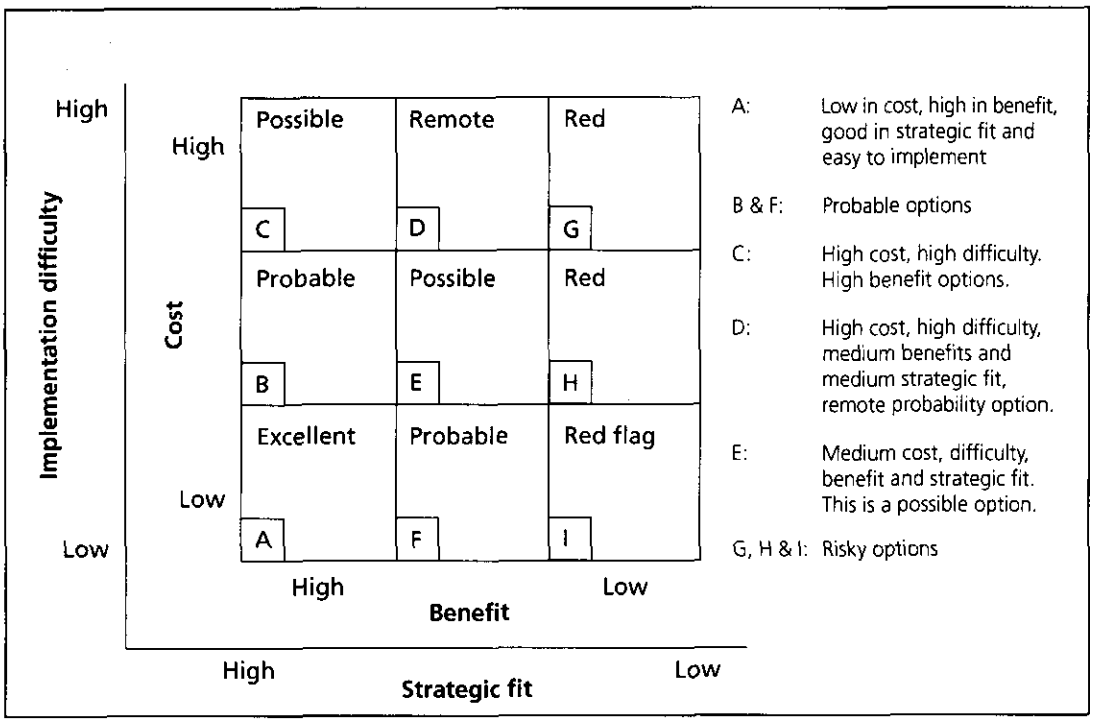


Figure 3.5 Opportunity identification matrix



Then the firm could select the appropriate manufacturing strategy that optimizes the return on assets.

Manufacturing strategy

Over the past decade, businesses have worked hard to reduce the "capacity fat" and "inventory fat" in their supply chains (SAP, 2005). The essence of competitive strategy is to integrate the manufacturing and the supply chain, such that the cost of producing, logistics and inventory is minimized in a combined manner.

> Supply chains are the arteries that carry and distribute blood to the enterprise; the factory is the heart that pumps the blood. Good free flowing arteries are vital to business efficiency but only when they are supported by a manufacturing process that responds as needed to changing conditions. And manufacturing—the heart of the supply chain—has not yet been effectively incorporated into the streamlining process. As supply chains continue to become leaner and the level of fat (inventory, capacity, labour) continues to drain, companies whose manufacturing cannot respond quickly to variable demands become increasingly vulnerable.

To be successful in today's increasingly time sensitive and competitive markets, business needs manufacturing processes that are fast, flexible and adapt quickly to change. Manufacturing strategy has the objective of integrating in order to optimize the cost with minimum disruption risk. This requires connecting supply chains to factory processes, production equipment, factory systems and logistics in a seamless customer-centred network. Any global supplier has to have this competence if it is to become a competitive and reliable supplier in a globalizing economy.

The challenges in manufacturing that a firm faces in a global economy are essentially multi-fold and some of the major ones are:

- *Fragmented manufacturing facilities*—Globally distributed manufacturing locations are increasing exponentially.
- *Mass customization*—The rapidly increasing demand for product variety across various countries presents challenges in areas such as manufacturing capacity and resource planning.
- *Shrinking life cycles*—Product life cycles are rapidly shortening and there is enormous demand on time and resources in areas such as manufacturing cycle time, productivity and inventory management.
- *Response velocity*—Customer empowerment and customer choice is driving managers to enhance flexibility which in turn leads to higher manufacturing capacity costs and labour deployment challenges.
- *Zero defect quality*—Product quality requirements are becoming increasingly stringent thereby causing manufacturers to focus on "zero defect" production capabilities.

Purely traditional manufacturing practices, which were based on the push and made to stock philosophy with little visibility to true demand, will not succeed in the current

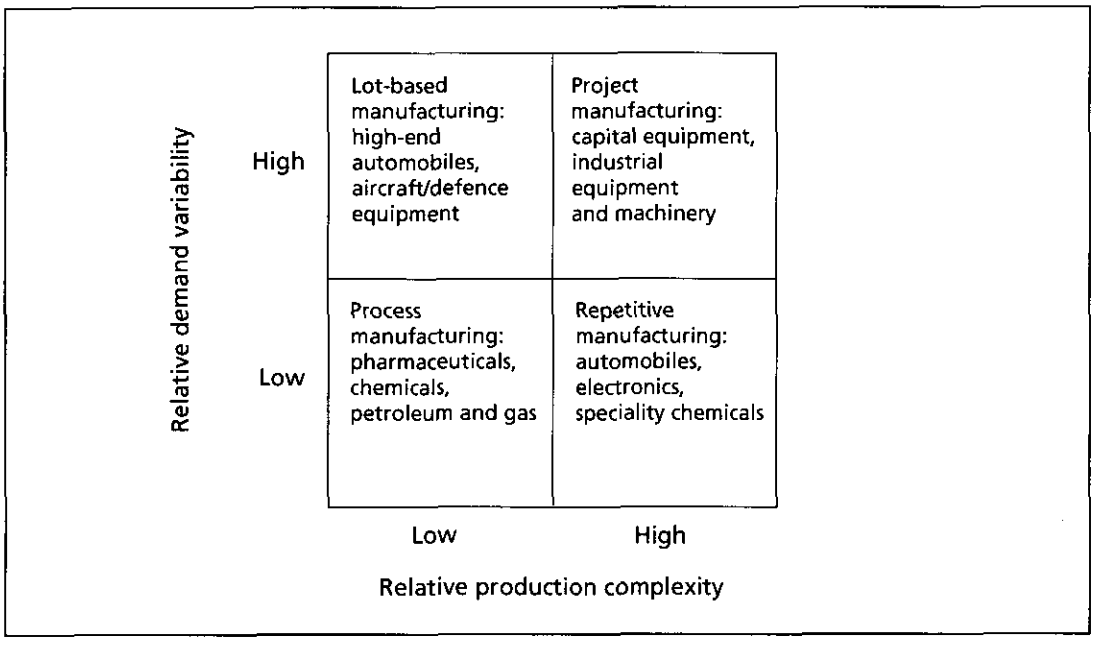
business environment. In a highly competitive context, manufacturing strategy will be determined by two major variables:

- Relative production complexity
- Relative demand variability

The interaction of these driving variables generates four choices.

Manufacturing strategy is essentially balancing complexity and variability so that supply is done at a minimum cost.

Figure 3.6 Manufacturing strategic options



The manufacturing strategy for each component differs considerably. They are schematically represented as manufacturing strategy options as shown in figure 3.6:

- *Made to stock*—When variability and complexity are low the strategy used is made to stock. Since the demand pattern does not vary significantly and complexity is low, stock is made and kept to match demand. Pharmaceutical chemicals come under this category.
- *Assemble to order*—When variability is low but production complexity is high, a firm has to use an assemble-to-order or a made-to-order strategy.
- *Made to order*—When variability is high and complexity is low, lot-based manufacturing is selected as the manufacturing option. Made to order is the preferred strategy.
- *Engineer to order*—Industrial equipment such as chemical process reactors and CNC machines that are for a specific industry would use the engineer-to-order strategy.

Manufacturing strategy has the objective of maximizing the return on assets. Return on assets is a function of profit margin and how quickly assets are used. Assets are fixed and variable assets. High returns on assets require a six action agenda, namely:

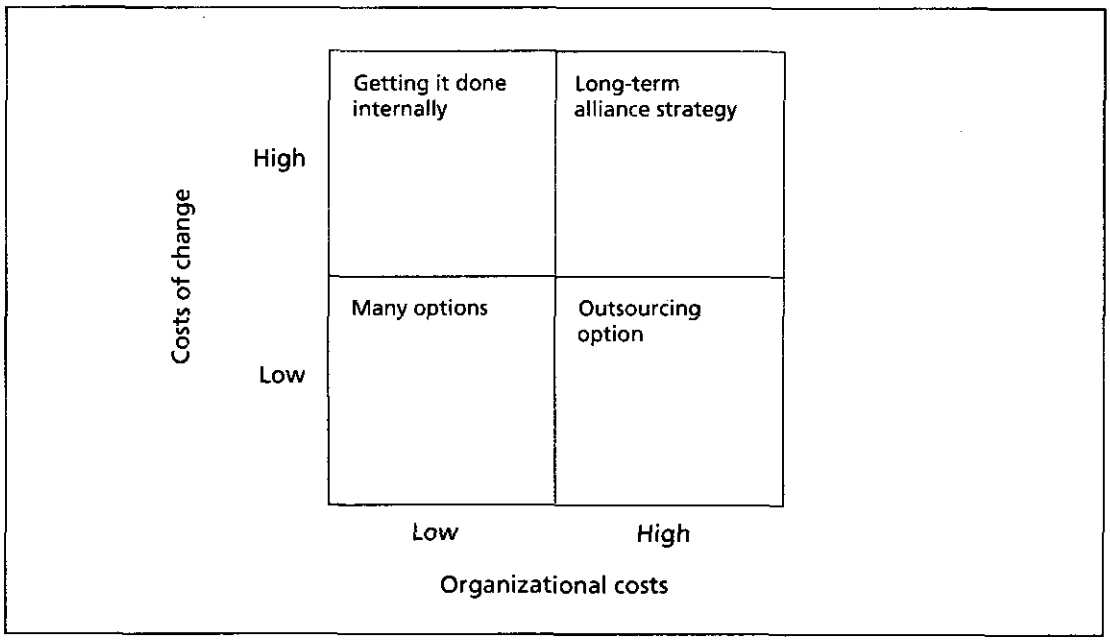
- Improved throughput from the factory
- Faster time to market with just-in-time inventory
- Higher service levels
- Reduced production set-up costs
- Higher machine utilization
- Lower capital usage per product

With the emergence of Enterprise Resource Planning Software platforms such as SAP-ERP, it has become relatively easy to implement a cost-effective manufacturing strategy.

Outsourcing strategy

With the cost of communications coming down and the emergence of the Internet, a variety of options are emerging for getting work done at different locations using IT platforms. This option enhances competitiveness as work can be done at the most competitive location. Outsourcing covers a large part of the business activities done by a firm. Design, engineering, manufacturing, supply chain coordination, as well as customer support can be outsourced to other firms in competitive locations with competitive cost structures.

Figure 3.7 When to go for outsourcing?



The criteria guiding outsourcing are two-fold:

- *Internal costs*—Costs incurred by the firm: organizational costs such as direct expenses covering communication costs, people costs, material costs and conversion costs.
- *Change costs*—Costs incurred by the firm if the work at the outsource location gets disrupted such as monitoring costs, disruption costs, renegotiation costs and legal expenses. These are the opportunity costs or transaction costs.

Generally four situations are encountered as shown in figure 3.7.

The four strategic options a firm could exercise for any technological activities are examined below:

- *Low organizational costs and low change costs*—A firm could undertake a technological activity in many ways. Non-core activities of a firm which a number of other firms could undertake will come under this quadrant.
- *High organizational cost and low change cost*—Many firms undertake such an activity but the cost of doing this internally will be high. IT services are an example of this activity. Many corporations outsource their IT activities. The Ford's entire IT is outsourced to Oracle and managed by them worldwide. This gives Ford opportunity to focus on its core business. The cell phone company Bharati Tel operating in India outsourced its entire network management activities to IBM, thereby allowing the company to focus on its core telecom business.
- *Low organizational costs and high change cost*—Critical core technological activities of a firm will fall under this category. Canon outsources everything except the proprietary IC chips.
- *High change cost and high organizational cost*—This is the most difficult option to manage. Both options entail a high cost. In such cases the activity could be carried out through an alliance or joint venture. Alliances reduce the risk and the transaction costs. Automobile manufacturers generally get their components manufactured through joint ventures. China uses joint ventures for the production of automobile components through joint ventures.

More and more technological activities will be outsourced to locations that are competitive. In outsourcing, reliability of delivery, cost, security, risk management systems, speed of response and process certification are the critical parameters that are needed for maintaining the competitive edge.

Alliance strategy

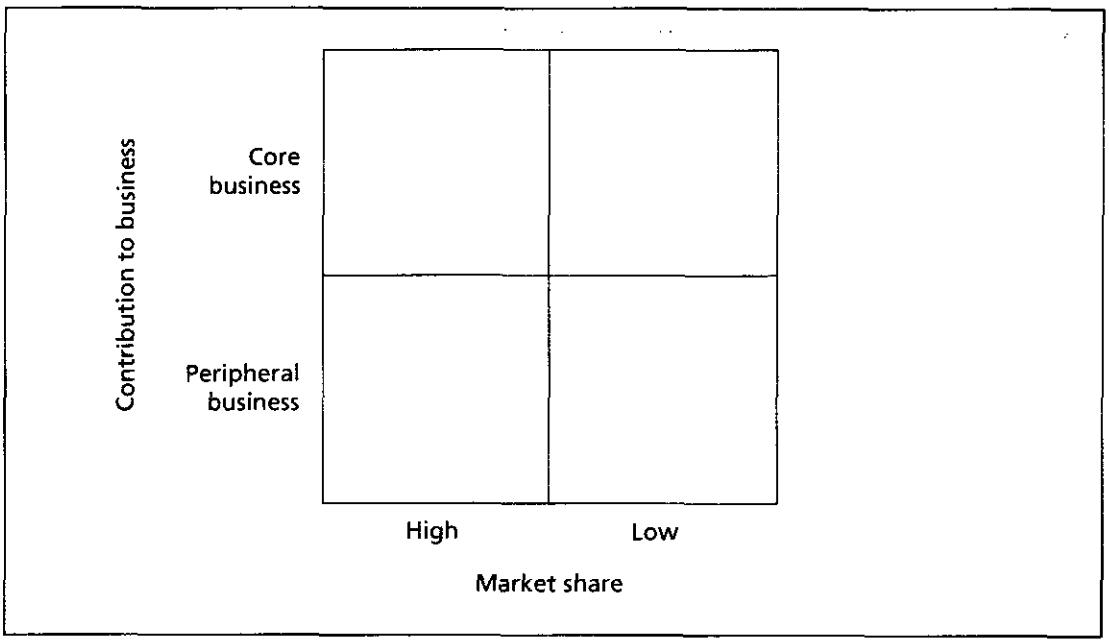
As competition increases, collaborative work among firms is also increasing. In high technology, alliance strategy is one of the most promising options for enhancing competitive advantage. The logic of alliance strategy is to create a win-win situation among two or more players by pooling resources and sharing risks. An alliance strategy helps in minimizing resource commitments. For example, a company from an emerging

market such as China could use a partner to market products in other parts of the globe. Johnson Controls is a company based in the United States that makes automobile seats. It is a firm that supplies seats to global car manufacturers across the world. When Fiat wanted to enter the Indian market it was looking for a high technology supplier. Johnson Controls came to India through an Indian company alliance. This firm is known as Tata Johnson Controls. Tata Johnson Controls supplies automobile seats to many car manufacturers operating in India, namely Ford, Fiat and Tata Motors. Alliances help firms to bring in synergies, leverage complementary capabilities, explore new markets and reduce risk.

Alliances can be leveraged for many activities in the business arena. The possible alliances that could be deployed are schematically given in figure 3.8 indicating that opportunities for alliances are enormous.

The alliance strategy could be leveraged to achieve a variety of business objectives. The strategy will depend on the market share in a given business and whether it is a core business activity or a peripheral activity. Below are four distinct strategic objectives that an alliance strategy could achieve for a firm:

Figure 3.8 Alliance strategy options



- *Core business and high market share*—In this quadrant, since the firm in question is the market leader, the strategy for an alliance will be to maintain its share of the market.
- *Core business and low market share*—In this quadrant, the purpose or objective of an alliance will be to enable to firm to enhance market share or catch up. An alliance partner should provide the desired product mix, competence, resources or brand visibility.

- *Peripheral business and high market share*—The focus of businesses located in this quadrant is to remain as a leader even if it is a peripheral area of business. For a semiconductor manufacturing firm, the networking business will be a peripheral. The firm could retain its market through an alliance whereby it could use the technological know-how and licences of the partner.
- *Peripheral business and low market share*—This is essentially a new business into which a firm is planning to venture. The alliance strategy is to get into a segment and then increase the market share. For example, a pharmaceutical firm may be envisaging entry into nutraceuticals. This could be achieved through a joint venture or a pure strategic alliance without any equity. The transfer of know-how will help the firm to enter the market in a shorter time frame.

Alliances as a strategic option have a major value. Strategic alliance is a major source of know-how for firms that operate in emerging markets. Basically alliances attempt to create a win-win situation in which both partners could benefit from the business. The emerging country partner gains technical know-how from the matured market, essentially a global player looking for market access with minimum investments. The emerging country partner also gets technology, competence as well as know-how for implementation. Honda entered the motorcycle market through an alliance with a local firm, Hero. The market knowledge and local infrastructure was provided by the local partner Hero. Hero Honda became a major selling brand in a short time and it continues to maintain its leadership through the introduction of a new design from Honda including the 4-stroke engine.

The strategy essentially comes under offence or defence. In offence, the strategy is to enter a segment in which there is a strong competitor. Attack requires considerable strength and resources and it should be well prepared. The competitor will retaliate and the new entrant should anticipate the response and be ready to repulse the attack. In defence, the firm is trying to ensure that he does not lose the market. In this case, the existing player should fortify his strengths and ensure that he is monitoring and responding without allowing the competitor to take away his market share.

IT strategy

Using IT for strategic purposes could be another element of technology strategy. In this case IT could be used for five distinct purposes:

- IT for digital product definition
- IT for manufacturing, supply chain and logistics coordination
- IT for enhancing market reach through B2B or B2C
- IT for improving customer satisfaction
- IT for networking or collaborative working.

Companies are using IT for various aspects of the value chain. It reduces cycle time, enables collaboration, smoothens work flow, connects with customers and facilitates coordination. Examples will explain the applications in a lucid manner:

- *IT for rapid product creation*—Tata Johnson Controls used IT to reduce the cycle time for designing seats for passenger cars. Digitization helped it to reduce testing and validation cycle time. It also helped in creating multiple prototypes and reduced the fuzzy end of product creation by doing failure analysis along with design validation.

- *IT for supply chain coordination*—Firms from developing countries can now participate in global supply chain links through the Internet for easy coordination. This has enabled many SMEs to participate in global manufacturing networks. This has opened up many new opportunities. An Indian firm has been able to become a global supplier through leveraging IT. An SME namely Hind High Vac Ltd. has become a supplier for Xerox through IT-enabled supply chain management.

- *IT for enhancing market share*—The reach of a traditional type of footwear (known as Kolhapuri Chappal) was enhanced to become a global player by an IT company through the creation of a portal. Footwear designers could see contemporary designs and also let customers see the product range. The use of Internet marketing helped traditional footwear manufacturers to increase their revenue as well as margins. Knowledge of contemporary design helped them to enhance product acceptance. IT has increased productivity (Computer Aided Design), increased customer acceptance by providing real time market information and enhanced the market reach through the knowledge of buyers of traditional products. The use of information and communication technology (ICT) has helped revive a traditional footwear manufacturing group, which was unable to meet competitive pressures.

- *IT for enhancing customer satisfaction*—By providing digital design images, the traditional garment industry was able to enhance customer satisfaction. Potential buyers were able to see designs in advance and provide feedback. IT helped in empowering buyer and manufacturer interaction. Traditional garment makers were able to create different designs in a shorter time frame.

- *IT for collaborative working and networking*—Tata Auto Plastics is a new company and was able to participate in a global auto show and network with many global suppliers. IT enhanced its market knowledge and reduced communication costs by the use of IT networking.

IT can help a firm to enhance competitive advantage. The mode of leveraging IT could depend on the nature of the value chain of the business. It could be used for increasing the speed of a process, improving coordination among many partners, facilitating exchange of information and enhancing customer satisfaction in many new ways. IT could help a firm to differentiate itself from its competitors. The main advantage comes from the ability to integrate the value chain. Outsourcing opportunities have increased because of the abilities of firms to leverage IT-enabled services. Many Chinese, Taiwanese and Indian firms have started designing products with the use of IT-enabled services. Any firm could ask itself the following series of questions:

- How can the firm enhance its competitive edge through the use of IT?
- Which part of the value chain could use IT to enhance productivity?
- Is there a possibility of reducing inventory through better supply chain coordination?
- Is there a way of enhancing customer satisfaction?
- Can a firm use IT to understand customer needs precisely?

IT provides a firm with many new opportunities. A firm needs to develop its strategy in order to leverage them.

Technology strategy: caselets

Technology strategy is essentially leveraging technology to create strategic advantages. These caselets depict examples of companies from developing countries that have grown using technological capabilities to be ahead of their competitors. Many SMEs fail to grow because of a lack of growth strategy. These caselets illustrate the manner in which companies have leveraged technology. Only the SMEs that could cross the "valley of death" will become global enterprises, with considerable reach. Each of the caselets depicts a trajectory that an enterprise followed in order to leverage technological capability to beat competition. The titles of the caselets and the focus of each caselet are given below:

Technology strategy staircase—Cemex becomes a global giant

Learning through partnering—Case study of Lenovo

Praj—From SME to global supplier

Tata Steel—Growth through acquisition

Haier—Leveraging the product pipeline

Tetra Pak—Thinking out of the box

Tata Kisan Sansar—Leveraging technology for customer relationships

Himalaya Herbal Healthcare—Making a traditional technology firm competitive

Asian Paints—Understanding customer needs to gain competitive advantage

Biocon—Leveraging manufacturing technology to go global

Technology strategy—Growth of Embraer as a global manufacturer

Lijjat Papad—Growth of an SME through franchising

Leveraging technology—Amul Dairy

Ittium—Leveraging knowledge to go global

These caselets illustrate that technology can be used for creating and sustaining competitive advantage depending on the nature of the industry and the nature of the competition. The role of leadership is to provide strategic vision and ensure the faultless

execution of the strategy. Technology strategy implementation requires a robust strategy and leadership capability for its execution. This can happen when technology strategy and business strategy are aligned and top management is committed to the implementation of technology strategy as a part of the business strategy. Failure occurs when business leaders consider technology as something that is extrinsic to business goals. SMEs can grow to become large firms only if technology is used as a vehicle for realizing growth and competitiveness.

Technology strategy staircase: Cemex becomes a global giant.

Cemex came into existence in 1906. The first cement manufacturing unit was set up in Hidalgo, followed by a second in 1920. The two units were merged into a single company in 1931 known as Cementos Mexicanos. Cemex added about 15 million tons of capacity through greenfield projects and acquisitions.

Growth through exports

The United States is one of the world's largest markets for portland cement and cement clinker. US demand for cement was high and the shortage was met through imported portland and cement. Cemex exported cement at a lower price and had a good share of the US market. Due to the closed nature of the Mexican economy, Cemex had diversified into petrochemicals. Since Cemex had to invest for growth, it had its initial public offering on the Mexico Stock Exchange in 1976. The Mexican economy started liberalizing slowly after the debt crisis after 1982.

US demand for cement rose steadily between 1980 and 1987 before levelling off at 80 million metric tons at the end of the decade. The increase in Mexican exports to the United States occurred in the years when US consumption had levelled off. In 1988, Mexico had 29 per cent of the US cement import market, the highest percentage of any individual country.

An overview of US domestic market production showed that there were 141 cement manufacturing plants operating in the United States in 1986. The number had decreased to 134 by 1989. Of the 134 plants, 67 were operated by foreign ownership or as joint ventures with foreign-owned companies.

The Mexican industry at that point consisted of nine corporations operating 26 cement plants. Four of the corporate groups accounted for 90 per cent of the Mexican market. Cemex owned or had interests in 17 cement plants and controlled just over 71 per cent of all Mexican cement production in 1989. An antidumping case was initiated against Cemex in 1989. As a result of the consistently lower price of portland cement and clinker, Cemex's market share was continuously increasing. Producers of portland cement from Arizona, New Mexico, Texas and Florida filed an antidumping petition with the US Department of Commerce and the US International Trade Commission on 26 September 1989.

Cemex starts looking outward

The antidumping case against Cemex was a major setback. This was the first stimulus that made Cemex to look outward, happening at the same time that the new CEO was examining how Cemex could change. Lorenzo Zambrano was made CEO in 1985. The grandson of the founder of Cemex and a graduate of Stanford Business School, Zambrano had worked in the plant for 18 years prior to this assignment. He was of the view that Cemex should focus on the cement business. He first made a series of changes within the company to improve the efficiency of its internal operations. "If you are not competitive in the local area you cannot compete globally" was his philosophy. In his own words he saw globalization as an opportunity. "We suddenly found ourselves competing with very large international companies at a time of consolidation in the world cement industry. There were few independent players left. Either we became large and international or we would end up being purchased by a bigger player." Accordingly Cemex bought Cementos Anahanc in 1987. Cemex bought a second cement company, Cementos Tolteca, in 1989. These two acquisitions cost Cemex $US 1 billion. Zambrano was a born leader. He acquired Tolteca when he heard that global competitors Holderbank and Lafarge were planning to acquire it. The acquisitions were carried out with the help of a Stanford MBA who had joined the firm in 1987 to assist Zambrano. His name was José Domene and he was 32 when he joined Cemex. These two acquisitions increased Cemex's market share from 40 to 65 per cent. The head of Cemex's trading business stated that the acquisition was strategically important: "The Tolteca acquisition was the big move because it gave Cemex the size within Mexico to compete internationally. We were still very small compared to the big multinational companies, but with two-thirds of the Mexican market and probably the best technology in the world, we were able to compete with anyone."

A number of things changed at and around the same time. Because of the financial crisis the cost of capital remained very high in Mexico. The debt crisis induced Mexico to open up. Real GDP dropped until 1988. The increase in exports from Mexico to the United States that sparked the antidumping case was caused by a series of factors. First, the Mexican market for cement had dropped. Secondly, the foreign exchange crisis made firms export products to global markets. Cement being a transport intensive business, Cemex focused on the US market. The United States imposed antidumping duties of 58 per cent ad valorem on cement imports from Mexico. The imposed duties were meant to offset the difference between "constructed export price" and "normal value."

Mexico started its liberalization process in the early 1990s. Global majors considered this as a major opportunity. The next major strategic shock that made Cemex look outward was the entry of Holcim into the Mexican market in 1989 when it acquired Cementos Apasco and thus a 25% market share. Both the entry of Holcim and steep import duty prompted Cemex to look for new emerging markets.

Becoming a global player

Having acquired two cement firms in 1987 and 1989, Cemex started looking for global expansion. Cemex moved into Spain in 1992, taking over two firms: Valenciana

and Sanson. This was the beginning of the globalization of Cemex. Through these deals Cemex reached a market share of 25 per cent. It was ahead of Lafarge and Holcin. Simultaneously, it started looking for acquisitions in Latin America. It acquired Venocemos, the largest cement company in Venezuela, gaining a 40 per cent market share, in 1995. The same year it acquired Cementos Nacionales in the Dominican Republic. Cemex bought stakes in Cementos Diamante and Inversions Samper to get a 33 per cent share of the Columbian market. Cemex invested $US 650 million in Rizal and APO of the Philippines and $US 190 million in Semen Gresik of Indonesia to get a foothold in Asia. Cemex continued its global expansion after 1995 with rigour after Zambrano became chairman of Cemex.

Cemex acquired a 95 per cent stake in the Costa Rican firm Cementos del Pacifico in 1999. In the same year it obtained a 12 per cent stake in Cementos Bio-Bio of Chile and two terminals in Haiti that handled 70 per cent of Caribbean cement. Subsequently, it got listed on the New York Stock Exchange. Then Cemex started moving into the other continents. Cemex acquired a 77 per cent stake in the Egyptian Assiut Cement Company to enter the Middle East market. It also entered into a distribution agreement with Universe Cement of Taiwan.

In the 1990s Cemex mostly acquired non-US plants. Cemex bought out the second largest US cement producer Southdown in its largest ever acquisition in 2000. Cemex acquired stakes in the French cement firm Pastorcello in 2000. It took equity stakes in the Wangan Cement plant in Japan in 2001. The same year it acquired Saraburi Cement Company of Thailand. In September 2004 Cemex purchased the British ready-mix giant RMC group for $US 4.15 billion in cash. This is the largest acquisition ever made by a Mexican company. The RMC group is the largest ready mix manufacturer in the world, operating in Western Europe, the United Kingdom as well as in the United States. Cemex could operate this plant along with its ready-mix plants operating in North America. This takeover helped Cemex to enter East European markets as well as to strengthen its position in the US market. The main reason for acquiring the RMC group was to produce more value added products rather than producing a commodity product such as cement.

Cemex used acquisitions as its favourite mode of entry as it had considerable market experience. Prior market experience encourages expansion by acquisition rather than using the joint venture route. Because of its product and size, Cemex needed to position itself in international markets (Vasquez–Parraga, Felix and Borders, 2004). Although, the main strategy was to concentrate on developing countries based on their growth prospects, it also went to developed countries because it needed earnings in dollars from stable economies. Such earnings helped the company to survive the Peso crisis and avoid the damage other companies suffered. The example of Cemex counters a point found in literature that firms use specific criteria to evaluate different countries for market entry. Cemex did not use any such criteria. It sought entry into any market that looked attractive enough, regardless of where it was located. Cemex preferred FDI over exports because of high transportation and logistics costs. It used IT tools extensively for information coordination.

Learning from Cemex

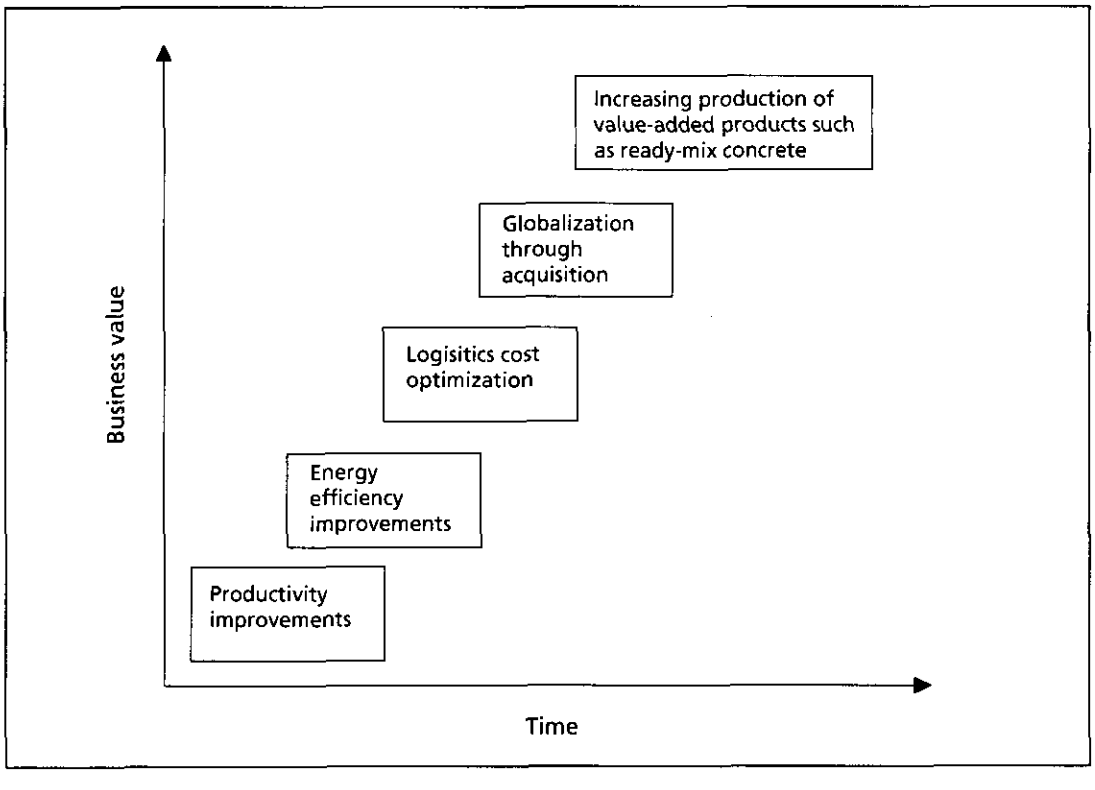
Cemex mostly used inorganic growth or rather the acquisition route to growth and not a joint venture option. It started as a small cement manufacturing firm. The acquisition route to growth has less risk associated with it. Acquisition requires funds but results are quick. Leadership made a substantial contribution to global growth. Vision is a major element that provides directional clarity to the strategy.

Cemex used information technology to optimize its logistics costs. It focused on efficiency improvements and leveraging IT in all the acquired plants. Through a five-pronged strategy it became the third largest cement company in the world. Only a national player in 1990, by 2004 it had become the third largest player in the world. It used five strategies to achieve this position, namely:

- Productivity improvement
- Energy efficiency improvement
- Logistics coordination
- Acquisition of plants across the world
- Increasing productivity of ready-mix cement.

This strategy is illustrated in figure 3.9

Figure 3.9 Five-pronged strategy of Cemex



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Learning through partnering: case study of Lenovo

Background

Lenovo is China's largest personal computer maker with a 27 per cent share of China's PC market. According to the consulting firm Gartner, it was the world's ninth largest PC maker worldwide. It was started by Liu Chuanzhi 21 years ago in Swindler's Alley, Beijing's electronics black market, then called the Legend Computer Group Co. Lenovo was the first to introduce the concept of home computers in China in 1984. It became the market share leader in 1996 and has maintained its position since. Lenovo held about one third of the emerging Chinese PC market and leading shares in many enterprise PC markets around the world. In 2003 Legend announced its Lenovo logo to prepare for its expansion into the overseas market. The company's earlier attempt to go global had failed. It had started to expand into Spain and regional European markets but had to retreat in 2002.

What is unique

Lenovo started as a distributor for IBM personal computers in China. In December 2004, Lenovo announced its acquisition of IBM's personal computer business. IBM held on to 18.9 per cent share of Lenovo. The deal was worth US$ 1.75 billion, one of China's biggest foreign acquisitions. According to Lenovo chairman Liu Chuanzhi, this acquisition made it possible for Lenovo to make significant inroads on its path to globalization. The deal also made Lenovo the third largest PC maker in the world, behind Dell and Hewlett-Packard. It was previously the ninth largest PC maker worldwide.

Acquiring IBM

Lenovo was allowed to use the IBM logo for ThinkPad products. The rest of the product line, specifically the formerly IBM-branded desktops, were to be sold under the Lenovo name. Before the deal Lenovo did not have much market presence outside Asia. Because of the deal it found a firm foothold in the global market. IBM would also handle technical support and financing and warranty coverage for Lenovo through IBM Global Services and IBM Global Financing respectively. After the acquisition Lenovo relocated its headquarters to New York. IBM's Stephen Ward became the CEO and Lenovo's former CEO Yang Yuanqing took over as chairman.

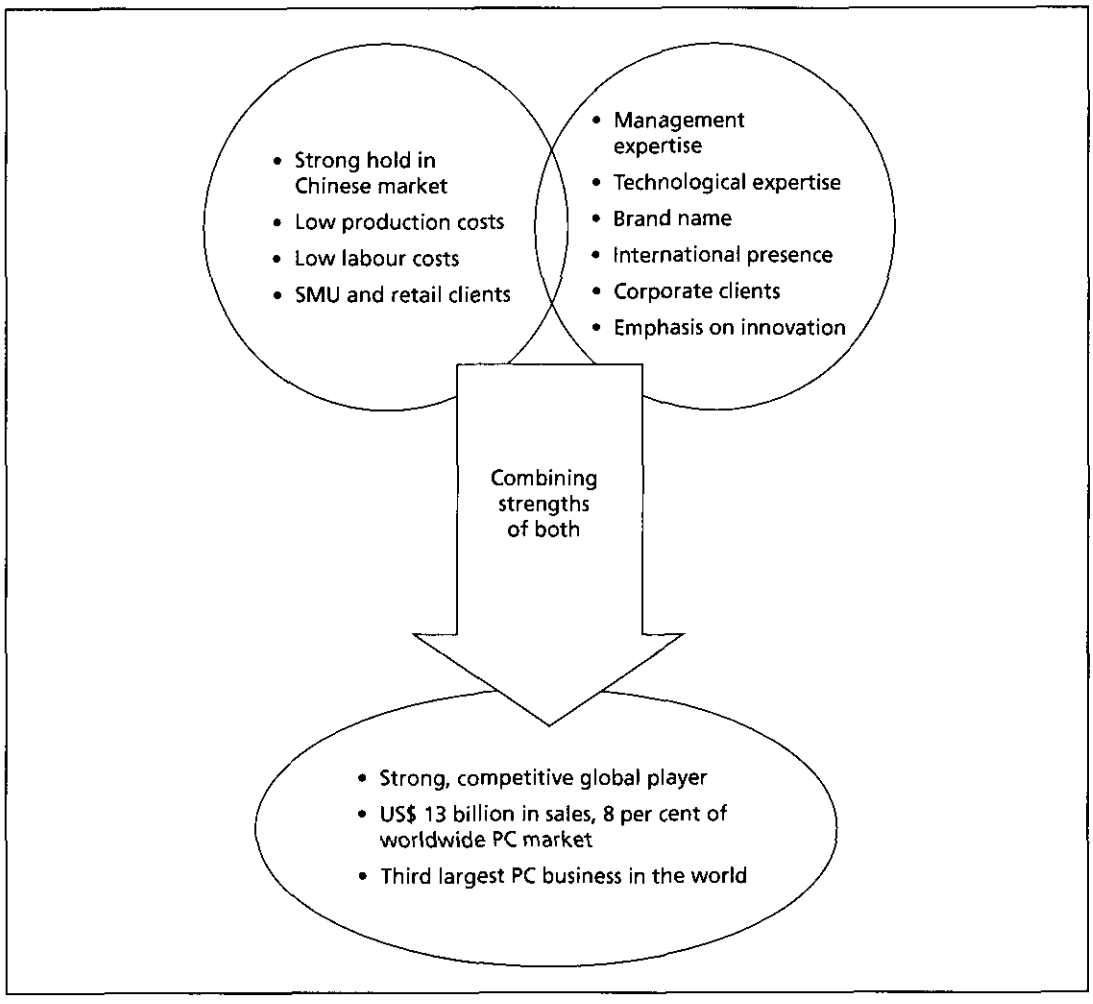
A main concern facing Lenovo was whether Lenovo's executives were capable of running a complex global business. It was concluded that Lenovo could recruit IBM's top executives to manage the company. The management team consists of 30 people with 15 from each side in the team. The new Lenovo had US$ 13 billion in sales and

8 per cent of the worldwide PC market. It combined the management, corporate reach and technical expertise of IBM with low manufacturing costs, low labour costs and a proven record in the developing markets of Lenovo. The deal also gave IBM an edge as it entered the Chinese market with its software and services.

Synergy from complementary capabilities

The business of both the companies was complementary. Lenovo traditionally sold its PCs to consumers directly. It had a great number of medium and low-end consumers. IBM on the other hand catered mainly to corporate and high-end clients. Lenovo only did business in China. The deal gave Lenovo a good mixture of relationship customers and small and SMUs as well as direct customers.

Figure 3.10 Globalization of Lenovo



IBM has consistently been ranked among the most innovative companies. For the past decade it was number one with regard to the maximum number of patents granted in the United States. Lenovo performed very little R&D and mostly manufactured low-end systems. IBM were constantly innovating its ThinkPad notebook PCs. Lenovo

understood the importance of investing in R&D and innovation to maintain and expand its market share. Instead of cutting R&D budgets to cut costs, Lenovo decided to use R&D to generate innovative production tools so as to cut costs. The deal also included the takeover of the IBM innovation centre in Japan. Lenovo also started a new innovation centre in North Carolina in association with Intel, IBM, LANDesk, Microsoft and Symantec.

Lenovo always aspired to become a major international player and a recognized brand. This deal defiantly gave Lenovo a strong foothold in the international market. In December 2005, it announced a new CEO, Mr. William Amelio, who was formerly with Dell. Lenovo planned to use his supply chain management skills and ability to attract and retain customers for aggressive and profitable expansion. Figure 3.10 indicates the synergy of Lenovo/IBM partnering.

Learning from Lenovo

The example of Lenovo shows that learning and technology assimilation can help a firm go global. Technology assimilation can help a firm to move up the value chain.

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www.businessweek.com

Praj: From SME to a global supplier

About Praj

Praj was started in 1985 as a provider of technology solutions to the distillery industry. It focused on alcohol technology and the engineering of alcohol plants. Over time it turned into a multi-product and multinational company having expertise in alcohol technology, brewery technology, fruit processing and heat transfer systems. Praj is amongst the world's largest suppliers of molasses-based distillery technology, plant and equipment. It diversified its range of solutions to include fermentation systems having technology packages for multiple feedstock including cane molasses, cane juice and filtrate, starch-based raw material such as sorghum, wheat, tapioca, tropical sugar beet and many more. Today it provides services to industries in over thirty countries across five continents. It is among the top sugar stream distillery technology suppliers worldwide.

Matrix: the innovation centre

Praj was quick to realize the importance of innovation to sustain itself in the market. It started an innovation centre called Matrix in 1991. It was conceived with the objective of carrying out intensive R&D to provide high-end technology and engineering solutions for the distillery and brewery industry. It also started working on waste water treatment at this centre. It was equipped with state-of-the-art biotech, analytical, instrumentation, chemical and pilot facilities. Matrix was expanded in 2002 to focus on more productive processes for developing renewable energy such as ethanol. Today Praj has seven patents to its credit. When fuel ethanol was being considered as a petrol

additive to reduce transport fuel transmission, Matrix started working on developing an alternate feedstock as a source for ethanol production. After extensive research it came up with a technological breakthrough by producing ethanol from sweet sorghum. It also achieved success in identifying, cultivating and developing a high yielding variety of seeds. Matrix also came up with an innovative processing technology called the "Thermo-permeation Process" which ensured a higher extraction of sugar from the stock. It developed a dual route distillery model which operated all year round by switching between molasses and grain as the feedstock source. Matrix developed the technology for the production of ethanol based on the multi feed process. It received an award from the Department of Science and Industrial research for the same (FROM WHERE?). It developed an innovative new bio nutrient for the ethanol industry called the MashTone. This was a unique nutrient formulation that improved the alcohol formulation performance and gave high rates of yeast metabolism, healthy growth and improved yield. It developed a unique machine called the Spranhillator to incinerate the waste. This was also efficient in terms of energy and with low pollutant emissions

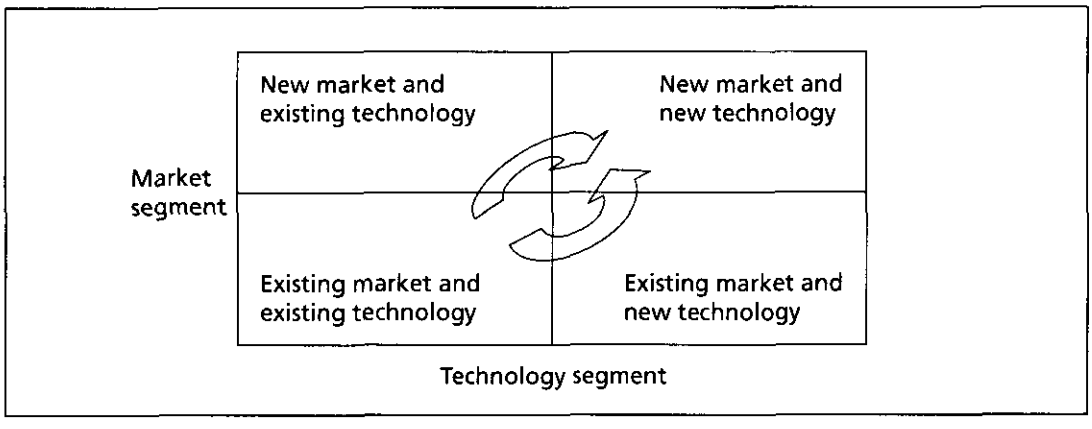
Market driven research agenda

The R&D Department at Praj works in close collaboration with the marketing group and with customers. The process begins with scanning and identifying potential customer needs. This is done by the marketing teams. Then the available technologies are shortlisted. These are then passed on to the research centre. Following this lead, the researchers visit prospective client sites to find out the applicability of the technologies, clients' exact needs, adaptations which would be required to meet these needs, and so on. Thus, customization of technology to customer needs starts even before the selling process has started.

Going global

Praj's operations cover three continents including Asia, Africa and South America through its own offices and to other alcohol/beer producing countries through its international operations outside India. It has constantly grown by increasing its profits, entering new geographies, getting new customers and innovation. The strategy of Praj is schematically presented in figure 3.11

Figure 3.11 Expansion strategy of Praj



Praj strongly established itself in India. Focusing on overseas expansion in synch with its growing business in India, Praj established itself in South-East Asian countries such as Thailand and the Philippines, and Australia. It planned for organic growth to add to the profits from these markets. It aggressively promoted itself in new markets. It obtained 100 per cent of the market share in Columbia. It successfully commissioned an evaporation plant there. It finalized contracts for two greenfield ethanol production plants there. It also set up an office there to serve and promote itself in that region. It also leveraged its R&D capabilities to develop new technologies. It reduced manufacturing costs and developed new yeast and enzyme strains for improved and efficient alcohol fermentation. It created a technology edge by investing into future technologies such as cellulose for ethanol process development. It maintained its focus on basic research apart from applied research.

Learning from Praj

Praj is an example of an SME going global by balancing and creating synergy between its technological capabilities and marketing capabilities. It leveraged its technological power to enter new markets. It used a combination of options for growth.

Continuous learning and new opportunity seeking have been the major strategic elements they have used to grow consistently.

Innovation has been central to the technology strategy of Praj. It has a strong innovation focus and continuously creates new knowledge.

Reference

www.praj.net

Tata Steel: Growth through acquisition

Background

Tata Steel is India's largest integrated private sector steel company. It was established in 1907 as a small steel plant. It remained a relatively small plant until the Indian economy liberalized. Its steel plant at Jamshedpur presently produces four million tons of hot and cold rolled flat and long products. The company is backward integrated with its own iron ore mines and collieries. It is one of the lowest cost producers of steel in the world. It was ranked fifth among Asian companies by BusinessWeek in November 2005. Through a modernization programme it reduced the cost of production and improved its operational efficiency. It has the highest energy use efficiency in steel making. Tata Steel used two acquisitions to enhance its production capacity. Tata Steel has planned to be among the best steel corporations globally. The first milestone it has set itself is to produce 15 million tons of steel by 2010. It has planned to extend its portfolio range from semi-processed steel to include finished steel too.

Growth strategy

The strategy is to have manufacturing plants in areas where raw material and energy are available at cheaper rates, so that manufacturing costs are low. The second element of the strategy is to carry out finishing, processing and distribution of the product close to the customer base. Tata Steel rightly noticed that the global steel industry had excess capacity, even at a time of reasonably high growth rates. It is better not to expand manufacturing capacity, but focus on producing value-added products.

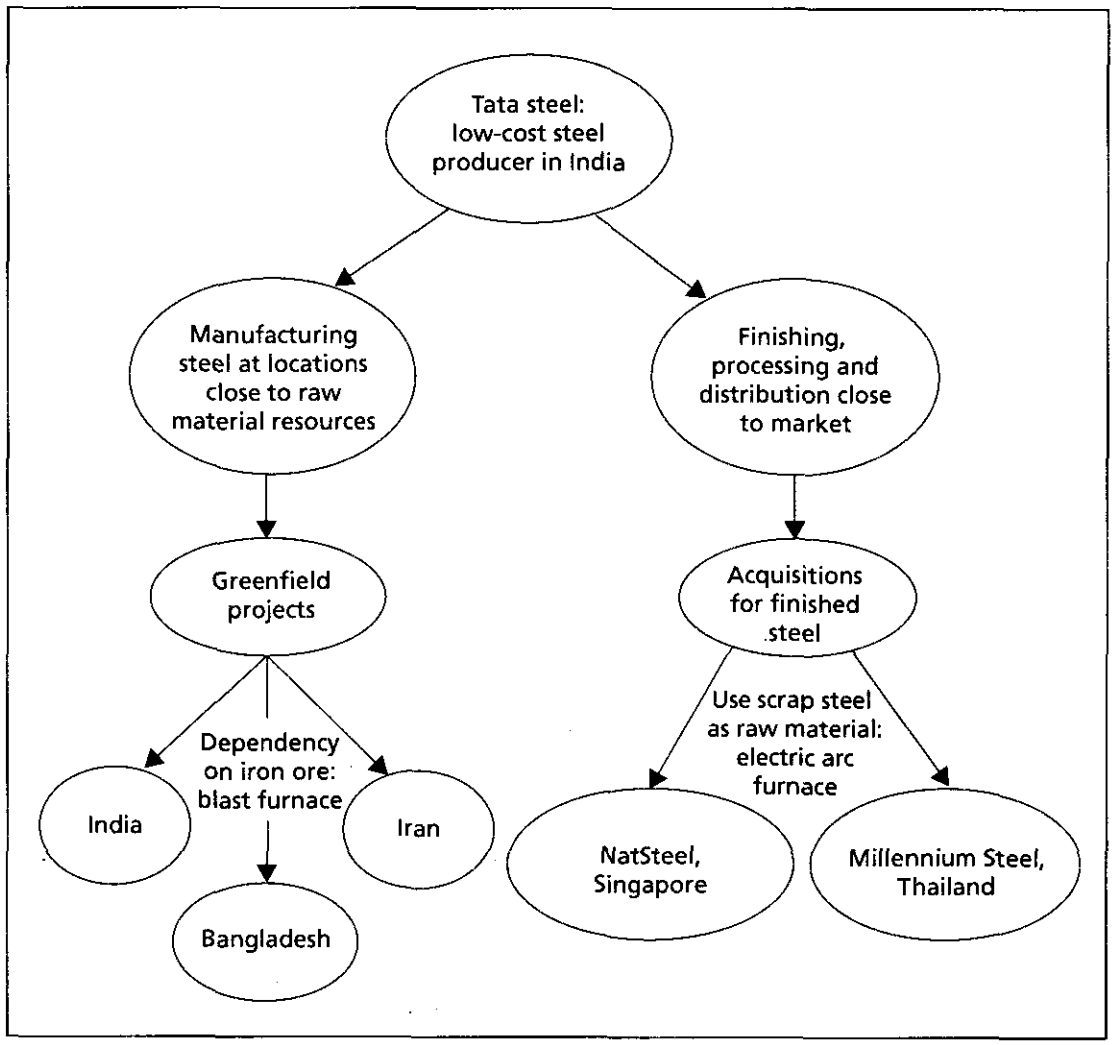
It decided not to opt for setting up greenfield projects everywhere, but rather to take the acquisition path. It then made the largest investment by an Indian company in Singapore by acquiring NatSteel, a steel making company operating in seven locations. This investment has given Tata Steel access to high growth geographies such as Australia, China, Singapore, Malaysia, Philippines, Thailand and Vietnam. In December 2005, it announced its plans to acquire the Thai company Millennium Steel. Both these companies produce construction grade steel through electric arc furnace technology. They use scrap steel as raw material reducing dependency on iron ore. Together they can produce up to 3.7 million tons of steel per annum. Through this acquisition it has access to technology and markets. This is a way to move up the value chain. Through technology acquisition a company can move up its value chain. Inorganic growth options help a firm to grow rapidly. One of the fast growth options for an SME is the acquisition option. Greenfield projects have a long gestation period and high risk associated with them.

These acquisitions are a significant progression in Tata Steel's globalization initiative, significantly enhancing Tata Steel's market position in South-East Asia. They also fit perfectly into Tata Steel's strategic expansion plans to own manufacturing facilities which can add value to the semi-finished steel that they already produce. They will continue to produce semi-finished steel at places where primary steel can be made economically. The company has initiated plans to set up manufacturing units in Iran and Bangladesh. It has also signed an agreement to build a steel plant in Chattisghar and is expanding its production plant close to its current location. This steel will then be shipped to other units of NatSteel and Millennium Steel for further value addition, according to customer specifications, and sold in nearby markets. The Tata Steel approach to growth is shown in figure 3.12.

Learning from Tata Steel

- Any firm has to look continuously for growth opportunities that can be realized through inorganic growth or growth through acquiring firms closer to customer locations.
- Growth through acquisition is a faster route for enhancing production capacity.
- Firms can move up the value chain by moving over to the production of high value products instead of remaining at the commodity processing end of the value chain.
- Acquisition is becoming a growth option even for SMEs as financial institutions are looking to finance acquisitions by good and financially sound firms.

Figure 3.12 Technology acquisition for moving up the value chain



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Haier: leveraging the product pipeline

An overview

Haier is China's largest consumer electronics company. It was earlier known as the Qingdao Refrigerator. In its initial years the company produced refrigerators. It initially imported refrigeration technology from Germany. However due to the poor quality of its products sales decreased and put it on the verge of bankruptcy. However, today Haier manufactures a wide range of household electrical appliances, 15,100 varieties of items in 96 product lines, and exports products to more than 100 countries.

Haier's global sales reached $US 12.5 billion in 2004. The Financial Times ranked Haier first in a list of China's top 10 global brands on 30 August 2005, and Haier CEO Zhang Ruimin 26th in a list of the world's 50 most respected business leaders in 2005. Fortune magazine ranked Zhang Ruimin 6th in a list of the Asia's 25 most powerful people in business in 2004 and first of the 25 most powerful business leaders inside China in April 2005. The company today exports its products to more than 160 countries. It has established 22 manufacturing facilities and 18 design institutes outside China. Its rich product pipeline helped Haier to grow rapidly.

The leader driven turnaround

The CEO of Haier, Zhang Ruimin, played an important role in turning the company round. He took over as director of the Qingdao Refrigerator General Factory in 1984, when the plant was suffering huge losses and had disgruntled employees. Zhang Ruimin understood that for a company to survive, the first thing it should do was to start with basic management. Very soon, a 13-article management regulation was worked out. The major reason why Qingdao Refrigerator was approaching bankruptcy was the poor quality of its products. He knew that maintaining top class product quality would be essential for the survival of the company. By failing to maintain product quality, the company wouldn't last long. He urged the workers to be equally conscious of the quality of the products. To emphasize his commitment to quality, qualitatively faulty refrigerators were ordered to be smashed to pieces by the very employees who made them. He held group meetings to sensitize the importance of quality and good working methods. In 1991, the company changed its name to Qindao Haier Group Company. It became the first company in China to obtain the ISO 9001 certification in 1992. The company's name was again changed to the Haier Group. Zhang Ruimin instilled in the workers a passion for good work. He introduced the Overall Every Control (OEC) management system at Haier. This system helped the workers to get things done effectively and in time with fair rewards and penalties.

Overall Every Control and Clear Management Control

OEC promoted discipline, quality, personal responsibility and attention to customer needs. Haier introduced workers contracts and tied job security to performance. Employees were rewarded for good work and penalized for poor work. The OEC system also encouraged workers to find innovative solutions to manufacturing problems. Every worker was supposed to finish his work on time on a day-to-day basis. Even the evaluation was done on a day-to-day basis. The process began with the supervisor briefing his team daily before work. The workers perform their tasks keeping the following OEC parameters in mind: job quantity, quality, raw material consumption, equipment condition, workplace safety, workplace attitude and discipline. The managers also worked on the same parameters. Supervisors paid routine inspection visits to detect and solve problems. At the end of the day everyone was asked to fill out 3E (everyone, everything and everyday) forms. These forms were evaluated and graded in terms of A, B and C. The workers who were awarded an A on a regular basis were suitably rewarded. Those who underperformed regularly were demoted to temporary workers. The OEC management system enabled Haier to improve the quality of its products, improve the speed to market, operating efficiency and create innovative products.

Developing into a global brand

After effectively establishing itself as China's premium brand name, Haier began exploring newer markets in the mid 1990s. Zhang believed that if Haier could effectively establish itself in tough markets such as Europe and the United States, it could easily conquer the other markets. It began exporting its products to Germany as early as 1992. It entered the Indonesian market through the joint venture route in 1996. It set up greenfield projects in Malaysia and the Philippines in 1997. It focused on building volume and gaining international experience. It made a major greenfield investment in Camden, South Carolina, United States in 1999 to build its own manufacturing facilities in the United States. Zhang explained this decision by stating, "You can't be an international company if you only make things at home and export them." The major problems that it faced in the overseas market were the lack of an established brand name and the absence of an effective distribution system. It had to work hard to convince dealers in these markets about the quality of its products. It carried out many tests to prove the same. It entered into agreements with leading retail chains such as Wal-Mart and BestBuy to sell its products in the retail market. Local talent at its design centre helped it to understand local needs. This helped them to design and produce products that were the most suited to the local market. Increasing the speed to market also helped Haier in distinguishing itself from other manufacturers. While it would take other manufacturers 18 months to develop a new wine storage cabinet, Haier would do the same in five months. This ability to identify and satisfy customer needs helped it to gain more than 50 per cent of the total United States market share in this segment.

Learning from Haier

The learning that we can get from Haier's turnabout and its subsequent dominance of the consumer electronics industry are:

- *Focus on customer needs*—Zhang was quick to notice the customers' dislike for low quality products and changed it. Haier also paid close attention towards customer needs. When it found out that rural Chinese customers used washing machines to wash vegetables, Haier was quick to modify its washing machines to cater to this requirement. Haier used cycle time reduction to reduce the time to market and generate and maintain customer excitement.

- *Work culture*—Haier's new work culture promoted discipline, quality and personal responsibility. There was transparency in the evaluation system for the workers. Innovative systems such as the OEC were introduced, as well as an innovative system of competitive bidding by the workers for vacant jobs. The employees were given opportunities to prove their competence. These processes created a performance-oriented culture.

- *Product innovation*—In 1998 Haier developed 262 new products and launched 236 new products when it entered the global market in 1998. Sales from these products in that year amounted to 74 per cent of total sales. Haier globalized its R&D activities and established many product design centres outside China. It gathered technical know-how from advanced countries and adapted it to suit its needs

in the local market. It leveraged its new entrant status to obtain advanced technology from Japanese and Western companies.

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Tetra Pak: Thinking out of the box

"A good package must save more than it costs"

Dr. R. Rausing

Background

Ruben Rausing and Erik Akerlund started a packaging company in Sweden in 1920 called Akerlund and Rausing (A&R). The company had to initially struggle for its survival. In spring 1933, Akerlund decided to leave the company and Rausing bought out his equity stakes. A&R aimed to replace the bulk selling of unpacked goods with consumer adapted packaging for sugar, flour and salt. However it also worked on finding ways to package milk and cream. Both of these were perishable goods and were traditionally sold over the counter in loose form or in glass bottles. There was a great demand for a type of packaging that would be convenient for distribution, easy for the consumers to carry and hygienic. In 1944 development work began on creating a milk package that required a minimum of material whilst providing maximum hygiene. They began investigating the possibilities of creating packaging in different geometrical shapes. This resulted in the tetrahedron-shaped Tetra Classic carton. This Tetra Classic was released in May 1951. Within a short period of time many dairy companies in Sweden began installing Tetra Pak machines and sold milk and cream in Tetra Classic cartons. In 1954 Tetra Pak machines were exported to Germany and later in 1955 the commercial production of tetrahedron milk packages (300 ml) began at Helsingborg in Sweden. The cost effectiveness, minimal storage space and hygiene made it very popular among customers as well as the dairy industry.

Aseptic packaging

Tetra Classic was not capable of keeping food fresh for long periods of time. Hence the company began looking at ways to preserve food longer without preservatives or refrigeration. Researchers at Tetra Pak came up with Aseptic Packaging Technology. It was based on the principle of ensuring that both food and packaging materials were free of harmful bacteria at the moment the food was packaged. To accomplish this, everything in the production chain had to be sterile including the food and packaging materials, all the machinery involved as well as the environment in which the packaging took place. The materials used for packaging were paper, polyethylene and aluminium foil. Paper was used to provide strength and stiffness, polyethylene

prevented the action of micro organisms, and aluminium prevented air, water and light from entering the carton. The first aseptic packaging machine for commercial use was launched in Thun, Switzerland in 1961. Aseptic packaging technology changed the liquid food industry forever. Unlike other methods of food processing and packaging, such as canning and bottling, aseptic technology kept the food safe and fresh for at least six months, without refrigeration or preservatives. It retained the colour, texture, taste and nutrition. In addition to improved product quality, aseptic packaging also offered a variety of package shapes, consumer convenience and economies in energy and packaging materials. In 1989, the Institute of Food Technologists named the aseptic technology the "most important food science innovation to have occurred in the past 50 years".

Portfolio enrichment through innovation

Even as research on aseptic technology was underway, Tetra Pak was working on developing new packaging designs. Tetra Pak realized that the rectangular shape for packages made distribution more convenient. The rectangular shape complied with international standards for pallet loading (a pallet is a portable platform for storing or moving cargo). Tetra Pak launched the Tetra Brik commercially in Motala and Stockholm, Sweden, in 1963. Subsequently the Tetra Brik aseptic package was also brought out. The company launched Tetra Rex, a fibre pack with a triangular top in 1969. Tetra Pak introduced Tetra Top in 1989, a square package with rounded corners. In the 1990s the company brought out many new designs and expanded its portfolio of products. They introduced Tetra Prisma Aseptic which was octagonal in shape. The shapes were designed so as to consume less material, keep costs low and take up less space. This variety of shapes also helped beverage manufacturers to differentiate their products from those of others.

Tetra Pak also diversified in manufacturing a variety of drinking straws. Designed, produced and marketed by Tetra Pak, these innovative straws were appealing and hygienic in nature. They launched the LifeTop range of straws that contained an inner straw filled with Lactobacillus Reutri, a bacterium which released lactic acid. It helped improve the body's immune system and reduced the risk of stomach disorders. In 2001 Tetra Pak introduced sensory straws which had four small holes punched on the sides and the top closed. It used the principle of giving the customer a new experience and helped beverage manufacturers differentiate the product at low cost. The new straws could be manufactured by the existing straw applicators without making any technical modifications. The company introduced a new distribution box called the Apogee box for the effective distribution and handling of the straws.

Venturing into new sectors

After establishing their supremacy in the milk, milk products and juices sector, Tetra Pak ventured into offering packaging services for other food sectors. In December 2002, the company introduced packaging solutions for dried fruits, cereals and confectionary. Bonduelle, a processed vegetables manufacturer in Europe, launched its premium range of vegetables packed in Tetra Recart. Nestlé also used the Tetra Recart for the packaging of its pet food. It has also been used as packaging material for other products such

as hair oil. In January 2005, Tetra Pak announced the world's first microwavable aseptic package aimed at the growing market in prepared sauces for both retail distribution and food services. It also began research into other technologies such as nanotechnology and radio frequency identification in order to make better products.

Learning from Tetra Pak

- *Leveraging innovation*—Innovation could be leveraged continuously for creating new markets. The "think differently" policy and reuse of knowledge in many new market segments helped the company to grow in many market segments.
- *Customized solutions*—It worked closely with customers to provide "customized solutions" that helped Tetra Pak to generate customer excitement.
- *Seeking opportunities in many segments*—Innovation can be a major source of sustained competitive advantage. Tetra Pak has a proprietry technology that it can leverage in many different markets.

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Tata Kisan Sansar: leveraging technology for customer relationship

Background

In 1988, Tata Chemicals set up Tata Kisan Kendras, a one-stop shop for fulfilling Indian farmers' requirements, from seed sowing to post harvest activities. Four years later the company conducted a strategic review of the initiative; it was decided to give it a greater thrust as a distribution tool. The focus was shifted from products to services. Tata Chemicals wanted to create a strong service brand, with a focus on the delivery of products and services through a reliable channel. This is what is presently called Tata Kisan Sansar. The main focus is to offer end-to-end farm management solutions and provide reliable, top quality agricultural inputs and services to farmers.

Business structure

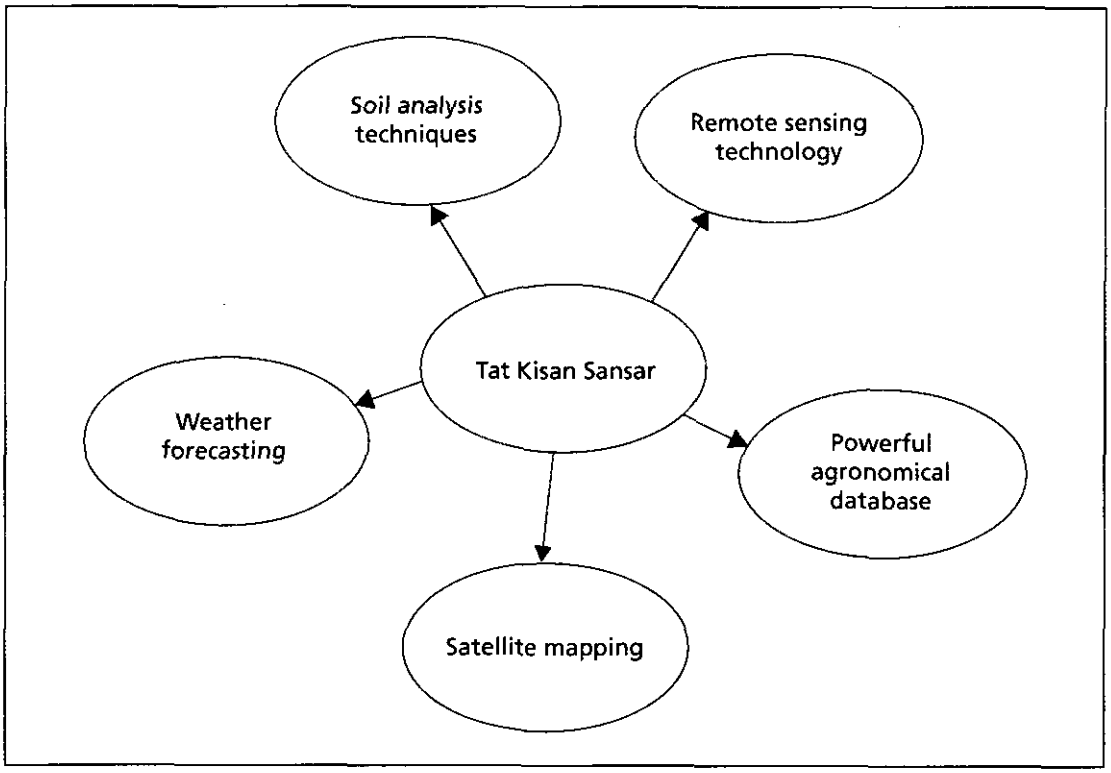
Tata Kisan Sansar (TKS) is an innovative project to help small farmers harness sophisticated modern technology so as to enhance the yield from their farms. The network of farmer centres is divided into Tata Krishi Vikas Kendras (TKVK) and franchisee TKSs. Each TKVK covers 20 franchisee centres, and each franchisee about 60 villages. Currently, 40 TKVKs and about 800 franchisee TKSs are in operation, catering to 27,200 villages and almost 2.5 million farmers. To make use of TKS services, a farmer has to become a member of Tata Kisan Parivar or pay selectively for services.

Leveraging technology

The TKSs, or farm centres, provide end-to-end solutions, right from what crops to grow to how to sell them for the maximum returns. They use a wide variety of technologies to achieve the same. Many Indian states have low productivity and poor farmers have no access to technical information. Tata Kisan Sansar is designed to fill this gap. Through this business the company develops a close relationship with farming communities. In a competitive environment, relationships can become a major differentiator for gaining market share. This could be classified as organizational innovation as opposed to product innovation. The model provides cascading information and develops a closer relationship with customers.

TKS uses remote sensing technology to analyze soil, inform about crop health, pest attacks and so on. Staff members at each Sansar are well equipped to find solutions to agriculture-related problems. The TKS network runs crop clinics where agronomists use computers to access information from the global information system and advise farmers on what to grow, where and when to grow and the fertilizers to be used. At the soil testing laboratory, technicians analyze soil samples to determine their compositions. TKS also operates experimental farms where scientists conduct agricultural research and development. The computerized model of soil testing analysis helps farmers decide the nutrients that the soil requires. TKS is an information kiosk providing information on weather, market pricing, crop production, etc. The entire business operation is in the process of being computerized using software designed by Tata Consultancy Services. The technologies provided by Tata Kisan Sansar are shown in figure 3.13.

Figure 3.13 Technologies provided and leveraged by Tata Kisan Sansar



To create a valuable agricultural database, TKS plans to combine satellite maps, census data, socio-economic and other data collected within geographic information systems (GIS). GIS software operates by superimposing layers of data in digitized maps with information about the administrative, socio-economic and physical set-up. The source of these maps also includes data from satellite image processing. When the data-building exercise for the precision-farming project is completed, it will reduce the complex task of selecting, mapping and testing land holdings in the command area of TKS to a few clicks of the mouse.

The road ahead

Tata Chemicals has tied up with Cornell University's College of Agriculture and Life Sciences to exchange information and people expertise. Talks are on with five more universities to set up development centres.

The TKS initiative has fetched Tata Chemicals a significant share of business. What was initially a support for the company's fertilizer business has now grown into an alternative business which benefits both the farmers and the company. Tata Kisan Sansar acts as a one-stop shop to provide solutions to farmers. In this way, a product company becomes a total solution provider. This model helps in building strong customer sensitivity as well as customer loyalty.

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Himalaya Herbal Healthcare: Making a traditional technology firm competitive

Background

Himalaya Herbal Healthcare is a privately owned company offering a wide range of products with presence across the globe. It had a revenue of more than $US 90 million in 2005. It was started in 1930 when on a trip to Burma, Mr. Mohammad Manal saw restless elephants being fed with roots of a tree, *Rauwolfia serpentina* in order to pacify them. On his return he had it scientifically tested and it was found that it contained natural tranquilizers with anti-hypertensive properties. He pawned his mother's bangles to raise funds for his new initiative. He was searching for ways to make herbal tablets and to present herbal medicines in modern form. After extensive research, Serpina, the world's first anti-hypertensive drug was launched in 1934. This marks the beginning of Himalaya Herbal Healthcare. It continued with its innovative efforts and extensive R&D and in 1955 came out with Liv.52, a medicine for improving the functioning of the liver. The company carried out extensive research, clinical trials and

testing in the various parts of the country before putting it on the market. It went on to become one of India's top ten sellers with over one billion tablets and 13 million syrup bottles being sold yearly across the globe. The company set up an advanced manufacturing unit in Bangalore in 1975. The R&D facility was also shifted there in 1991. The Bangalore manufacturing unit became the largest tablet coating unit in the country with a capacity to punch over ten million tablets a day. This caselet explains the manner in which Himalaya Herbal Healthcare grew into a large firm. The strategy was to leverage traditional knowledge to make drugs that are new.

Developing new products

The focus of the company was to bring out new products based on traditional knowledge. Then it validated the products and launched them on the market. It started looking into opportunities that were lucrative. Their core competence was essentially in identifying new windows of opportunities. This was done by scanning traditional practices that were in vogue. Product development and validation were its strengths. It leveraged these strengths to generate new revenues. Along with product development it focused on brand building. New product development reinforced the company's identity and it became a respected Indian brand. Through new product development it enhanced its brand value over time. Through rigorous research and development and constant improvements, it created innovative products such as Bonnisan, a natural paediatric tonic and Reosto to strengthen bones and to slow bone loss. It introduced Pure Hands, a hand sanitizer based on the germicidal properties of trees such as neem, lemon and hrivera. Instead of using published literature as the basis for product development, Himalaya invested in primary research and extensive clinical trials before introducing any product. Validation helped to treat the efficacy.

Leveraging R&D for innovation

Himalaya had a legacy of research from its own initial stages. It successfully used modern technology to harness the science of ayurveda. It used cutting edge technology to create pharmaceutical grade ayurvedic products. It had a well-defined R&D policy which stated that no investment was too much when it came to scientifically creating safe drugs and therapies. It invested between 8 and 20 years on research before launching any product. Their product development cycle was typically an eight-step process, as shown in figure 3.14.

The R&D team used a unique thin-layer chromatography technique of fingerprinting. This allowed it to test and measure all the physical and genetic properties of each ingredient. Himalaya built up a genetic bank of more than 500 herbs, the largest of its kind. The R&D centre at Bangalore undergoes upgrading every two years. In 2004, Himalaya announced plans for a new R&D centre at Bidadi. To monitor quality, Himalaya started growing many herbs on its own farmlands. It also trained farmers to grow medicinal plants organically with the promise of buying back 100 per cent of the produce. This helped the company to keep a check on the herbs it used. The technology strategy of Himalaya is given in figure 3.15. It first focuses on market penetration. Then new product development occurs. New products are used for market expansion. This results in market diversification.

Figure 3.14 Product development sequence at Himalaya Herbal Healthcare

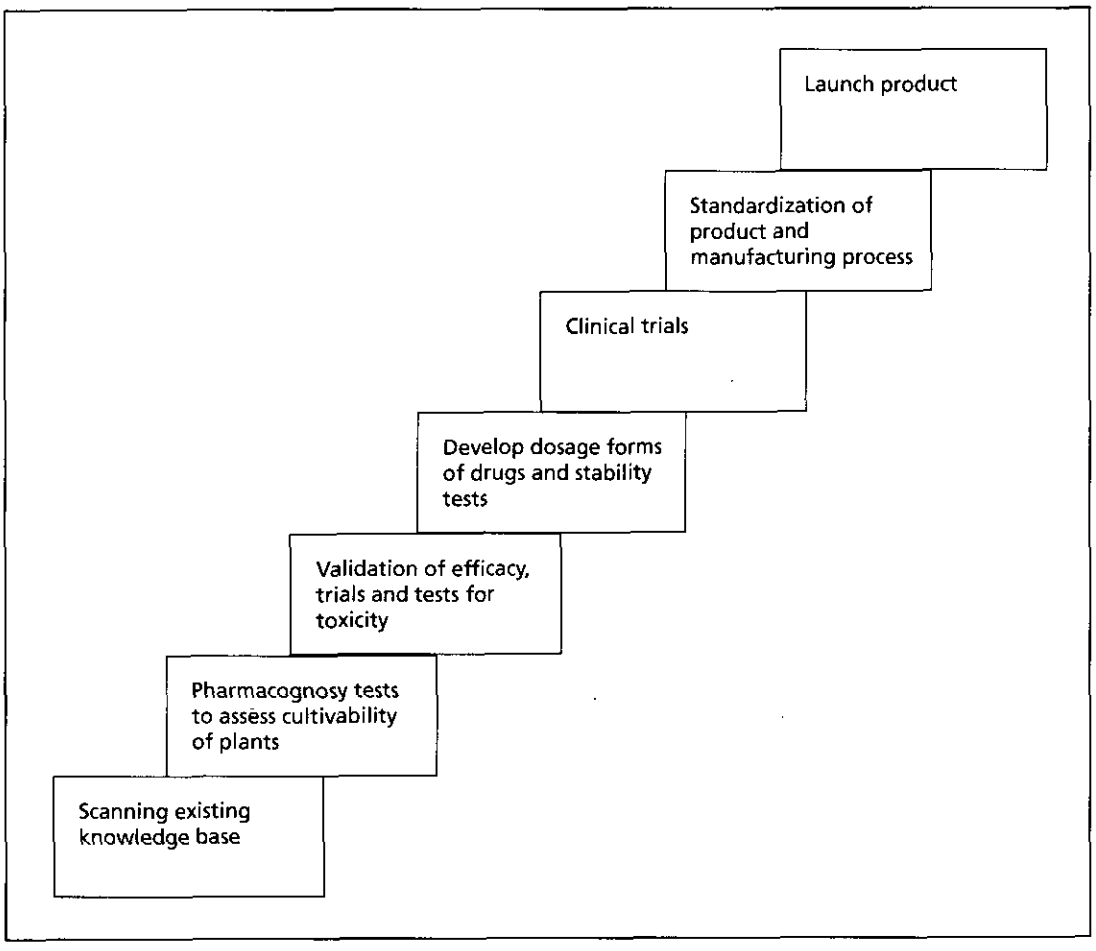
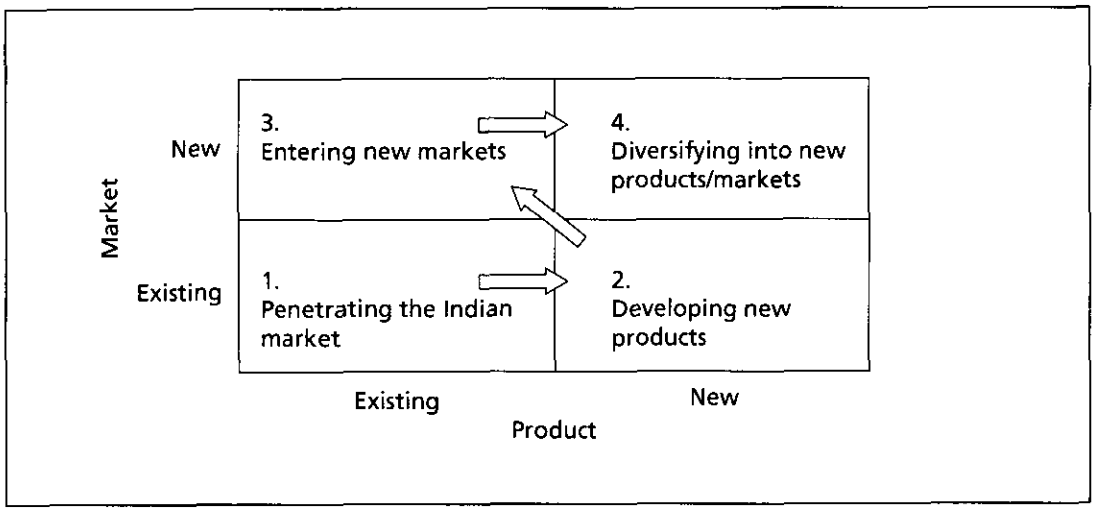


Figure 3.15 Growth trajectory of Himalaya Herbal Healthcare



Expanding markets

After firmly establishing itself in India, Himalaya Herbal Healthcare started looking to expand into newer markets. In 1996, it opened an office in Houston, Texas. It slowly spread across the globe and opened offices in South America, Singapore and the United Arab Emirates (UAE). In 2004 it entered the Mexican market by tying up with a local manufacturer there. In December 2005 it announced its plans to enter the Russian market with more than 25 products. Outside India, the UAE formed the biggest market followed closely by the United States. Malaysia and South-East Asia are also fast catching up.

Sharpening innovation

Himalaya Herbal Healthcare has also diversified its products. It launched its animal health products for commercial livestock in 1998. It later introduced other products to include poultry, aquaculture and pet health products too. Ayurvedic concepts for personal health care were introduced in 1999. They were later merged under the Himalaya Herbal Healthcare brand. They entered the baby care segment by introducing a wide range of baby care products in 2004. The personal care range grew into a business of more than $US 16 million spanning health care, oral care, hair and skin care and baby care. In 2003, the well-being division was formed. This division offered products such as honey, chyavanprash and throat drops. It also continued to bring out more products in the pharmaceutical range. It offered more than 35 products for children, men, women and general health.

Learning from Himalaya Herbal Healthcare

- *Leveraging technology*—By leveraging technology a traditional technology company could transform itself into a competitive venture. It has been able to compete very effectively in both domestic and international markets. The two elements of technology strategy have been leveraging technology and comprehensive market development. SMEs can grow only if they can integrate technological innovations and market development.
- *Innovation*—Innovation is central to becoming a modern enterprise. Traditional technologies can be converted into good windows of opportunity in the market through systematic vision and innovation. Innovation needs a considerable amount of top commitment since many traditional companies do not have a culture that is supportive of innovation.
- *Validation of traditional knowledge*—Innovation is possible by continuously developing newer ideas and converting them into novel and practical concepts. This requires experience and a systematic approach to the validation of traditional knowledge.

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Asian Paints: Understanding customer needs to gain competitive advantage

An overview

Asian Paints is India's largest paint company and one of the top ten decorative companies in the world, with a turnover of $US 572 million. Asian Paints operates in 22 countries and has 29 paint manufacturing facilities in the world servicing consumers in over 65 countries. It was ranked among the top 200 best small companies in the world by Forbes Global magazine in 2002, and was ranked the ninth best employer in India by Business Today magazine. It has consistently been ranked among the top ten companies in the country. It was awarded the Economic Times – Harvard Business School Association of India award in the "mini-giant" and the "Private Sector Giants" categories.

It was started in 1942 as a partnership firm between four associates and grew to become a US$ 7,800 company by 1945. In 1945 it became a private limited company, then called the Asian Oil & Paint Co. Pvt. Ltd. From the late 1950s, the company began to experience tremendous growth. It developed innovative ways of producing the international quality chemicals needed and set up six state-of-the-art plants in various parts of the country. In 1965 it changed its name to Asian Paints Pvt. Ltd and in 1973 it went public. By 1968 it had emerged as the country's leading paint company. Today it is double the size of any other paint company in India and manufactures a wide range of paints for decorative and industrial use. It envisages being among the top five paint companies in the world by 2007.

Impetus on technology

Asian Paints has always put emphasis on technology and innovation. In 1957, the R&D Department developed an innovative process for producing international quality phenolic and malic acid resins. To keep abreast of world technology and to protect its competitive edge, Asian Paints entered into a 50:50 joint venture with Pittsburgh Paints and Glass Industries (PPG) of the United States, the world leader in automotive coatings. Another wholly owned subsidiary, Asian Paints Industrial Coatings Limited was set up to cater to the powder coatings market, one of the fastest growing segments in the industrial coatings market. This wholly owned subsidiary of Asian Paints entered into a tie-up with Canada-based Protech Chemicals. Protech was one of the top ten global powder coatings companies in technological know-how for powder coatings. It was one of the first companies in India to extensively computerize its operations. It used computers widely in areas of distribution, inventory control and MIS for faster market analysis and better decision-making. It successfully deployed ERP, CRM, Business Intelligence and Portal software from leading solution providers and integrated SCM systems. This helped to improve efficiency in the business as well as increase the transparency and accuracy of information across the company.

Connecting with customers

Asian Paints were always on the lookout for unfulfilled customer needs. It introduced various types of paint products with different benefits and for different users. It introduced paints in smaller tin sizes. Earlier the smallest tin size was one litre. However,

Asian Paints saw a market for smaller tin sizes. Farmers liked to paint the horns of their bullocks. This need was left unfulfilled in large parts of the country. So it introduced 50 ml tins which were an instant hit in the market. In the post-liberalization period Asian Paints also focused on the industrial coatings segment. The automobile industry was gaining momentum. It entered into a joint venture with the Pittsburgh Paints & Glass Industries of the United States, the world leader in automotive coatings. It also realized that distribution and services were equally important so it expanded its network to the rural areas of the country. It trained its salesmen to develop close relations with these dealers. For this market it launched Tractor, a paste distemper which is a product unique to India and introduced the synthetic distemper as an alternative to lime coating. It not only concentrated on the low-end and middle-end consumers but also introduced products with a large variety of colours in the high-end of the market.

Expansion into new markets

Asian Paints was among the earliest Indian companies to tap into international markets. In 1977 it entered and went on to dominate the Fiji market. Since then it has established itself in countries such as Egypt, Mauritius, Oman and Sri Lanka. It ventured abroad as it felt that the Indian market was growing at a slow pace. In the late 1990s it set up greenfield projects in Bangladesh and, in 2000, a manufacturing plant in Oman along with the Al-Hassan group, a local company. It also acquired Pacific Paints in Australia. In 1999 it acquired Delmege Forsyth & Co in Sri Lanka. In 2002 it bought a 50.1 per cent controlling stake in Berger International of Singapore. This gave Asian Paints access to twelve entirely new markets where Berger had a strong brand presence. It also acquired the SCIB Chemical SAE of Egypt and Taubmans Paints of Fiji. These acquisitions put it among the top ten paint manufacturers of the world. They only entered markets where the potential for growth was high. Acquisitions were made in markets where competition from other MNCs were low. These were also the markets which presented enough market segments for Asian Paints to establish itself. It focused on quality and cost competitiveness in all the markets it entered.

Learning from Asian Paints

Asian Paints has been able to establish itself as a premium brand for the following reasons:

- *Customer excitement*—Besides introducing a variety of colours and products for various market segments, Asian Paints also introduced features such as paint calculators and Colourworld. The paint calculator helped customers to calculate the amount of paint necessary for various areas of rooms. Colourworld enabled the customers to choose accurate shades at economical rates. These features helped Asian Paints to create and maintain customer excitement.

- *Technology leveraging*—Asian Paints has always been at the forefront to acquiring and leveraging new technologies. It tied up with foreign paint manufacturers to obtain technological input and was also quick to understand the importance of information technology, to which it rapidly adapted.

- *Integrating acquired companies*—Instead of laying off employees of the companies it acquired, Asian Paints ensured that the employees of these companies also appreciated the same values as the rest of the group. They understood that the Berger brand is well recognized world wide and worked towards leveraging this brand name.

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Biocon: Leveraging manufacturing technology to go global

Background

Biocon was one of the first venture-supported companies that started in Bangalore in 1978 with a capital of Rs 100,000. Biocon began as a joint venture between the promoters Ms. Kiran Mujumdar Shaw and Biocon Biochemicals Limited, an Irish-based multinational. The Irish company was planning to source an enzyme derived from the papaya, a naturally growing fruit tree. Papain is a plant enzyme that is extracted from the tree. It also planned to produce isinglass, a marine hydrocolloid made from fish. Both papain and isinglass are needed for the brewing industry. A world class manufacturing facility was set up at Bangalore.

Spreading its wings

Biocon started a separate company to focus on R&D related to enzymes, namely Biochemizyme India. Biocon began focusing on innovation to develop novel enzymes for the Biocon group worldwide through solid state fermentation process technology. Biocon started another subsidiary to focus on pharmaceutical biotechnology, which later diversified into pharmaceuticals. The Unit Trust of India and Technology Development and Investment Corporation of India became the venture investors in Biochemizyme in 1989. Biocon obtained ISO-9001 certification in 1993 and started a contract research organization in 1993. Named Syngene, the objective of this company was to conduct research for third-party clients in the area of drug discovery. Biocon focused mainly on fermentation technology and microbial genetics. In 1995 Unilever acquired a 50 per cent stake in Biocon that Glentech International bought from Unilever in 1999. ICICI ventures, a venture firm acquired a 15.35 per cent stake in 2000, through an investment. Biocon continuously expanded its operations and, by 2000, it had became the largest biotech firm in India.

Biocon innovated a proprietary bioreactor for solid state fermentation technology. This technology was awarded a US patent in 2000. Solid state fermentation reduces the process cycle time and provides uniform quality output continuously unlike a batch reactor. In the same year Biocon started a research company for undertaking longitudinal clinical studies in select disease segments. In 2003 ICICI Ventures divested its shareholder interests in a private equity fund, AIG Asian Opportunity Fund.

Going public

Biocon went for an initial public offering to raise Rs 3,000 million to fund its huge capital expansion plans in March 2004. The issue was oversubscribed 32 times. Biocon closed day one of listing on the stock exchanges with a market value of around the US$ 1.11 billion mark. In October 2004 Biocon announced a research collaboration with a US firm to develop oral insulin to treat diabetes on a global scale. Biocon also announced a research partnership with Vaccinex to discover and co-develop four therapeutic antibiotics.

Learning

The case study of Biocon illustrates the manner in which the firm used business excellence and technological innovation in an integrated manner to become a global player starting from an SME base. Its main strategies can be summarized as follows:

- Learning rapidly to master technologies to manufacture products for global companies.
- Partnering with a number of companies to create new growth opportunities for the future.
- Innovating a process for fermentation that could be used for a number of products.
- Managing the business excellently to create value in the market place.
- Leveraging venture capital judiciously to manage the growth process that transformed Biocon from an SME to a global player.
- A world class manufacturing facility helped Biocon to market its products globally.

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Technology strategy: growth of Embraer as a global company

Background

The Empresa Brasileira de Aeronautica S.A.(EMBRAER) is the fourth largest manufacturer of commercial aircraft in the world. Its product range includes commercial, military and corporate aircraft. Ten years ago it was a company making only turboprop aircraft and losing money. Embraer was founded in 1969 with the intention of making Brazil self-reliant in aircraft manufacturing. It was conceived as a mixed enterprise, with the government holding 51 per cent of the voting shares and the rest with private investors. Though it showed profit initially, during the late 1980s and early 1990s the company was approaching bankruptcy and in 1994 it was privatized. By 2004, Embraer had gone on to become one of Brazil's largest exporters. The rise of the company from bankruptcy to a globally respected aircraft manufacturer can be attributed to strategic alignment and management of technology. Strategic alignment is the process of aligning business objectives, customer needs, people capabilities, business vision and technological competence.

Identifying the window of opportunity

Embraer found that there was a window in the market for aircraft that was underserved by other aircraft manufacturers. It determined to enter the regional aircraft segment. There was a rapid growth of regional airlines using point-to-point routes and Embraer decided to exploit this segment. With increasing demand for regional services along with the aging of the aircraft currently in use, Embraer focused on shorter regional routes with low operating expenses, lighter and more fuel-efficient aircraft and with low break-even load factors. In any technology business the identification of a distinct window of opportunity allows a firm to be the first mover.

Technology sourcing

Embraer used licensed technologies and created many growth opportunities for itself and acquired many crucial technologies. The first product from Embraer was a military plane, the Xavante produced in 1971 under licence from Aermacchi, an Italian company. From then on, Embraer has had many strategic alliances which have helped it to improve its R&D capabilities and technological know-how. Embraer introduced another fighter plane, the AMX. This was through a joint venture with the Italian firms Alenia and Aermacchi. This gave Embraer access to advanced technologies in the areas of system and data integration and electronics. To aid in-house technological development, the company has invited many international leaders in aeronautics to become minority shareholders. These include companies such as Thales and the European Aeronautic Defence and Space Company, world leaders in electronics systems for the aeronautics industry. The use of licensed technology allowed it to reduce product development cycle time. It learnt and absorbed technology and generated internal confidence to develop smaller capacity passenger jets for regional routes. The hub and spoke arrangement had created demand for regional jets.

Working through partnerships

Embraer leveraged partners for making major components such as wings, flaps and engines. This helped Embraer to reduce the risk involved in developing and producing costly, technologically challenging components. These firms are international manufacturers such as C&D Aerospace for cabin interiors and Sonaca. Sonaca has also set up a subsidiary in Brazil called Sobraer which focuses solely on supplying fuselage to Embraer. It established partnerships with Gamesa of Spain and Enaer of Chile to build the EMB 145. It has a joint venture with AVIC from China and has set up a plant in China. Embraer plans to use this plant to gain entry into the Asian market. It has used outsourcing to provide highly technical project and engineering support and also to perform less technical operations such as chemical coating.

Understanding the customers

Mauricio Bothello took over as CEO of Embraer in mid 1995. He transformed the company, changing the focus from manufacturing to serving customers. This led to the development of aircraft such as the Embraer 175 and Embraer 190. The Embraer 175 can carry 78-86 passengers and Embraer 190 about 95 passengers. These were very fuel efficient aircraft with low operating expenses. They were designed with greater levels

of passenger comfort and fuel consumption efficiency. When Bombardier was trying to modify its existing aircraft to make 70-110 seat aircraft, Embraer designed its planes from scratch, keeping comfort in mind. It made distinctive aircraft, as they were designed from scratch. Also, to maintain customer focus, Bothello created five new profit centres, three geographically based, one for light aircraft and one for government sales. Each centre has an "entrepreneur" in charge with responsibility for improving customer relationships. Embraer also started an Internet portal called Customer Integration System (CIS) so as to achieve substantial improvements in communication and data exchange and reduce transaction costs. As opposed to the usual e-business initiatives, CIS primarily focused on improving customer support instead of generating additional revenue. Mr. Bothello established a customer-centred mindset at Embraer

Systematic execution

Embraer's close competitor Bombardier believes that Embraer has profited through unfair government support such as export subsidies. However, it is equally true that Embraer has many competitive advantages over Bombardier. Embraer has a first mover advantage in the 100-seat market. Embraer has a common design for its new 70-110 seat jets. It has a set of shared parts and interfaces which allows it to scale maintenance and spare parts inventory across several types in the same family. This design commonality allows the same pilots to fly different aircraft. Embraer has slowly increased its market share. Many airlines such as Air Canada and JetBlue also acquired Embraer aircraft for regional routes.

Learning

Embraer is a successful example of managing technology. It has become the fourth largest aircraft manufacturer in the world. This was done by acquiring technology and then absorbing it to make its own product. Embraer brought out a product that is distinctively different and this product differentiation made it a global player. It identified a unique window of opportunity and developed a distinctly different new product. It pooled resources and reduced risk through partnering, licensing and alliances. The vision to be different and to execute the vision meticulously makes Embraer a role model of how to become a globally competitive aircraft manufacturer.

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Lijjat Papad: Growth of an SME through franchising

Background

Seven women gathered on the terrace of their building in Bombay to find out activities that could supplement their income. The idea of preparing papad (sun dried cereal wafers) originated on 15 March 1959. They started with an initial loan of US$ 2. As the papads received a favourable response, the women became busier. Within three months they had 25 women working in their group. The number increased to over 150 in two years. Under the able guidance of Mr. Chhaganlal Parekh and Mr. Damodar Dattani, they worked towards running the initiative as a business enterprise. These are the humble beginning of Shri Mahila Udyog Lijjat Papad, which is today a US$ 69 million business. It has over 40,000 women in 62 branches and 40 divisions working all over India. About 10 per cent of their income comes from exporting papads across the globe. Lijjat has now become a household name. This case illustrates how a traditional business can create brand reputation and value through systematic quality improvements in a food processing industry such as papad.

Business structure

Lijjat has a very innovative business model. The recruitment process is fairly simple. Only women can become members. Any woman can become a member by signing a form pledging to adopt the institution's values. They are allotted work as per the consensus of the sister members. Sister members in the branch office prepare the dough in the morning. Others take the dough home to roll the papads. Each member is bound by the pledge to roll out three kilograms of papad everyday. The papads made from the dough taken home the previous day are received. Payments are made straight away and none are kept pending. Lijjat became a very attractive proposition for women as they could earn a fixed amount daily.

All branches are responsible for their individual profits or losses. Profits (or losses) are shared equally among the sister members. The branches are also responsible for marketing their products. All the branches send their accounts on a regular basis to the central office where the final auditing is done. The central office at Mumbai also intervenes in quality maintenance and assurance. They supply the raw material to all the branches to ensure quality. The papads are prepared all over India. To prevent any inconsistencies in quality Lijjat has set up a laboratory in Mumbai where the final products are tested and coded. The central unit looks after quality, branding and taxes.

The organization is run by an elected committee of 21 people including the president, vice-president, two secretaries and two treasurers. The managing committee is chosen by consensus of the sister members once every three years. The central office used to coordinate the activities of all the branches. But due to the increasing number of branches, authority was decentralized in terms of routine work and profit sharing. However all branches are supposed to obtain the approval of the central office before starting any new project. Each branch has an eleven-member committee to manage their affairs.

Diversification

Lijjat has diversified from its basic papad business to offer a wide variety of products such as detergents, khakras, atta (flour) and masalas. They also own a printing division, a polypropylene set-up and an advertising division in Mumbai. It has tried its hand, albeit unsuccessfully, at manufacturing incense sticks. leather bags, tiffin boxes and matchsticks. It has also started manufacturing chappatis on the same model. Today Lijjat is one of the most respected brands in the country symbolizing the strength of the Indian woman.

Growth through franchising

Lijjat is an example of value creation through franchising. A traditional food processing unit grew slowly and scaled its operations to become a multi-unit entity. Branding, advertising, procurement and quality are the processes carried out at the headquarters. The main learning point is that a traditional industry can grow provided quality assurance is ensured and the distribution network is reasonably good. Even a simple technology such as papad has the potential to grow as a large national brand. Franchising and low investment have made this business asset light and reasonably profitable. Traditional industries have an enormous number of growth opportunities, provided they have a viable business model and a quality management system.

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Leveraging technology: Amul dairy

Amul dairy: its origin

Amul is India's largest food brand with an annual turnover of around US$ 600 million. It started as two dairy units collecting and processing milk for sale to urban centres. It was started in 1946 in Kaira District, Gujarat by forming cooperative societies in two villages in the district. The Kaira Union began by providing pasteurized milk to the city of Bombay, as it had a huge demand. The concept was made a success by a visionary leader, Mr. V. Kurien, who wanted to create rural employment through a chain of dairy units. The assured market acted as an incentive for production. By the end of 1948, more than 400 milkmen had joined in. The quantity of milk handled by each community grew from 250 litres to 5,000 litres between 1946 and 1948. This is the beginning of the Gujarat Cooperative Milk Marketing Federation (GCMMF). It started small dairies around small rural communities in Gujarat.

Innovation as a source of growth

Slowly the dairy set-up extended to other parts of the district. As the movement spread, it was found that Bombay could not absorb the extra milk collected by the Kaira Union

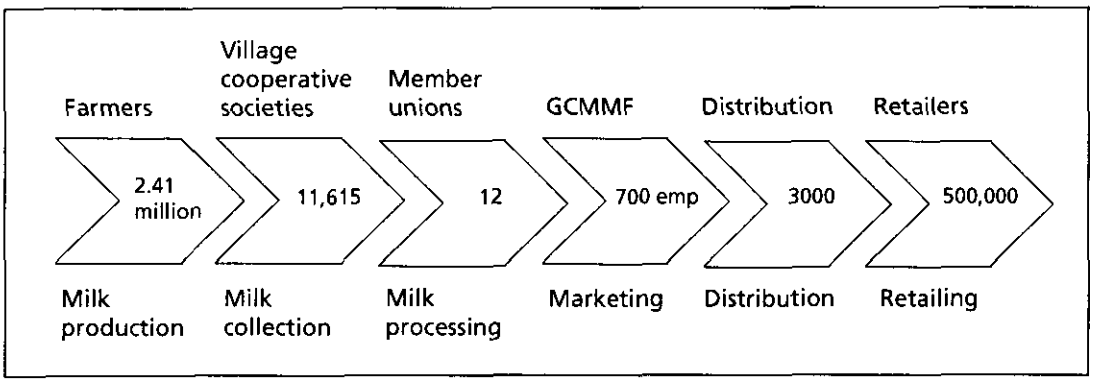
during the flush season. Production in winter was on average 2.5 times more than in summer, which is the lean season. The United Nations Children's Fund suggested to Amul that it should convert the surplus milk into milk powder. With the research support of the Central Food Technology Research Institute in Mysore, buffalo milk was made into powder, though no one had attempted it before. It was ready to provide the equipment for the same. At that time, it was not considered technically feasible to make milk powder from buffalo milk. India has a large buffalo population. Mr. Harichand Dalaya provided the required technical help and a Rs 5 million plant to manufacture milk powder and butter was commissioned in 1955. The factory was expanded to manufacture sweetened condensed milk in 1958. The know-how used was indigenous. Two years later, a new wing was added for the manufacture of 2,500 tons of roller-dried baby food and 600 tons of cheese per year, the former based on a formula developed with the assistance the Central Food Technological Research Institute (CFTRI) in Mysore. This was an innovation. It was the first time anywhere in the world that cheese or baby food had been made from buffalo milk on a large, commercial scale.

The next step was to enhance the productivity of dairy animals, as productivity was low because of lack of fodder. A plant was set up in Gujarat to manufacture balanced cattle feed. The plant was donated under the "Freedom From Hunger Campaign" of the Food and Agriculture Organization of The United Nations. To meet the requirement of milk powder for defence personnel, the Kaira Union was asked by the Government of India in 1963 to set up additional milk drying capacity. A new dairy capable of producing 40 tons of milk powder and 20 tons of butter a day was speedily completed and declared open in 1965. Innovation and growth were the two strategies used by Amul. Anand, where Amul established its first dairy slowly became an industrial cluster. Amul slowly increased its market penetration.

Expansion into new markets

Today the apex cooperative organization, the Gujarat Cooperative Milk Marketing Federation Ltd. has 12 union members and is jointly owned by over 2.41 million milkmen. It handles over 7.4 million litres of milk per day and produces more than 50 milk products. Though it was started as two small dairies, it spread to other regions. The value chain of GCMMF as on today is presented in figure. 3.16

Figure 3.16 The GCMMF value chain



Its range of products include milk powder, ice cream, cottage cheese, pizza, cream, health food drinks, etc. Amul also expanded into other states replicating their successful "cooperative" model. Now they have a presence in 22 states across India, forming a National Milk Grid. It has been responsible for the first instance of the successful transportation of liquid milk in tropical conditions. Amul is helping many other countries to replicate the model in Africa where job opportunities are poor in summer, especially in rural areas.

Leveraging technology across the value chain

Amul provided its members with every provision needed to enhance milk production. As early as the late 1950s, the Union started producing high quality buffalo semen. Through village society workers an artificial insemination service was made available to the rural animal population. Animal health was a neglected area. The Union started its own mobile veterinary services to provide animal health care on the farmers' doorstep.

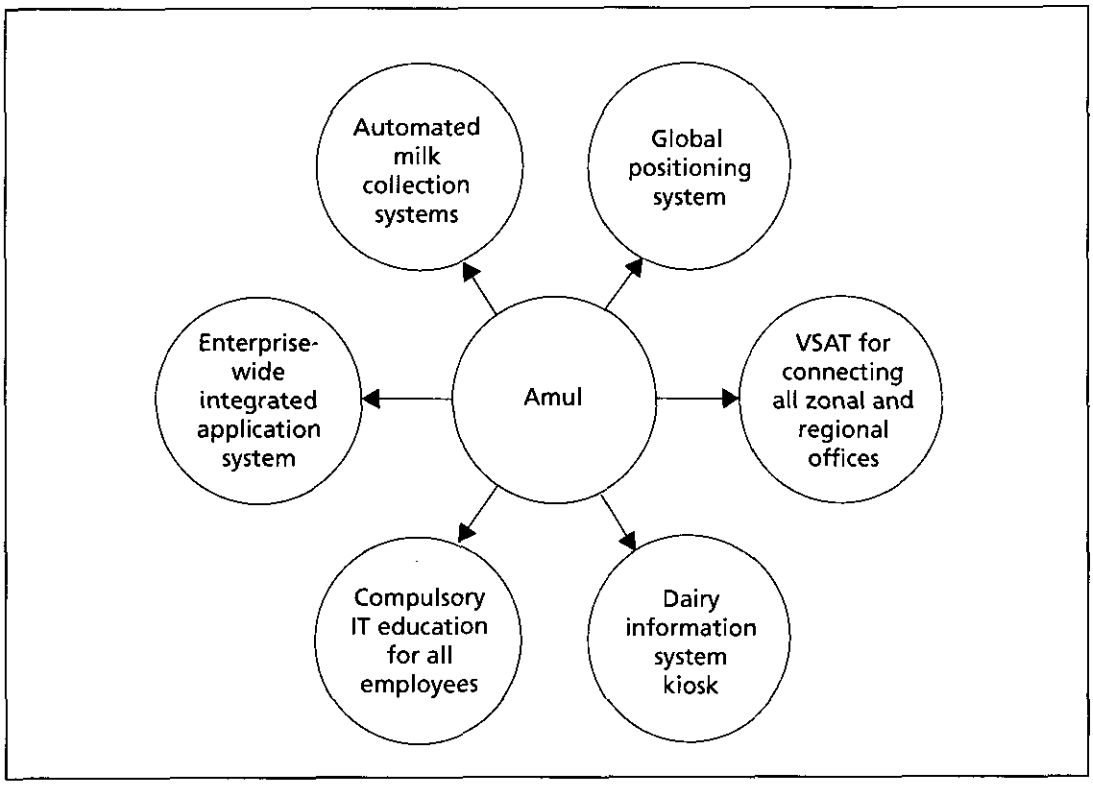
Amul has also consciously leveraged IT to provide better service to the milkmen so that they don't have to travel to the collection centres. IT plays an important role in managing the logistics of collecting 7.4 million litres of milk per day. More than 3,000 automatic milk collection system units have been installed. They are implemented so as to capture member information, milk fat content, volume collected and the amount payable to each member. Amul has an ERP software development project called the enterprise-wide integrated application system (EIAS). It covers a plethora of operations such as market planning, advertising and promotion, distribution network planning, stock control, sales and accounting, budgetary control, quality control management and cooperative service management. The various zonal and regional offices of Amul are also connected through VSAT. Amul has been using Global Information Systems (GIS) to locate zone, depot and distribution locations. This data is used for sales and distribution planning. GIS is also used for monitoring veterinary health, controlling outbreaks of diseases and forecasting milk production in various regions. The various examples of IT leveraging done by Amul can be seen in figure 3.17.

Learning from the Amul experience

The basic reason behind the success of Amul is that it has used technology to effectively provide an assured market at remunerative prices for producers' milk. Amul became a channel to market milk products so that it could provide a variety of value-added products. Amul is an example of rural industrialization through technology leveraging. The dairy is the main source of income for the rural poor. Using technology the shelf life of milk is extended, products are created, logistic support is strengthened, the productivity of animals is increased and animal health is improved. Amul also illustrated that market penetration and technology diffusion are modes through which technology can create value in rural communities. The dairy business has a high potential for catalyzing the growth of clusters. Clusters have become a major source of competitiveness. Leveraging IT could help even traditional industries to enhance competitive advantage. Amul has used technology in every aspect of its value

chain to enhance business value. Amul has been able to compete effectively with multinational corporations because of its customer linkage and technology network.

Figure 3.17 IT leveraging by Amul



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Ittiam Systems: leveraging knowledge to go global

Ittiam is positioned in the fastest growing segment of the core technology space: Digital Signal Processing Systems (DSP Systems). The DSP chip market was valued at about US$ 5 billion in the year 2000, and is growing at 30 per cent per annum. The market for DSP software and system design is worth about US$ 9 billion, growing at more than 50 per cent per annum.

Founders and their dreams

Srini Rajam, formerly head of Texas Instruments India Ltd, and six passionately determined colleagues decided to create a world-class technology company in India. These seven people, with between 15 and 25 years' experience each, came together to meet

the challenge of creating "the world's best DSP systems company". TI India Ltd was one of the most innovative companies in India, as it topped the best companies operating in India and were granted US patents in the year 2000.

Venture capital

Ittiam started in 2001 with a seed capital of $US 5 million from Global Technology Ventures. (GTV is an investment arm of Sivam Securities, in which the Bank of America has an investment stake). After that, in the second round, the Bank of America Fund offered $US 5 million for another 6.6 per cent, a price which valued this start-up at a staggering $US 75 million.

Products

Within a year of its start, Ittiam had developed multiple products in all its target domains. This includes video imaging and an audio speech product in multimedia, in addition to wireless and wireline communication products. Ittiam also announced its wireless products, which are IEEE 802.11 based wireless LAN. Ittiam has developed solutions for both 802.11b standard which has a bandwidth of 11 Mbps and orthogonal frequency division multiplexing.

Ittiam will lead the new wave of global product companies from India. The company represents the collective aspiration of the team to lead the new wave of Indian technology products, thriving in the global arena. Ittiam is singularly focused on digital signal processor-based systems in wireline, wireless, audio speech and video-imaging products.

Consistent with its bold vision, Ittiam is pushing at the frontiers in all the key areas: business, technology and people. In business, Ittiam has chosen to go beyond the traditional service model and has committed itself to products, both customized and off-the-shelf technology. In technology, Ittiam selected integration as its strategy algorithm, through software to operate the actual reference board that resides in the end equipment. On the people front, Ittiam works with the fundamental belief that the company is co-owned by all who work and share the dream, irrespective of their function. The company has given shares to all its employees.

Learning from Ittiam

Ittiam is one of the most innovative firms operating in India, with high-quality intellectual property. DSP solutions are implemented on a generic platform. Ittiam has system focus and not chip focus. The platform integrates all the interrelated domains. The company has a full-fledged marketing group and it has entered into strategic partnerships for overall solutions. In other words, Ittiam is a unique niche player with the ability to innovate. There were no technology companies in India and Ittiam positioned itself as a technology company. The core competence of Ittiam is its capability to identify good windows of opportunity. The five aspects that distinguish Ittiam are as follows:

- Experienced team
- Market focus
- World-class orientation
- High-level platform as the mode of integration
- Vision to be a global leader in DSP design

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Chapter 4 Technological innovation

Innovation typology

Opportunity analysis

Innovation cycle

Organizational culture

Support for innovation

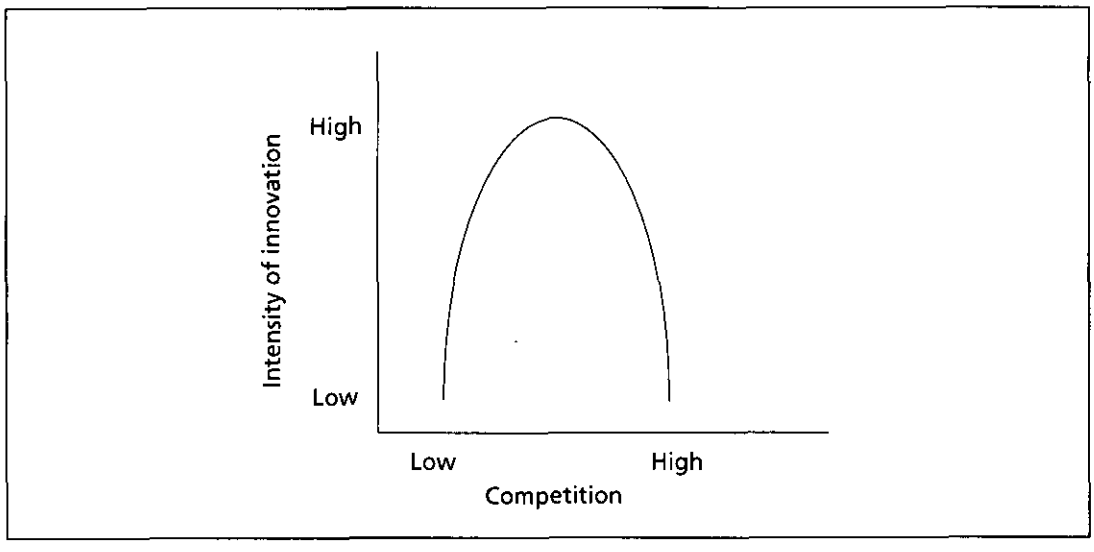
Best practices on innovation

TECHNOLOGICAL INNOVATION

"Wealth is not gained from perfecting the known". New knowledge, ideas, services, concepts, applications, processes and new products are the major sources of economic growth. Schumpeter was one of the economists who showed that innovation is the engine of growth. Innovation flows from corporations or entrepreneurs. One of the first management experts who talked about innovation was Peter Drucker. He proposed that innovation was a systematic search for change and opportunity. Innovation is becoming the major source of competitive advantage as other sources diminish in significance. Availability of raw materials, location benefits, and tax breaks are not advantages that can be leveraged across a number of markets. Creating new markets, exciting customers and overtaking competitors can be achieved through innovation. It follows from this that innovation is coming up with new ideas and commercially benefiting from these ideas. Innovation requires a mindset that is willing to be open to new ideas. Organizations that are bureaucratic tend to keep away from innovation. Also, innovation is a paradoxical process that requires logic as well as imagination. Logic is needed for getting projects executed whereas imagination is needed for creating a novel product or a service.

Many firms in developing countries did not have experience in generating new ideas and implementing them. In economies that were closed to competition, the business environment was protective and this curbed the innovation initiatives. As global economies become more and more open to competition the need for innovation will also increase. Innovation and competition have an inverted relationship, as shown in figure 4.1. This indicates that optimum levels of innovation are what could give the best results. Beyond a certain point, competition hinders innovation as product life will become short and companies will not be able to recoup the investments made in generating innovative products, services or processes.

Figure 4.1 Competition and innovation

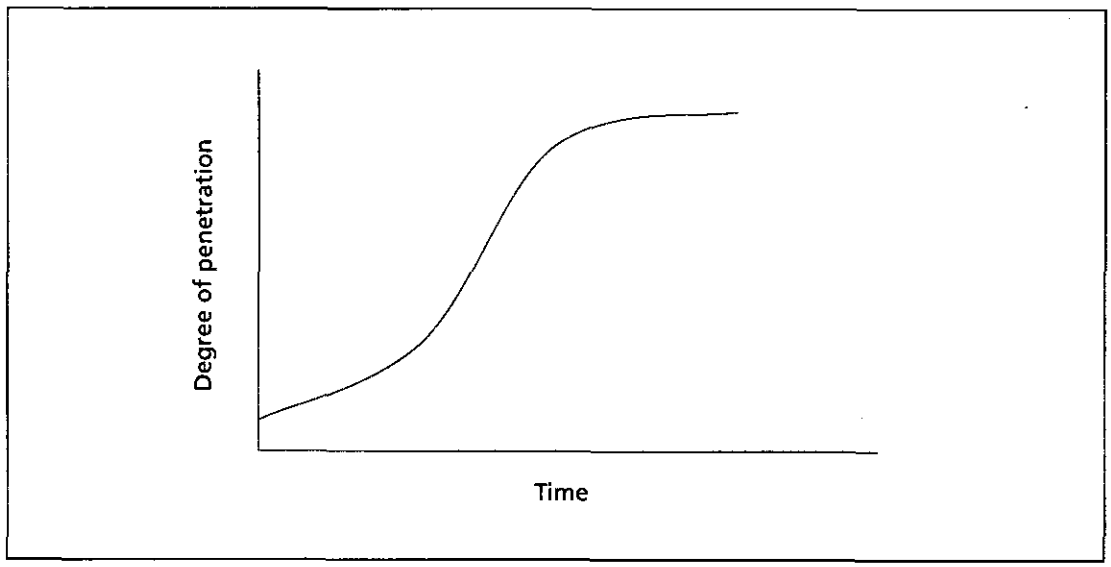


From the organizational perspective, there are three distinct horizons of innovation. The first is typically horizon 1. These are incremental improvements that are not investment intensive. They are simple and can be realized rapidly. For example, reducing water consumption in the production of a chemical could be an example of innovation. Incremental innovation needs minimum investments but benefits will be marginal. Incremental innovations are easily generated.

On the other hand, radical innovations are difficult and require strong organizational commitment. This requires the courage and commitment to pursue new ideas and execute them flawlessly. An example of this is the aseptic packaging that does not require refrigeration for juices and milk products. This innovation was generated by a small entrepreneur in Sweden who developed a method for storing fruit juices as well as milk. This innovation benefits a large cross section of people as fruit juices could be easily transported and sold in areas where there is no electricity. This packaging also is very convenient for people who are travelling.

The third level of innovation is disruptive innovations. These are essentially innovations that change the structure of the industry. For example, compact discs based on lasers have revolutionized both the computing and entertainment industries, making video cassettes obsolete. Disruptive innovations are slow to gain acceptance but once they are accepted they change the industry structure. Disruptive technologies penetrate at a slow pace, following an S-type growth trajectory, as shown in figure 4.2. New technologies take time to get accepted. Once they are found useful they penetrate faster.

Figure 4.2 Diffusion of new technology



Instead of classifying innovations as incremental, radical and disruptive, they could be categorized in terms of the nature of the innovations as shown below:

- *Product innovation*—These are new and innovative products that are being introduced. These novel products have new features but not all of them are successful in the market place. It is reported that the new product success rate is around 60 per cent. Although there has been considerable focus on new product development, failure rates are still on the high side. This phenomenon is also known as the "valley of death". Of the 3,000 ideas that come on to the market, only one product will become a real commercial success. Hence, it is necessary to create as many ideas as possible so as to ensure a rich product pipeline. It has been found that the success rate of innovation could be enhanced if three prerequisites exist:
  - An innovation champion who could take it from the beginning to the end
  - A process that companies will follow for managing innovation
  - Critical competencies and resources that are needed for executing the innovation

- *Process innovation*—The second category of innovation is called process innovation. "Doing things differently" is the focus of this category of innovation. For example, Pilkington developed a process for making large sheets of glass by drawing them over a pool of molten tin. It revolutionized the glass industry. Large sheets of glass without defects could be made through this process, known as the "float glass" process. In mature industries process innovation is the major source of enhancing competitiveness.

- *Application innovation*—An existing idea is used for a different purpose. For example aspirin, formerly an analgesic, is now used for thinning blood or rather preventing clotting thereby reducing the risk of strokes. Many innovations are used for new purposes. For example Teflon, originally developed as an insulating material, is now used for many new applications.

- *Platform innovation*—Developing an innovative product or service and from that deriving a series of variants is platform innovation. Airbus developed Airbus 320 and by using a common wing and many common components it developed a series of variants in quick succession. The A-321, A-319, and A 318 are the derivatives that were brought out through platform technology. Innovation allows for economies of scope and reuse of knowledge to give many variants. Platform technology allows companies to meet diverse customer needs with a single platform as indicated earlier in chapter 1.

- *Marketing innovation*—Applying innovation for marketing a product or a service is marketing innovation. Amazon.com was the first book store to start selling books through the Internet. It has overtaken the oldest bookstore in United States in a short time frame. Ideas can come from anywhere and they can be used for any human endeavour.

- *Business value chain innovation*—Configuring the business value chain differently and deriving business value is called business value chain innovation. Outsourcing business processes to other countries and leveraging competitive advantage is an example of this type of innovation.

These illustrations are presented to highlight the diverse ways in which innovation can be leveraged for the creation of customer value and business growth.

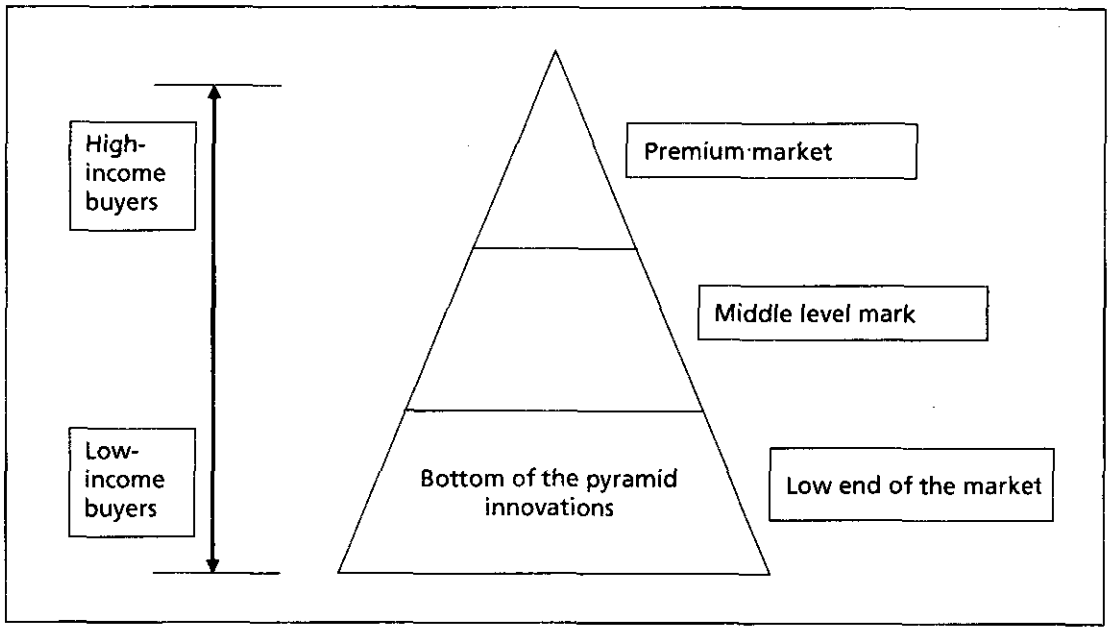
Opportunity analysis

The main purpose of innovation is to exploit a market opportunity. This could be in a variety of ways, namely:

Can we use innovation to satisfy unmet needs?—For example, could we classify or identify fragrances using digital methods? The idea gave birth to the concept of "digital noses". Fragrances, wines, tea, fruit juices, coffee, etc. could be precisely identified using the "digital nose".

Could we use innovation to perform a current activity differently?—Credit card usage came up as an answer to this. Electronic money grew very rapidly and is widely used in many market segments. An SME in the United States developed a new innovation in which computing could be carried out through the Internet without having a central processor. This could be a revolutionary innovation that uses client server technology to bring low cost computers. Such innovations have been termed "bottom of the pyramid" innovations. They are schematically shown in figure 4.3. Producing products and services that could be at the low cost end of the market segment is emerging as a new market opportunity.

Figure 4.3 Bottom of the pyramid innovations



A SME located at Chennai in India, namely KevinCare, developed shampoo and then sold it in small sachets in India at Rs. 1 (46 Rs = 1 US Dollar). Low-income residents could buy this and use it instead of buying a bottle of shampoo. This innovation penetrated the market and KevinCare grew rapidly. Now KevinCare markets many products in small polyethylene sachets. Creating demand at the low end of the market through innovative approaches is the essence of this innovation.

- *Could we create value out of waste materials?*—This is another opportunity for leveraging innovation. A food processing firm that processes pineapple in the Philippines used pineapple waste to generate cattle feed. Pineapple waste is a major area of concern in the food processing sector. New value creation from waste is an innovation opportunity.

- *Could we customize an existing low quality input to replace a high quality input?*—Tata Steel is an Indian steel manufacturer that faced a problem of high phosphorous levels in the iron ore it used for steel making. Many applications need low phosphorous steel as phosphorous reduces the strength of steel. Tata Steel developed a modified process that could use high phosphorous ores to make low phosphorous steel. Adapting available inputs in an innovative manner reduces the cost of production.

- *Could we reduce cycle time to enhance customer convenience?*—A defence laboratory operating in India developed "ready to eat" foods that need only reheating before eating. This innovation has been useful for people staying at remote locations such as desert areas, mountains, islands, etc. This innovation is a user friendly product and very convenient. Vacuum processing also keeps the food hygienic.

- *Could we create products with distinctly different properties?*—A small entrepreneurial firm, Nano-Tex, introduced a fabric with virtually magical properties. Coated with a nano-material, this fabric behaves as though it were a lotus leaf, repelling stains and spills. It can be used in any environment. In summer it functions as a thick fabric allowing heat to be dissipated. In winter, it functions as a barrier to minimize heat loss. Nano-materials provide magical properties as they operate at quantum level. It is reported that there are 5,000 products that leverage nanotechnology already in place. Nanotechnology is one of the fastest growing areas.

- *Could we use existing traditional knowledge to create an innovative application?*—In traditional knowledge the extract of a common flower found in many parts of the world is used for treating the degeneration of eyesight arising out of ageing. The name of the firm is Indus Biotech. The drug is undergoing clinical trials in Europe. It has been found to be highly effective. Many traditional uses are being validated and then new products are derived based on these.

3M has developed a three-step process for screening innovative ideas to assess their potential utilization. First, new ideas are collected and then classified into three categories:

- Revolutionary ideas that will have business value
- Evolutionary ideas that could be implemented quickly
- Overlooked ideas that were rejected as they may not have been found to be of any use at that juncture.

These ideas are then subjected to a three-step filtering process, namely:

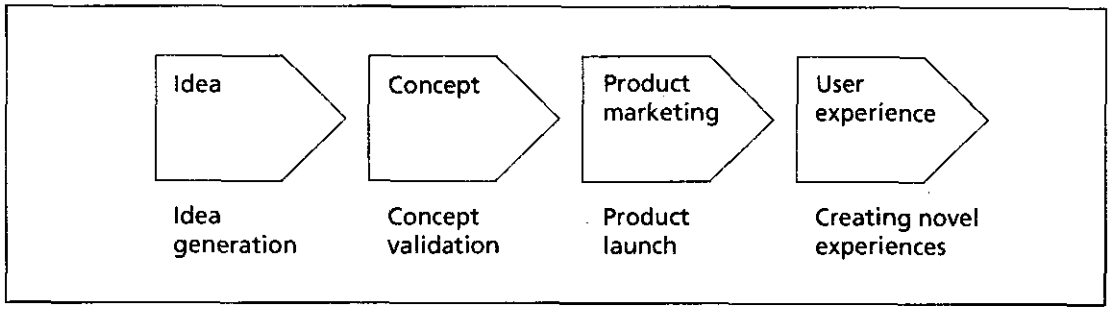
- Is the opportunity arising out of this innovation real and practical?
- Will it be possible to get the idea on the market in a competitive manner?
- Will this innovation be worth pursuing and will it generate enough revenue in relationship to the investment that the firm has to make?

If the answer is yes to all the three questions, the ideas are pursued or modified or they are rejected or stored for the future. Idea generation is the starting point of innovation and only new ideas or combinations of ideas can become innovative products or services.

Innovation cycle

The innovation cycle involves moving new ideas to new concepts to new products or new services and to new customer experiences. The movement of a new idea to an innovative product or service is given schematically in figure 4.4

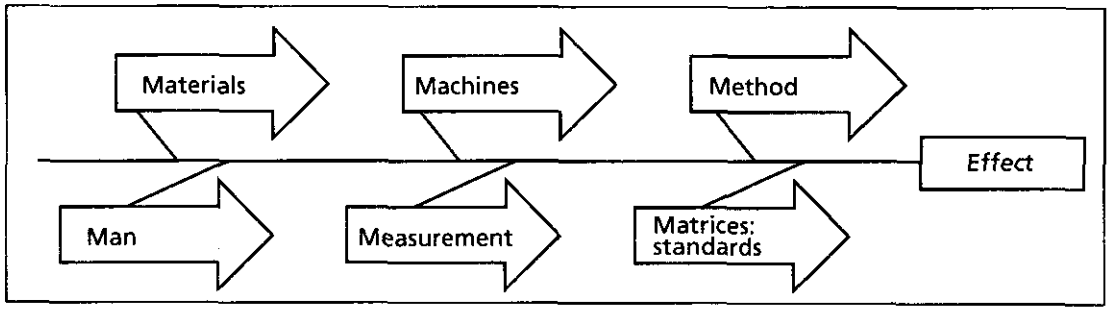
Figure 4.4 Innovation cycle



Idea generation: Ideas get generated and they are used for a business application. There are many idea generation tools currently in use. They are summarized below:

- *Picture of the future*—conceptualizing or visualizing something distinctly different
- *TRIZ*—This is a Russian method that uses contradictions for innovation. Developing a scooter that is light at the same time very sturdy is a contradictory requirement. From this idea one could get an innovative product: a light but crash resistant structure
- *Ishikawa diagram*—The Ishikawa diagram is a method for looking into a problem with the aim of obtaining new ideas. A schematic presentation is given in figure 4.5.

Figure 4.5 Ishikawa diagram



- *Morphological analysis*—Components are combined in many ways to get different sets of product or service architecture
- *Product template*—The attributes of a product are listed and deliberately changed to get a different set of attributes that could give a unique product attribute

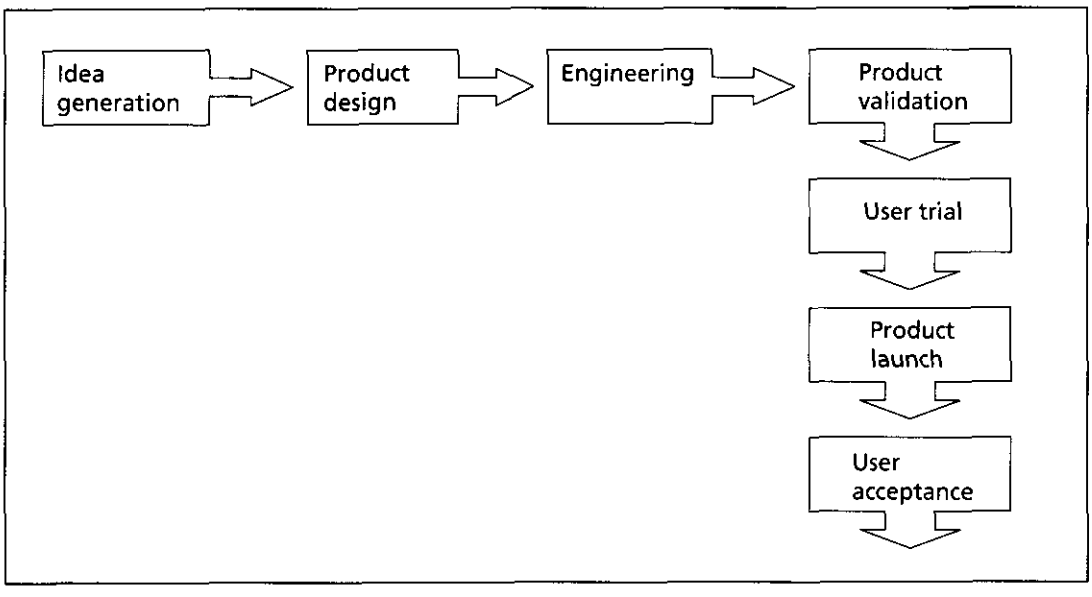
- *Solution tree*—This is a reverse thinking diagram. An objective that has to be achieved is subdivided into sub-objectives and then the action needed to achieve the sub-objective is identified so that the objective is met
- *Forced relationship*—This is a method in which a new property that is needed in a product is forced so that one can obtain a distinct product. Introducing vitamin-A into rice through genetic engineering is an example of a forced relationship. Plastics are mostly considered insulating materials. Inducing conductivity in plastics to obtain conducting plastics is another example of this.

Concept validation: Ideas are converted into a workable concept at this stage. This requires robust processes to identify and develop workable concepts by building new ideas. Concept validation requires new product or service realization and its validation. Prototyping or testing will also be done at this stage so that the product or service can be launched.

Product or service launch: After detailed market assessment the product or service in question can be launched. Developing a launch schedule, planning a distribution system and the formal launch of a product or service occurs. Any product that requires a substantial service network such as motor cycles, cars, TVs or refrigerators, will have to start putting such a system in place long before the launch of the product or service.

User experience: This basically occurs at the user end after one procures a product or service. Customers are currently facing a multiplicity of choices. In such a context, the product or service that is being introduced should have some unique features that could provide value to the customer. Products such as photocopiers or coffee vending machines require service facilities that provide continuous support.

Figure 4.6 Sequential approach to innovation

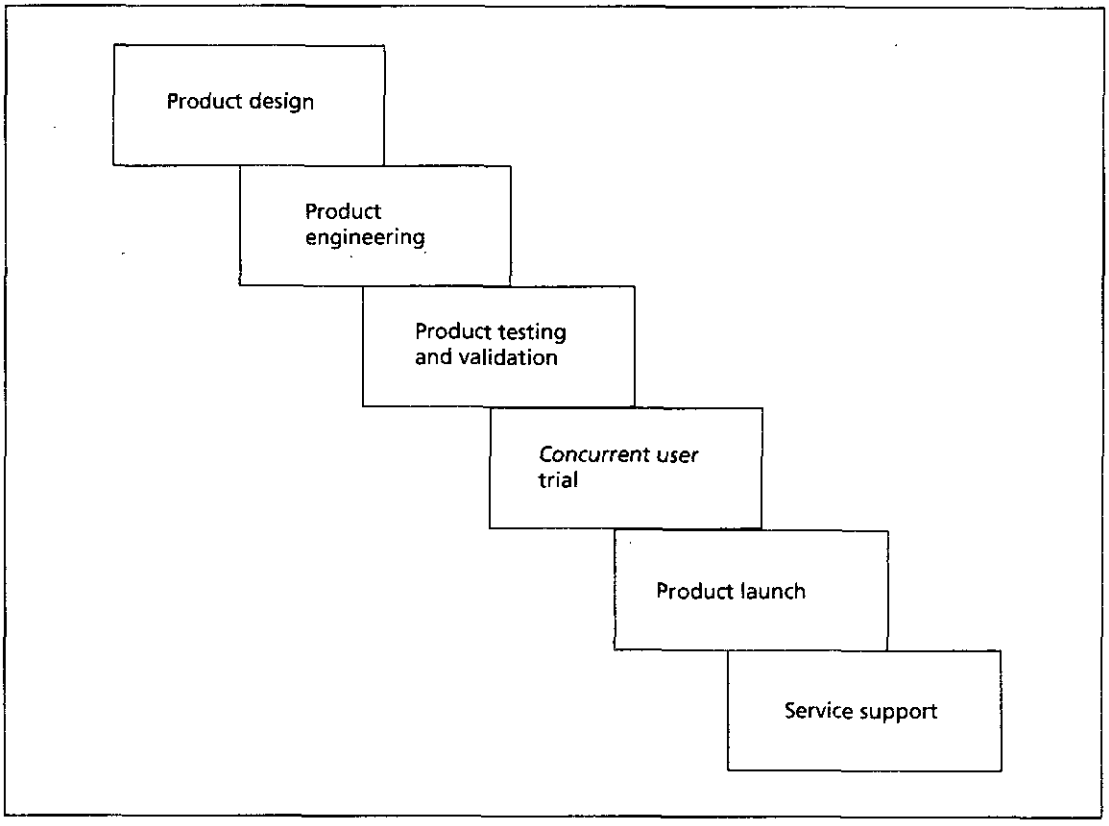


Concurrent engineering: Although these phases were carried out sequentially in the past, because of the need to reduce the product development cycle time, these are now done in an overlapping manner to reduce the cycle time. The need to offer the

customer more products is greater than ever. The "time to market" has been reduced by ensuring that products are developed in a shorter time frame. This concept has been termed "concurrent engineering". Concurrent engineering has helped firms to reduce the product development cycle time by about 33 per cent. The conventional approach to product development is the sequential approach shown in figure 4.6

Concurrent engineering involves overlapping phases of development in which the teams involved in the next stage and the previous stage work together to reduce the cycle time. A schematic representation of the concurrent engineering approach is given in figure 4.7. Concurrent engineering reduces the cycle time and enhances customer acceptance.

Figure 4.7 Concurrent approach to product development



Product launch

Market assessment is the most critical activity in the innovation cycle. Understanding the size of the market, its scope, the differentiating elements, the nature of the market segment, benchmarking with competitors' market, customer service support, etc., are some of the elements that need critical examination. The basic purpose of a product launch is to highlight the unique features or the differentiating elements of a product so that customer can see or understand the distinguishing features. As more and more products are being launched, there is a fight for the mind space of the customer. The concept has been termed attention economy. As more and more products

enter, competition will be about getting the required attention from the customers. Attention is becoming a scarce resource as there is an information overload in the business environment. Creating innovative products is nothing but devising a distinctive approach to capturing the attention of customers and creating an aspiration in them that leads to purchase.

User experience

The actual user experience of a product and service has become a strategic thrust because of intense competition. Creating value through exciting user experience has become the focus of business. Customer experience management is one of the areas that companies are able to leverage using new technology tools. Tools such as "customer relationship management" are helping firms to resolve customer complaints in a relatively shorter time frame.

Organizational culture

Innovations are generated in an organization when there is a culture that can nurture, encourage and support innovation. Culture is like soil in agriculture. If a culture is not conducive to the generation of innovation, innovations do not get generated. There are some basic traits that are needed if an organization is to generate innovation in a sustainable manner:

- Innovation has to be a shared identity: Organizations that generate innovation have a shared identity that the organization is innovative.
- Passionately supporting high potential ideas: Innovative organizations have a culture that support and encourage people to bring out innovative ideas
- Supportive of risk taking behaviour: Innovative organizations support taking risks as an integral part of sense making so that opportunities are positively approached.
- Openness to new initiatives: Innovations come out only when organizations are willing to accept new and different ideas from any source. Such an organization enables the free exchange of ideas and opinions which eventually help in generating innovative ideas.
- Opportunity seeking behaviour: Innovative organizations continuously seek new opportunities and avenues that could enhance their business portfolio, customer satisfaction and organizational performance
- Drive to be ahead of competition: Organizations need to get ahead of competition if they are to succeed. This requires commitment to innovate and exploit innovation in order to be ahead of the competition.
- Entrepreneurial orientation: Innovative organizations need to possess an entrepreneurial orientation so that they support the exploitation of innovation.
- Corporate agility: Innovative organizations respond quickly to customer needs and also respond to competitive threats. This ensures that new opportunities are exploited rapidly so as to ensure that they move faster than their competitors.

- Customer sensitivity: Innovative organizations are responsive to customers, and sensitive to their unstated needs. New products and services have to excite customers so that they remain loyal to the company's products. Loyalty minimizes the risk of switching. Customer sensitivity needs a customer-centric model and a customer-centric mindset.
- Multiple perspectives: Innovative organizations allow individuals to look at problems from different angles, so that they can examine various options:
- Courage: Innovative organizations have a culture that empowers employees to pursue options and try new ideas that need courage to take them through the innovation cycle
- Action orientation: Innovation blooms when individuals act on new opportunities and realize innovative products and services through focused execution.

These enablers support innovations. These enablers have a positive orientation and reduce the barriers to innovation. Low levels of innovation could be the outcome when there are a large number of barriers to the pursuit of new ideas or to the trying out new ideas.

Support for innovation

Innovation is a risky action and needs support. These are four kinds of support that innovation requires in the organizational context:

- Managerial commitment: Innovation needs top management commitment. Top management creates the visions, sets the long-term agenda, supports risky projects and allocates critical resources.
- Financial commitment: Innovation requires allocation of sufficient resources to take the innovation through the market to the customer. Sufficient venture support from inside and outside is absolutely critical. SMEs will not be able to derive all the resources from internal resources. They could seek grants from government, obtain venture capital from venture funds, and loans from term lending institutions. SMEs have to develop capabilities to develop project proposals and business plans that could get support from external sources.
- Information support: Innovation requires strong information support. This will help to avoid the "reinventing the wheel" syndrome. Considerable information will be easily available from documents that are in the public domain. Scanning trends by distilling the information into knowledge requires considerable industry experience. The major trends that will help in clarifying the direction of innovation are the following:
  - Business trends
  - Technology trends
  - Competitive products
  - Global investments

— Market opportunities

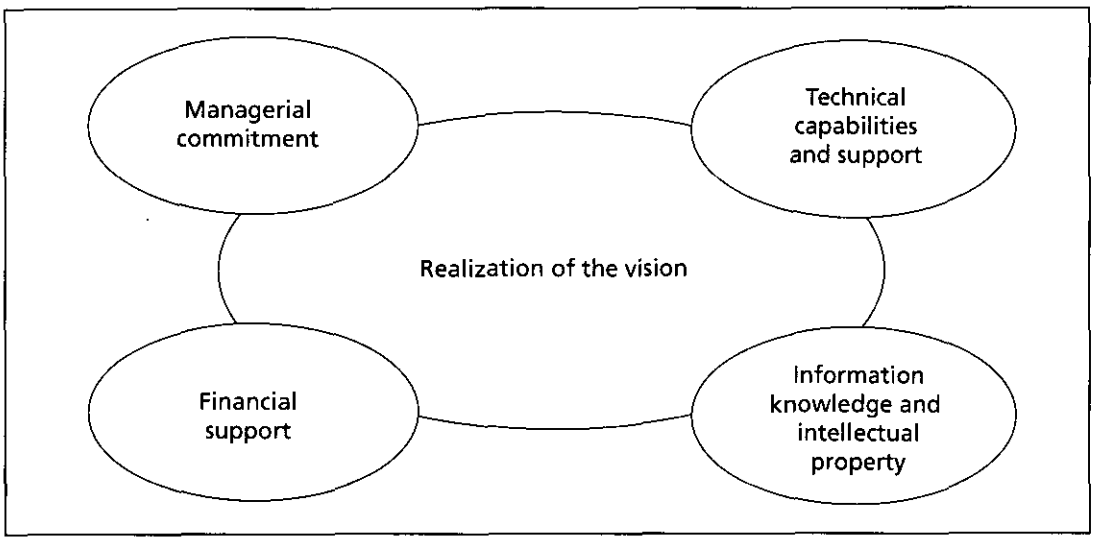
— Talent requirements

— Intellectual property trends

SMEs have to use consultants or internal experts to scan and monitor both threats, opportunities, strengths and weaknesses.

- Technical support: Innovation needs technical support in terms of design, engineering, manufacturing, warehousing, distribution and marketing. The crucial ones will be those relating to testing, validation as well as prototyping.

Figure 4.8 Innovation process alignment



Managing innovation is aligning these four processes to ensure the realization of the vision, as shown schematically in figure 4.8:

Best practices on innovation

This section illustrates some of the best practices that could make an SME leverage innovation and grow. Many SMEs do not succeed in this metamorphosis as it requires both business skills and technological skills. Both need to be leveraged in an integrated manner. Also, SMEs should continuously search for new growth opportunities. Financial prudence is a critical element of growth and profitability.

Lenovo: Lenovo entered the PC manufacturing as a low-cost manufacturer for IBM. It learnt and perfected the skills and remained competitive by sharpening its talent. Then when IBM was planning to exit the PC business it negotiated a deal with it. The main strategy of Lenovo was continuous learning and scaling up the manufacturing operation to become a global manufacturer over a period of time.

EID Parry: This is an Indian company that manufactured biopesticides to become a market leader. It scanned patents across the globe and acquired the technology from

a German professor to make neem-based biopesticides. Neem is a tropical plant and pesticide is manufactured from the fruit. Scanning and procuring new technologies and making it a growth platform to become a market leader required foresight and the systematic execution of manufacturing operations.

Embraer: Embraer was a small commuter aircraft manufacturing firm in Brazil. It slowly evolved and started making regional jets. They are now sold in many countries as the aircraft market started booming after 2003. The focus of Embraer was understanding customer needs by listening to customers and converting their input into unique product features.

Cemex: Cemex was a purely national cement firm with some market share in Mexico alone. It did not have any manufacturing locations outside Mexico. Lorenzo Zambrano took over as CEO in 1985. His first objective was to become the single largest domestic player in five years. By 1989, Cemex had become the largest cement producer in Mexico. It started exporting cement. Zambrano's first major technology strategy when he took over Cemex was to become a competitive manufacturer so that it could become a global player. Cemex became a competitive manufacturer on a global scale by first focusing on internal operations and then expanding through acquisitions. The best practices of Cemex could be listed as follows:

- Reducing cost through systematic benchmarking and identifying cost reduction opportunities
- Shortening the time to integrate a new company and to derive economies of scale in manufacturing, logistics and distribution
- Simplifying business processes
- Standardizing information processes
- Leveraging IT to improve coordination and automate operational performance

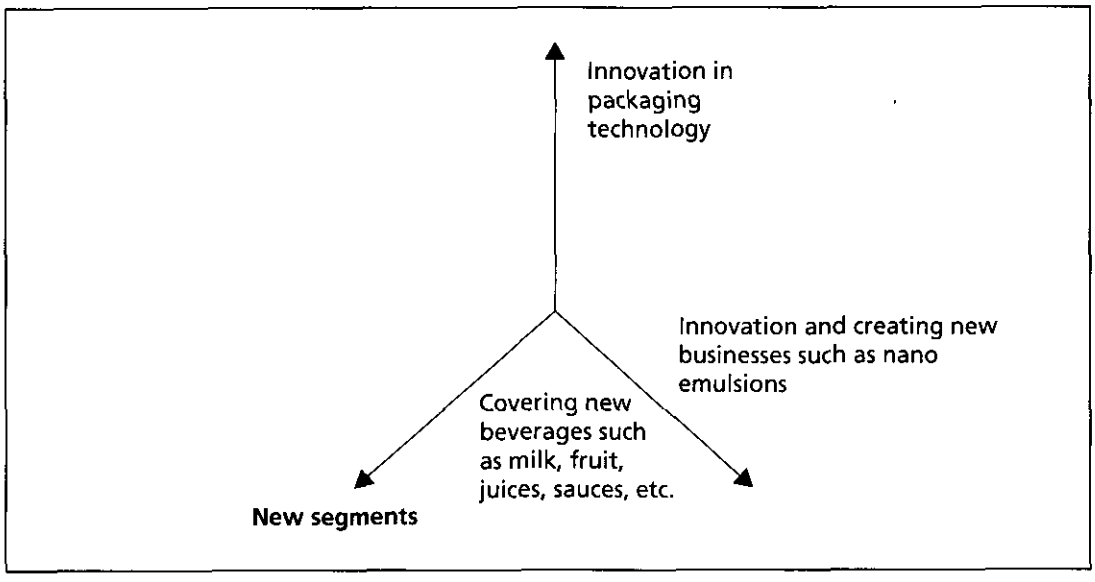
Tetra Pak: This started as a small firm in Sweden. The founder of Tetra Pak was an entrepreneur who used innovation to create business. This was launched in 1952 by creating a milk package that required a minimum of material whilst providing maximum hygiene. He motivated his people to look beyond the obvious and this led to the development of a unique innovation that changed the way food is packed, stored and distributed around the world. In 2005 Tetra Pak products were being sold in 153 countries. Every year about 110 billion Tetra Pak packages are used, covering 60 billion litres of food and beverages.

Tetra Pak used innovation in three dimensions:

- New packaging technology to cover aseptic, chilled and large volume markets
- Covering more types of beverages such as milk, fruit juices, tomato paste, ice lollies and fruit mixes
- Moving into non-leverage markets to cover basic oil-in-water, water-in-oil emulsions, multiphase emulsions, nanoemulsions and alcohol emulsions.

This means that Tetra Pak is continuously expanding the extent of its business both geographically and functionally. The innovation strategy of Tetra Pak could be schematically represented as a three dimensional approach as shown in figure 4.9

Figure 4.9 Innovation strategy of Tetra Pak



The focus on innovation has to enhance storage life and preserve taste. There are 23 tasting experts who work on removing odd tastes. They work with many firms to design new storage and distribution solutions.

The main lessons one could learn from Tetra Pak are:

- Continuous scanning for new windows of opportunity by exploiting innovations
- Working closely with user industries to create innovative solutions that are acceptable to customers
- Expanding existing technology to cover more and more new business segments and penetrating deeply into existing markets using innovative ideas. For example, Mexico is the biggest market for milk for school children. Morocco has emerged as the second largest along with Thailand for aseptic milk packing.

Tetra Pak considers innovation as a means of transforming knowledge into new products and services or into new processes and new working methods. Striving for renewal or innovation is one of the most important driving forces in the global economy. Tetra Pak is a completely recyclable material and it has started a joint venture to recycle aluminium as well as paper in 2004. This is the world's first plasma plant. It is a four-way joint venture between Tetra Pak, TSL (a Brazilian company), Klabin (a Brazilian paper company) and Alcoa of the United States. It has investments from all the partners. This is an excellent example of best practice. Innovation is used to reduce wastage and conserve the environment. The most significant element of innovation is

openness to search for new solutions to existing problems. Food can be preserved without refrigeration and with a high level of convenience to users. Innovation is in the organizational DNA of this company. Through innovation a small entrepreneurial firm has converted itself into a global company.

Small and medium enterprises in most developed countries have neglected innovation as an activity, considering it a difficult and an expensive proposition. It is essential that SMEs start leveraging innovation in various aspects of their value chain. The starting point will be creating awareness among senior people that any organization will not be able to sustain competitiveness without leveraging innovation. Innovation is essential for sustaining competitiveness in home markets and for entering global markets.

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1. B. Bowonder, Innovation Manual, Group HR, Tata Sons, Mumbai, 2006

Chapter 5 Critical tools

Technology audit

Market share-market attractiveness analysis

Technology foresight

Technology roadmapping

Conclusion

TECHNOLOGY MANAGEMENT: CRITICAL TOOLS

> Imagination is more important than knowledge, for knowledge is limited, whereas imagination embraces the entire world.
>
> — Einstein

Few phenomena are as ubiquitous as technology in their effects on the capacity to outwit, outmanoeuvre and outperform competitors (Fahey, 1999). Technology impacts every activity or process—at every stage of the activity or value chain of a business. The tools given in this section will help a firm in many ways:

- To meet customer expectations more precisely and in a shorter time frame
- To outperform, outwit and outmanoeuvre its competitors
- To envision new business opportunities
- To leverage existing capabilities to create and deliver new products and services

Technology can be defined as the research, development and application or use involved in products, materials, processes applications and services. Although research development and application represent three distinctly different facets of technology, the object or focus of each is essentially similar: the generation and use of knowledge for generating business impact.

The first tool enumerated here is the technology audit.

Technology audit

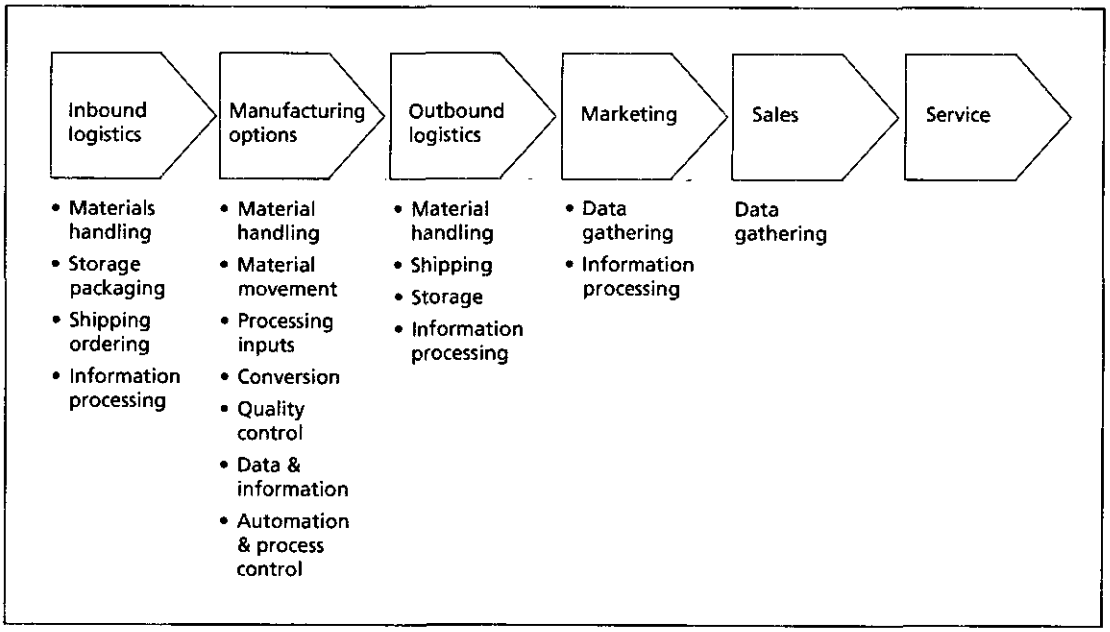
The first step in a technology audit is to map the business activity or value chain. A typical chain starts with procuring inputs for manufacturing from identified suppliers. Then comes manufacturing and outbound logistics. Then comes marketing, sales and service leading to reaching and serving the customers. Schematically the value chain and the activities are given in figure 5.1

The second step is to identify the key product technology strength in relationship to that of the competitor. The steps involved in the product technology audit are given in figure 5.2. Product technology audit involves assessing technological capabilities and competencies in the product technology chain and the value chain in relationship to the strength of the competitor. The result of the audit will indicate the areas of weakness that need to be addressed. Organizations must quickly and continually assess which parts of their value chain are vulnerable, which parts are defensible, which alliances make strategic sense and which threats are deadly (Fine, 2002).

The third step of the audit is identifying the state of the most critical competitive technology. This will involve examining the following issues:

- Product technology chain: How technology contributes to the organization's products
- Activity/value chain: The impact of technology on the organization's key activities and its ability to remain ahead of others
- Market place strategy: The technologies the competitor currently possesses and is likely to develop as indicated by changes in its market place strategy.
- Technology assets: The stock of technology specific assets possessed by the competitor
- Capabilities and competencies: The competitor's technology capabilities and competencies
- Technological alliances: The contribution of alliance partners to remaining at the forefront of technology.
- Intellectual assets: Patents, trademarks, designs, trade secrets, copyright assets the competitor is leveraging and their influence on competition

Figure. 5.1 Value chain elements for technology audit



Identifying technological capabilities and competencies requires an integrated approach covering both product technology and the activity value chain.

The fourth step in a technology audit is an explicit assessment of technology and marketplace strategy linkages.

Technology can be used for meeting four strategic objectives and these could have distinct marketplace manifestations. The technology audit brings out the linkages and strategic options a firm should create. The strategic options open to a firm are:

- Pursuing a new technology domain
- Extending an existing technology domain for a new purpose
- Reinforcing an existing technology domain through defensive action
- Narrowing technology domains through bridging and reducing the product range

These options have five possible business implications and these could be:

- Creating new business
- Generating new products to be ahead of competition
- Extending the scope of the existing business
- Enhancing the share of existing products
- Creating business synergy

The first step of the audit clarifies the role of technology in the whole business value chain. This indicates areas where technology could be leveraged in a business.

The second step of the audit provides you with an understanding of the relative strength and weakness of the firm in comparison with its competitors.

The third step involves assessment of the core/critical technology that is driving the competition. The fourth step is examining what the firm has to do to leverage market opportunities.

A technology audit has to be done regularly and is a must for firms. Audits also help firms to know where they stand in relation to their competitors. Auditing and benchmarking together provide an insight into gaps that need to be addressed. Along with benchmarking, auditing gives you a clear idea of the direction in which a firm has to move.

Market share—market attractiveness analysis

Once the auditing is done a firm has to focus its efforts on enhancing its market share. In any growing market the decline in market share will be a difficult thing to correct. Market position has to be continuously monitored in relation to market growth opportunities. The tool that is widely used for this is known as the Boston Consulting Group model (BCG model). The BCG model is an interaction matrix in which market attractiveness and market growth are mapped.

Market attractiveness represents things external to the firm, and depicts how competitors perceive the market. The major variables that determine market attractiveness are:

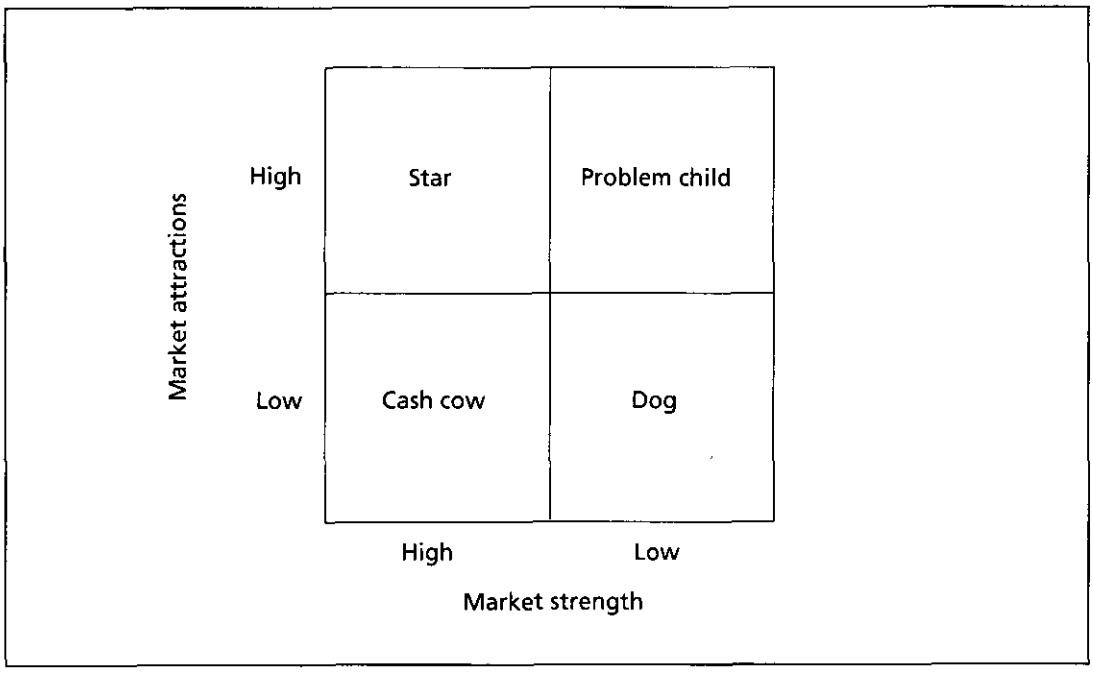
- Size of the market
- Scope of the market
- Segmental profitability
- Overall market size
- Annual market growth rate
- Historical profit margin
- Competitive intensity
- Technological requirements
- Inflationary vulnerability
- Energy requirements
- Potential environmental impact
- Social-political and legal acceptability.

This could be measured in terms of percentage growth. The business is attractive if the growth rate is above the average national industrial growth rate. This means by investing there they could grow faster than by investing in slow growth segments. By investing in low growth industries firms lose the opportunity to grow.

Business strength represents the internal strength of the firm. The market share of the firm in a given segment will be a measure of business strength. Business strength will depend on the following:

- Market share
- Share growth of the firm
- Product quality
- Brand reputation
- Distribution network
- Promotional effectiveness
- Productive capacity
- Unit cost of production
- Material availability
- R&D capability
- Managerial capability
- Strength of the talent pipeline

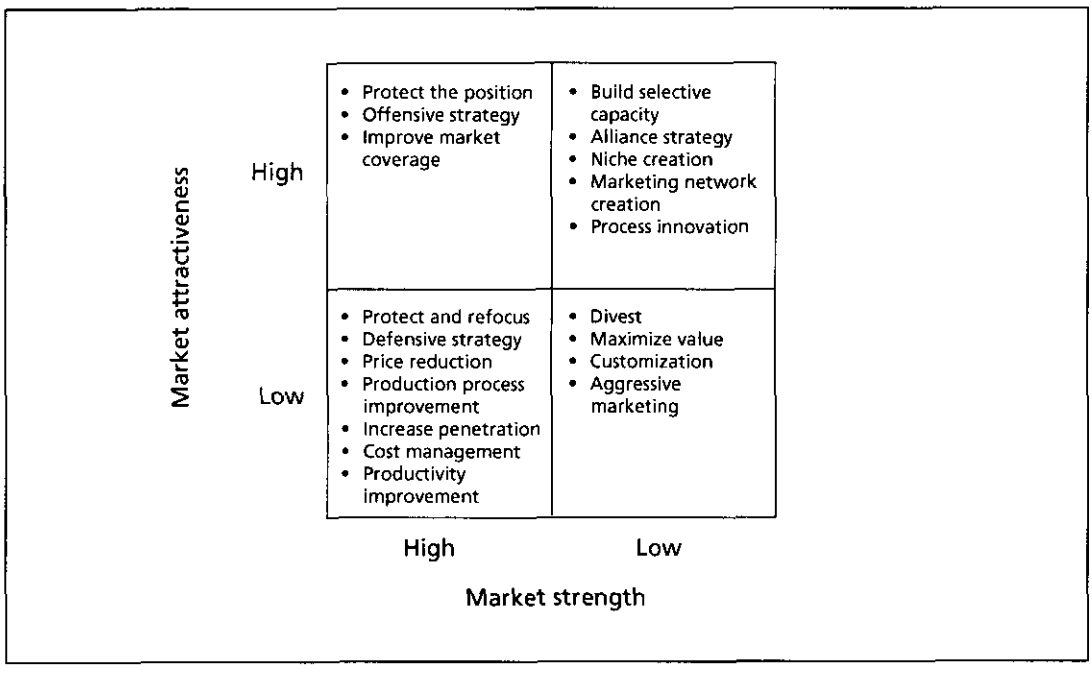
Figure. 5.2 BCG Matrix



The "market attractiveness – business strength" matrix can give an indication of what strategy could be deployed, depending on where the product falls in the market segment.

The strategies for each segment are summarized in figure 5.3 and given below.

Figure. 5.3 Strategic options open to a firm



High growth and high business strength

The firm has to protect its position in this segment. Even through the investment needed is high it is necessary if the company is to retain the market leadership position. The strategy focus has to be to fight aggressively. The firm has to concentrate on maintaining market share. Searching for new users, searching for new applications, new product development, etc., are some of the crucial imperatives. Market coverage has to be improved so that the firm does not give away any share that could be leveraged through penetration. Strength building has to be a continuous effort through growth needs investment. This is a segment that requires both investment and working capital as it is a growth segment.

Low growth and high business strength

This segment is the cash cow segment and yields considerable cash for the firm. This is a business segment that needs to be protected and refocused. The strategy must be one of maximizing current earnings and developing areas or segments for future growth. Firms should concentrate on attractive segments so that entry by competitors can be firmly resisted. The firm has to defend its position. It has to reduce manufacturing costs and improve product efficiency and, if necessary, reduce prices so that the competitive threat is minimized. The quality of customer support needs to be improved. The distribution system needs to be expanded to enhance market coverage. If necessary, firms need to go for vertical integration. A food processing industry at this stage may try to have its own packaging facilities. Pharmaceutical firms in the segment may look for entry into manufacturing bulk actives. Though it is good position to be in, such situations do not last long. Competitors will try to enter this segment. This segment must also be protected vigorously. Using surplus cash from this business to generate new businesses for the future is the major challenge in this segment.

High growth and low business strength

This segment is normally known as the "problem child". This segment requires cash both for enhancing business strength and meeting business growth needs. This is one of the most difficult market segments to manage as it requires attention in all three dimensions, namely:

- Investment needs
- Enhancing market share
- Managing market growth

Strategy has to be carefully managed when a business is in this segment. One of the possible strategies will be to leverage strategic alliances. Using the strength of an alliance partner a firm could enhance its business strength. The alliance could be for design, production, marketing or logistics support. This segment requires strong market development efforts as well as network development. Developing new applications, creating new riches and identifying new users could form the strategic thrust for this segment. Of all the segments this is the most difficult to manage. If it is not managed properly, it will slowly fade away in a competitive context.

Low market growth and low business strength

The businesses in this segment are known as the "dog". This segment needs cash but regenerates modern levels of cash. In this segment, the focus has to be on cutting costs and avoiding investment. This segment must try to harvest revenue without substantial investments. Eventually this segment will be divested. The strategy of businesses in this segment is to use depreciated assets to generate revenue without any additional investment. Existing assets are used to the fullest extent. Customization of products, focusing on niche markets and developing new applications are some of strategies used by businesses in this segment. The business has to ensure customer retention in this segment.

The BCG Matrix is a very user friendly tool for understanding the strengths and weaknesses of an industry in relationship to its internal strength and business growth opportunities in the market. It is a tool kit that can suggest generic strategic solutions applicable to various business segments.

Technology foresight

Technology foresight is a tool for looking ahead. Clarity about the future is always problematic when issues relating to technology are involved. Though there are many tools that can be used for predicting technological trajectories, foresight helps one to get clarity about the future. The future is always hazy. The focus of foresight is to create a desired future. One of the tools used for foresight was developed by Siemens for identifying the future and realizing the identified future.

"Picture of the Future" involves the identification of emerging technologies through the extrapolation of existing trends and technological trajectories. The second element of "Picture of the Future" is to look at the present from the future to identify what the future scenario could be and then create new solutions that could resolve the potential issues. Extrapolation is nothing but projecting current business, market, demographic and technology trends.

On the other hand "retropolation" looks at solutions needed to create and generate newer devices, newer tools, newer solutions, newer materials and newer systems. The schematic diagram of the "Picture of the Future" tools as practiced by Siemens is given in box 5.1. These tools attempt to create "out of the box" thinking by looking from the perspective of "what is needed to meet the requirements of the future world". It is a tool for clarifying the future direction.

An innovative firm such as Siemens was not satisfied with merely forecasting trends. This feeling was the genesis of the "Picture of the Future" tool. "Predicting the future works best when you create and shape it yourself", is the basis of creating the future according to Dr Pierer, CEO of Siemens. "Inventing the future" is more rewarding than simply chasing trends. "Picture of the Future" must identify promising ideas and new approaches at an early stage so that the firm can emerge as an innovation trendsetter. "Picture of the Future" is a schematic way of looking at the future.

"Picture of the Future" is a logic that creates breakthrough ideas by using two opposing visions that are complementary. Extrapolation is like roadmapping. The aim of extrapolation is to anticipate as precisely as possible, at what point in time things will become available or when a need for them will arise. But the method has an inherent weakness. It fails to predict discontinuities and great leaps forward in the development process. While extrapolation will take you on a journey along a well-built road, you won't see much of what is going on beyond the trajectory that you have created. One can never be sure that the road isn't about to end suddenly. The future is not a single point but the combination of many events. To overcome the deterministic approach, firms started using the scenario approach.

Siemens used an opposing approach that involves imaginatively placing yourself some 10, 20 or even 30 years or more into the future. The time scale depends on the business segment. In fields such as power and telecommunication, longer time frames are essential to understand the evolution of complex trends.

Retropolation creates a scenario that incorporates all relevant factors, including the future development of social and political structures, environmental considerations, globalization, technological trends and new customer needs. The most challenging task is to backtrack the present from the known facts of the future scenario. By using the "Picture of the Future" tool it is possible to identify the kinds of challenges that need to be overcome to get the desired future outcome. By combining extrapolation and retropolation and bringing these two approaches together, "Picture of the Future" can reveal which changes impact on different areas of business. The purpose of the "Picture of the Future" technique is not merely to depict visions of the future, but rather to create a systematic ongoing process that can help quantify markets, detect continuity, anticipate forthcoming customer requirements and identify new technologies with large growth potential and mass appeal. "Picture of the Future" generates business opportunities for the products, systems, processes and services of the company's segments as well as a unified vision of the technological future. Inventing the future is more exciting than merely trying to predict it. Foresight, thus, provides insights into the world of tomorrow but presents a coherent picture of the future.

For example, in the food sector "functional foods" that could provide the required functionality is a desired future. Firms such as Monsanto and Kraft Foods are evolving these. Rice with vitamin A, sugar with zero calories, oils that lower LDL and foods with anti-ageing function are some of the foods that are likely to be needed. Work on creating these "desirable foods" is the essence of the "Picture of the Future" tool.

UNIDO has carried out extensive research on technology forecasting in many countries, which was published in a manual in 2005. The manual summarized all the foresight methods that could be used for clarifying future directions. The same is reproduced in box 5.1. Foreseeing attempts to see the future before it occurs is synonymous with words such as prediction, prophecy, forecast, foresight and fore knowledge. Futures methods allow us to understand the risk dimension. They do not eliminate uncertainty, but help us to understand risk. In a way they ensure that we do not foreclose any future options. In a world where business has become dynamic, foresight is an interactive tool that could give some directional clarity. Foresight gives you an indication about rightness of a business direction.

Box 5.1 Foresight techniques

Approach	*Concept*	*Technique*	*Assumption*
Foreseeing	Prediction	Pre-recognition	Special ability
		Prophecy	
		Genius forecasting	
	Extrapolation	Time series/trend forecasting	Pattern recognition
		S curve	
		Envelope curve	
		Precursor analysis	
		Cycles	
	Analytical forecasting	Causal models	Explanatory system
Managing	Judgmental	Delphi	Expert opinion
	Forecasting	Cross impact	Interactions
		Content analysis	Scanning
	Management	Issue management	
		Environmental scanning	
		Impact assessment	Analysis
		Cost benefit analysis	
		Risk assessment	
		Mind mapping	
		Causal – layered analysis	Questioning
		Role play	Dramatic representation
		Scenarios	Alternative futures
Creating	Policymaking	Problem solving	Rationality
		Decision-making	
		Planning	
		Strategy formation	
		Politics	Power
		Backcasting	Logical steps
		Relevance tree	
		Morphological analysis	
		Roadmapping	

Box 5.1 ***(continued)***

Speculation	Science fiction	Imagination
Imaging	Brainstorming	
	Group support systems	
	Futures workshops	
	Visioning	
	Incasting	
	Creative imagery	

Source: UNIDO Technology Foresight Manual, Vol. 1 and 2, UNIDO, Vienna, 2005

Technology roadmapping

The requirement for a firm to link technology resources to business goals is not a new feature of industrial life, but the accelerating progress of technological development has made this issue increasingly important (Probert, Farrukh and Phaal, 2003). Technology roadmapping emerged in response to business needs. Motorola was an early pioneer, with the method widely adopted within the company as a central part of the business planning process and then extended to supply chain and industry level application. Technology roadmapping and its variant product roadmapping were subsequently adopted and applied in a number of industries and contexts.

Technology roadmaps take many forms, although the most general one is a multi-layered graphical representation of how technology and product developments link to market opportunities. The questions that are asked could be broadly stated as follows:

What is the target market?

Which products/services are needed?

Which technologies are needed?

What are the resource requirements?

What are the research, development and testing requirements?

How are the markets, products and technologies linked?

A typical roadmap attempts to answer these questions. A typical roadmap structure is given in figure 5.4.

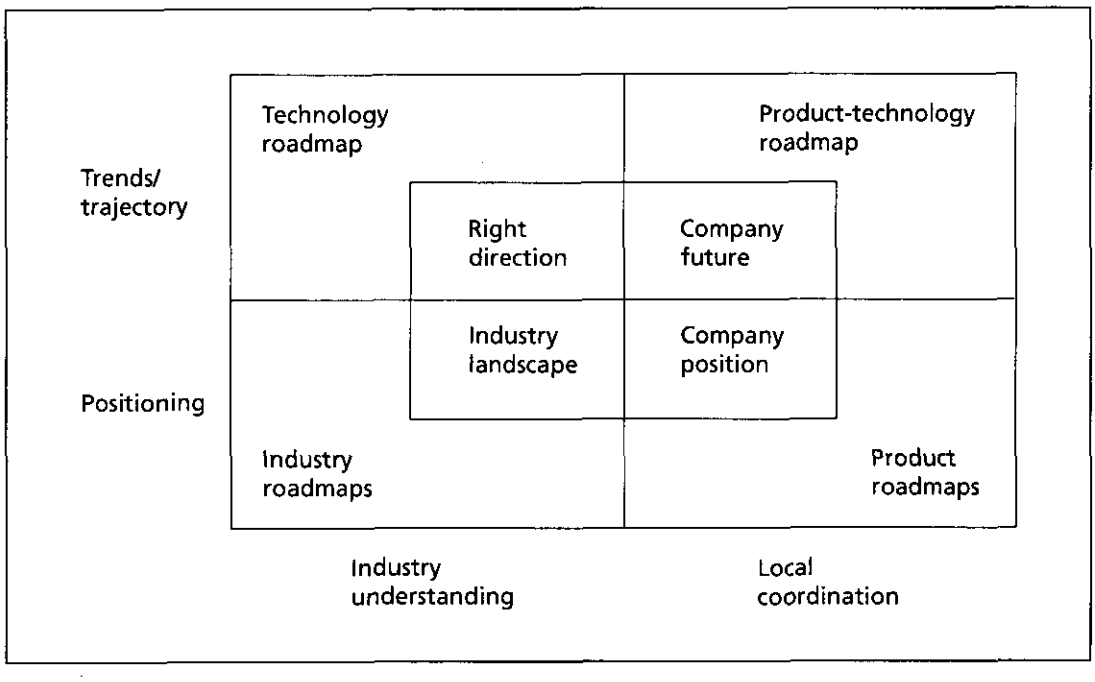
The roadmaps are broadly divided into four categories indicating that roadmapping could come in a variety of formats, namely:

- Technology roadmaps: set industry targets
- Product technology roadmaps: align discussions with trends
- Industry roadmaps: set industry expectations.

The characteristics and categories of these are shown in figure 5.4. Roadmaps essentially clarify the trajectory and action linkages needed for the realization of the target.

Once a foresight exercise has been done, a detailed roadmap can be prepared to set the action agenda.

Figure 5.4 Roadmapping typology



Benefits of roadmapping

Roadmapping has three potential benefits:

- Can help develop a consensus about a set of needs and technologies required for meeting those needs
- Provides a mechanism to help experts forecast technology developments in targeted areas.
- Can provide a framework to help plan and coordinate technology developments both within a company or an entire industry.

Roadmapping has been successfully used by a large number of organizations as well as firms. Some of the successful examples are:

- Sematech prepared a semiconductor industry roadmap known as the National Technology Roadmap for Semiconductors.
- The International Energy Agency prepared a roadmap for coal utilization as well as the hydrogen economy.
- Philips prepared a roadmap on embedded software for next ten years.
- Motorola prepared a roadmap on mobile telecom technology products

Implementation of roadmapping

The Conference Board of Canada has developed a three-phase approach to road-mapping:

Preliminary stage

- Satisfying essential conditions
- Providing leadership/sponsorship
- Defining scope and boundaries

Main stage

- Identifying the product
- Identifying critical system requirements and targets
- Specifying the major technology areas
- Specifying the technology drivers and targets
- Identifying technology alternatives and timelines
- Pinpointing technology alternatives
- Creating a technology roadmap report

Follow-up stage

- Critique and validation of the roadmap
- Development of an implementation plan
- Review and update

These technology management tools will help firms and organizations to prepare a cohesive set of roadmaps to ensure that technology management strategy is comprehensive and implementation rigorously detailed. Technology management tools help top management to ensure that there is a detailed strategy that an organization has to pursue.

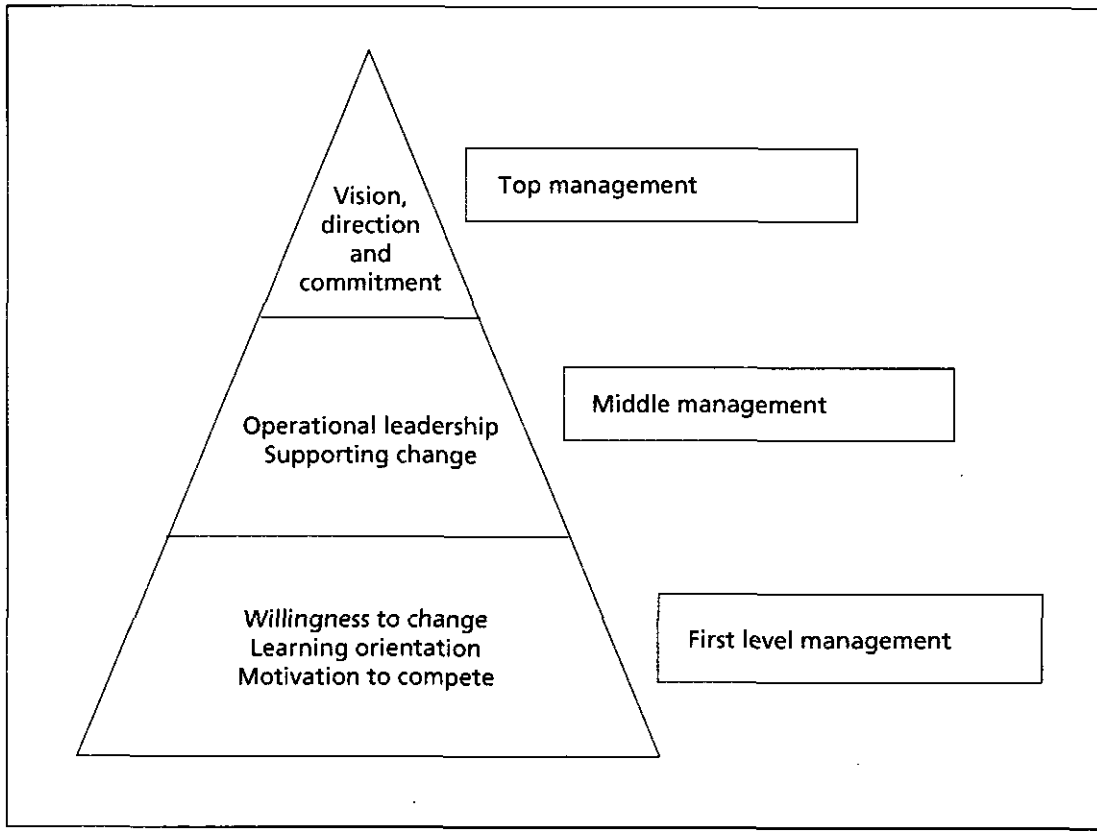
Conclusion

The most important element of technology management is its relationship with corporate strategy. Technology acquisition, technology leveraging and technology partnering should be an integral part of the overall business strategy. Technology is not an independent variable but an instrument that is used for enhancing business value, competitive advantage and customer excitement. This manual is prepared from that perspective. As topics such as technology foresight, technology acquisition, technology negotiation and technology monitoring have been covered, they are not discussed here. The focus of the manual has been to bring synergy between technology leveraging and business strategy. The major technology discussions have to be seen from the perspective that these discussions should lead to the fulfilment of at least one or more business objective namely:

- Cost advantage
- Superior product features
- Production efficiency
- Waste reduction
- Customer value creation
- Customer satisfaction
- Better business coordination
- Cycle time reduction
- Regulatory compliance
- Market share increase
- Logistic advantage.

Technology improvement, technology change and technology advancement can be brought about only through people. Thus the fulcrum of technology management is capability building. Capability building occurs when people, business process, organizational goals and technology are aligned to meet business goals. This requires top management commitment to examine newer technological challenges. This has to be percolated to lower levels and requires a process for ensuring continuous learning at all levels. Top management provides the vision, direction and commitment. Middle management should provide operational leadership and support for change initiatives. The lower levels have to be motivated to learn and change. This happens only when people are passionate about learning and adaptive to change. The focus of capability building is inducing passion for learning among people. The sum and substance of technology management imperatives can be summarized schematically, as shown in figure 5.5:

Figure 5.5 Technology management capability building pyramid



"Learn from the mistakes of others; you can't live long enough to make them all yourself"

— E. Roosevelt

Box 5.2 Technology failures

Technology can provide enormous competitive advantage. At the same time if technology does not meet customer expectations and business objectives, it could become a major risk. The business arena is full of such failures. The Iridium phone was considered a technological marvel but proved to be a major commercial failure.

Iridium was conceptualized by the Motorola communications group. It consisted of a constellation of 66 low earth orbiting satellites. These would allow subscribers to make phone calls from any location. Morotrola found the concept exciting. It started a separate company, Iridium LLC, to pursue the idea and invested US$ 400 million in the venture. Iridium was launched on November 1, 1998 with a US$ 180 million ad campaign. The then Vice-President Al Gore made the first phone call using the Iridium system. The handset was very expensive, US$ 3,000. At US$ 3-8 per minute, call charges were also very high.

By 1999, Iridium only had a thousand subscribers. The company had a huge debt but its revenue was negligible. The subscriber base did not increase substantially and on August 13, 1999 Iridium filed for Chapter 11 bankruptcy protection.

There is still debate on whether Iridium was doomed from the start (Finkelstein 2003). Iridium phones were too large and too expensive to compete with cellular phone services. Iridium focused on international executives going to remote locations. The volumes were too low to support an expensive service for this segment. Iridium was based on a technology that used line of sight between phone antenna and orbiting satellite. Because of the limitations of technology, subscribers were unable to use the phone inside moving cars or trams, inside buildings and in many urban areas.

Sales of Iridium did not pick up as it was five to six times more expensive than other products. Customers were not involved in the creation of this service and it was a major failure story of the last century. Prior customer involvement could have minimized potential customer problems and enhanced market acceptance.

Another example of market failure was the failure of soybean milk. When it was originally introduced, acceptance was poor because the milk had a raw bean taste. Then a US inventor patented a technology that could remove the bean taste.

He licensed the technology to many firms across the world. The acceptance of the milk from soybean increased due to the removal of the unpleasant taste.

These examples highlight that understanding customer needs and potential user problems are essential for a technology or an innovation to be commercial success. Any business normally faces three risks:

- Market risk: poor customer acceptance
- Organizational risk: poor organizational commitment
- Technology risk: risk of obsolescence

Technology management has to anticipate and manage risks while running technology-related enterprises.

An analysis of the success and failure of products and services can give good insights into the prerequisites of successful technology initiatives. Products can be classified into innovative products and standard products. These products could succeed or they could fail in the market place. The four options available are given in the matrix in figure 5.6

Figure 5.6 Product market matrix

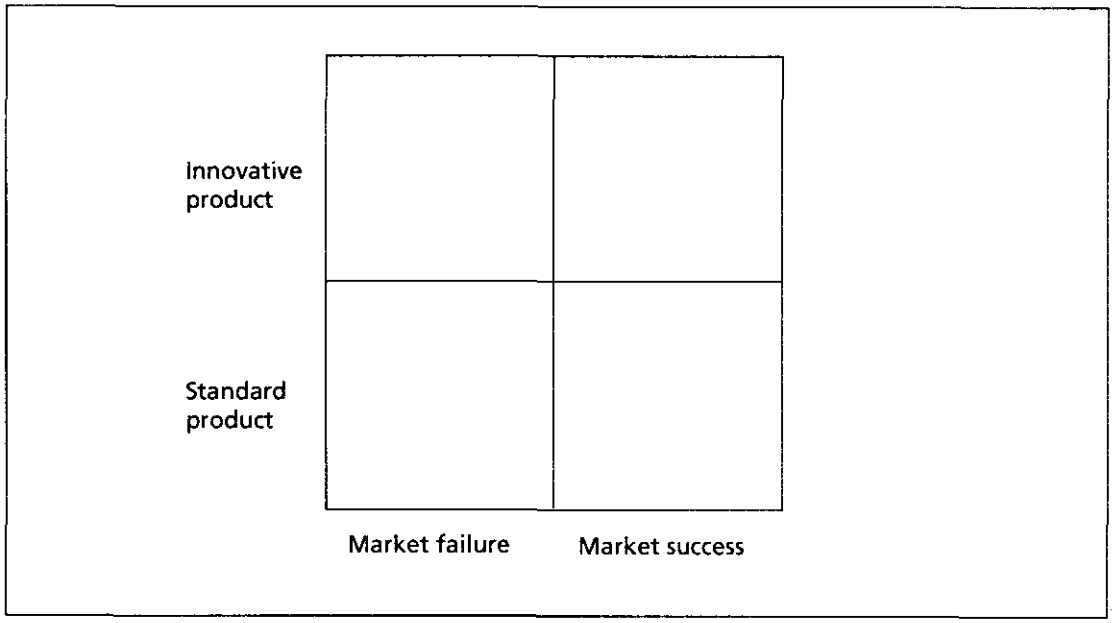
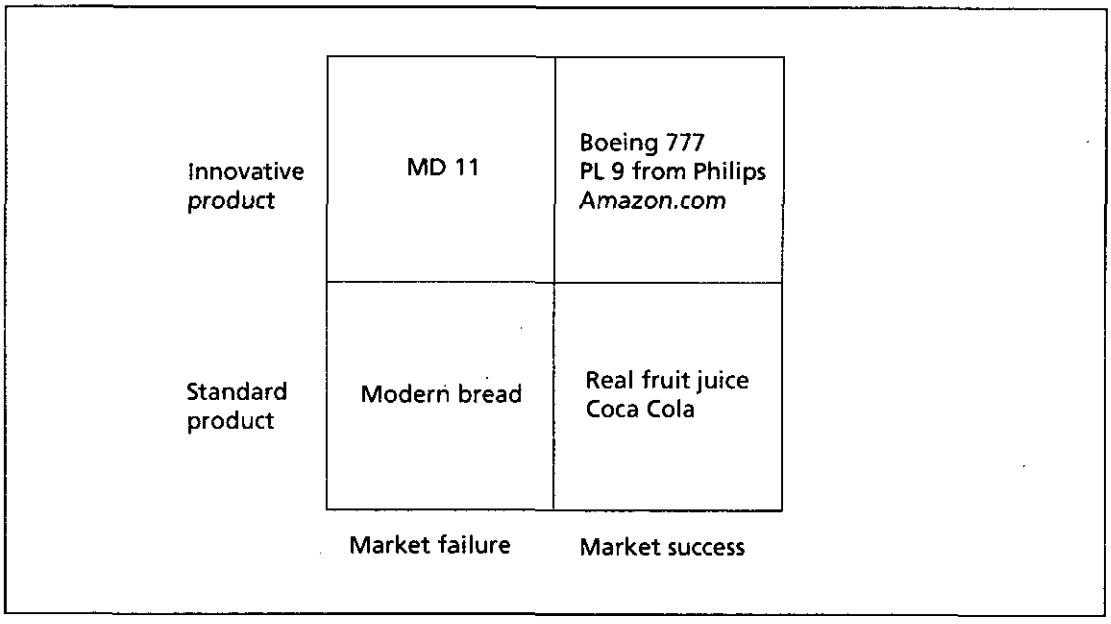


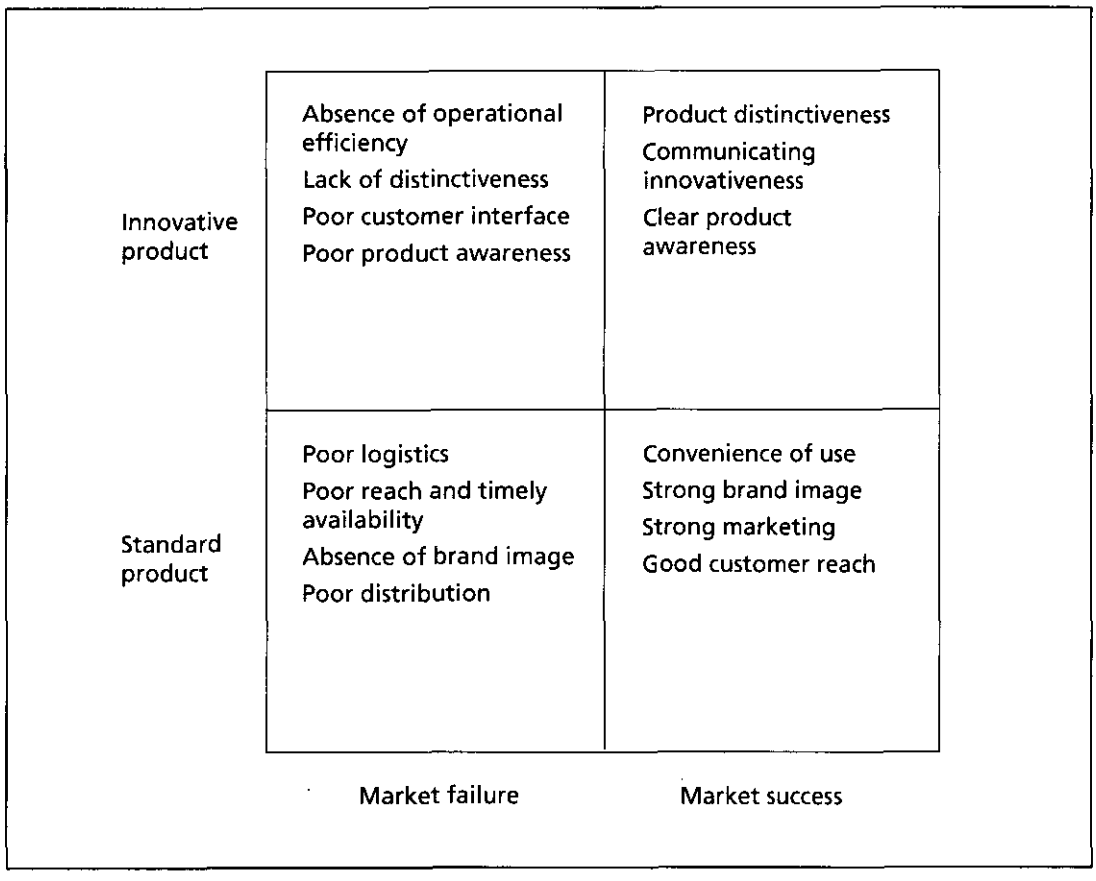
Figure 5.7 Illustrative examples of product failures and successes



MD 11 was an innovative product but it was a market failure as users did not consider it to be a distinctive product. On the other hand, products such as the Boeing 777, the PL 9 (compact fluorescent lamp from Phillips) and Amazon.com were innovative and successful in the market place. Consumers considered these products to be innovative, superior and distinctly different from those offered by competitors. Standard products can also fail when they don't meet certain expectations and when they do not have either a good reputation, or product image or brand. Standard

products such as bread could fail if they lack a good brand reputation and if logistics support and distribution is deficient. The lessons from these experiences are captured in the matrix figure 5.8.

Figure 5.8 Illustrative examples of product failures and successes



The essence of technology management is creating a passion for technology and leveraging technology for business advantage. This could be stated in a quote:

> "If you want to build a ship, don't drum up your men to go to the forest to gather wood, saw it and nail the planks together. Instead, teach them the desire for the sea."
>
> — Antoine de Saint Exupéry

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