GLOBAL TECHNOLOGY MANAGEMENT

10

Learning objectives

After studying this chapter students should be able to:

- describe the linkages between technology and strategy;
- explain how technology can be defined and employed as a strategic asset;
- describe how technology can be used to enhance competitive advantage;
- describe how technology needs to be managed to enable it to be used to enhance global competitive advantage;
- explain what ICT is, how it has stimulated globalization and how it can be used in a company's technology strategy.

Introduction

The scope of what we refer to as 'technology' is too large to be considered in detail in a single chapter of a book of this type. The many ways in which the word is used is testimony to the plethora of ways in which it can impact on business strategy. Technology can be found in electronics, chemicals, aerospace, telecommunications, design, production, logistics and many other fields – and in most cases, one technology is highly interconnected with other types. So, while we might think of technology as describing computers and robots (which it certainly does), we should not forget that the same management skills required in these sectors are also required in every other area of technology: in pharmaceuticals, petrochemicals, automobiles and in hundreds of other contexts.

This chapter seeks to explain the key themes of technology strategy as they relate to international business. Much of the literature in this field has stressed the growing influence of technology on the competitiveness of international business. Harris et al. (1984) focused on the influence of 'technology-driven events' causing a lack of competitiveness in US industry. They correctly forecast that technology would continue to trigger major market shifts. Hence, the need for transnational businesses to adroitly manage technology is difficult to overstate.

Technology and strategy

> *A powerful force drives the world toward a converging commonality, and that force is technology. It has proletarianized communication, transport and travel. It has made isolated places and impoverished peoples eager for modernity's allurements. Almost everyone everywhere wants all the things they have heard about, seen, or experienced via the new technologies* (Levitt, 1983).

> *Technology is, without doubt, one of the most important contributory factors underlying the internationalization and globalization of economic activity* (Dicken, 1998).

The impact of technology on strategy

Theodore Levitt's (1983) prescient paper on market homogenization captured the enormous impact that technology has and will continue to have on markets and businesses. Although other authors (e.g., Douglas and Wind, 1987) have pointed out weaknesses in Levitt's arguments, we can now look back and see how right he was to highlight the significance of technology in shaping the markets that the transnational deals with as well as the way in which the company is organized.

The effects of technology have however sometimes been different to those that Levitt discussed. For example, while communication technologies such as satellite television have continued to encourage a convergence of demand, flexible manufacturing technologies have enabled businesses to offer a much greater variety of product designs without sacrificing economies of scale. Similarly, while the dramatic improvements in information technologies have enabled businesses to operate on a global scale, they have also enabled a move away from the old style multinational

corporation with central control to the transnational with information shared throughout the organization.

Technology is one of the major factors behind the increased turbulence in the environment of many business sectors. The shortening of the new product design cycle through, for example, sophisticated CADCAM (computer-aided design, computer-aided manufacture) technologies has increased the rate of product obsolescence. Businesses have less time to respond to new developments and must make strategic decisions where the future becomes less and less predictable. The emergence of new, competing technologies and the acquisition of existing technologies by competitors can also increase the complexity of the environment. This complexity is even greater for the transnational facing both global and local competitors.

The general impact of technology on the macroenvironment has already been discussed in Chapter 5. The purpose of the present chapter is to examine how the transnational can 'manage' technology as part of its corporate strategy. To do this we shall first consider the role of technology as a strategic asset and how it differs from more conventional assets; second, we shall review the elements of a technology strategy – how the business responds to the challenges and opportunities posed by new technology; finally, we shall examine the special cases of information and communication technologies (ICTs) and their impact on the strategy and operations of the transnational.

Technology as a strategic asset

Defining technology

'Technology' is a word that is often used but not often explained. In this chapter we shall use the dictionary definition of the application of science to industry or commerce. There is an important distinction here: by 'science' we mean the results of fundamental academic investigations, while by 'technology' we mean the *application* of science. This distinction is important when we consider how businesses acquire new technologies.

The importance of technology to a business lies in the fact that possession of a technology can give a competitive advantage. Technology can be therefore regarded as a strategic asset. Furthermore, we can also say that a business's ability to manage and exploit its technology can represent a core competence. There is also a close link between a company's ability to

manage technology and its capacity to innovate. We shall now examine more closely how technology can give a competitive advantage through its products and production processes. The contribution that information and communication technologies can make to a business's operations will be discussed later in the chapter.

Technology and products

Technology can enhance a company's product portfolio in a number of ways:

New functions
A new product can be developed which allows the user to perform tasks that were hitherto not possible or else very difficult. An example of this is the development of the satellite telephone that allows the user to communicate from almost anywhere on the Earth's surface. Some customers are willing to pay high prices to own such a product. Such products are likely to be highly innovative requiring major investments in new technology.

New features
An existing product can be modified to make it more useful while the basic function remains the same (e.g., the development of compact satellite telephones that require almost no setting up). Companies continually seek innovations to differentiate their products from that of competitors. Although such innovations may be minor, over time these can add up to represent a significant advance in technology.

Greater reliability
As the technology becomes more mature, product reliability becomes a key factor in product differentiation. Design improvements and different assembly techniques will focus on performance and quality (e.g., increased use of specialized integrated circuits can make the product easier to assemble and more robust).

Lower costs
As the product matures, technology development focuses more on cost reduction. The use of specialized integrated circuits, mentioned above, which are expensive to design but in mass production offer huge cost advantages over discrete components offer a tremendous advantage to the businesses that can master this technology.

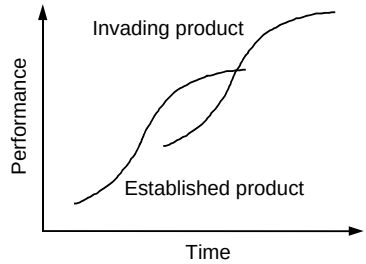

Figure 10.1 Performance of invading product compared with that of established product
Source: Abernathy and Utterback (1978)

Technology is one of the underlying reasons for the existence of a product life cycle. Product performance tends to follow an 'S'-shaped curve as shown in Figure 10.1.

When the technology is new, developments are rapid and product performance rises quickly. As the technology becomes mature, the rate of change of performance tends to level off as the technological limits are reached. At some point, a new technology may be developed and incorporated in the product. At first, product performance is lower than that of the existing technology. But as the invading technology is developed, product performance overtakes that of the current technology, and eventually the old product/technology becomes obsolete.

As an example, consider the technology in wristwatches. The basic mechanism of the wristwatch was established around 1765. By the early 20th century the watch was a sophisticated piece of precision mechanical engineering, but there was relatively little rate of improvement in accuracy. When the electronic quartz movement was developed in the 1970s, the inherent accuracy was much greater than conventional mechanical movements. Since the quartz movement was also much cheaper to mass-produce, the old mechanical technology was soon obsolete, with dramatic effect in the Swiss watch industry. The lesson here is that the invading technology can come from other industry sectors and other countries – and the time between initial launch and annihilation of the current product/technology can be quite rapid.

Technology and production

The section above has indicated that product design is a major factor in production cost. However, the technologies used in the production process itself can lead to competitive advantage.

Shorter lead times
The use of CADCAM systems has dramatically reduced lead times from initial design to full-scale production. In many industries, components can be designed on computer and a prototype generated within a few hours. After testing is complete the computer-generated design can be used directly in the manufacturing process. Design information can be electronically transferred from one location to another.

Increased quality
The use of automated assembly, with robots as a leading example, can not only increase throughput but can also reduce errors in complex, repetitive processes. Automation can also increase production flexibility; changes to a process can be introduced by reprogramming which is faster and cheaper than hardware changes.

Reduced cost
The higher throughput and increased reliability offered by new technologies can also lead to reduced unit costs. With flexible manufacturing techniques large production runs are no longer required to keep unit costs low.

An example of technological change was the development by Pilkington Brothers of the float glass process. The traditional method of manufacturing flat glass was to pass molten glass through a series of rollers until it was the correct thickness; the glass has then to be polished on both sides. In the float process the glass flows in a continuous process across a bath of molten tin and emerges as a perfectly flat sheet at the other end with no rolling or polishing required. Although the development of the new process required a huge financial outlay it revolutionized the economics of flat glass production and put Pilkington in an unassailable competitive position.

Patterns of technological innovation

The pattern of technological innovation outlined above has been shown to apply to many product types. Abernathy and Utterback (1978) described a model of innovation summarized in Figure 10.2.

In the early stages of the product's life, innovation dominates. The emphasis of technological development is on improving product performance, stimulated by information on user needs. The product design is 'fluid' with

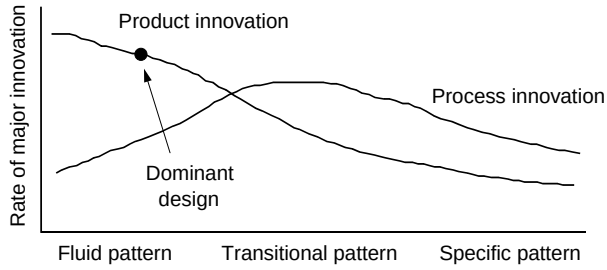

Figure 10.2 Patterns of innovation
Source: Abernathy and Utterback (1978)

frequent major changes, together with flexible and inefficient production. Organizational control tends to be informal and entrepreneurial.

At some point a 'dominant design' emerges which all manufacturers adopt as a basic standard. The emphasis moves toward process innovation with the objective of reducing costs and improving quality. Changes are incremental and cumulative, and products tend to be very similar. Production processes are efficient and capital intensive. Organizational control tends to be based on structure, goals and rules.

The significance of this for any business is that the nature of technological development and how it is managed changes greatly over the life of a product.

Differences between technology and other assets

Like other assets (except for some fixed assets), technology can be transferred from one location to another; it can be acquired and it can be considered as having value. The difference from other assets is that the *form* that the technology takes can vary. The clearest distinction is that between *tangible* and *intangible* technology. We can illustrate this difference in one way by considering how the technology appears to the user of the company's products.

Tangible technology

In the example mentioned above of the satellite telephone, the technology is embodied in the product itself and made available to the user. It would be possible for the user to 'reverse-engineer' the telephone and acquire the company's technology to design and build his or her own telephones. Of course, reverse-engineering complex integrated circuits and software is very difficult but most businesses make some attempt to examine their

competitors' products to see if any secrets can be learned. The company must therefore find some means of protecting its technology.

Intangible technology
On the other hand, the user of glass manufactured by the float process would not be able to deduce from the product itself anything about the manufacturing process. The technology is not embodied in the product; this helps the company to protect its secrets from competitors. This technology in its purest form is intangible. The knowledge of how something is made may reside in the heads of a few key employees. It is much more difficult to talk about acquiring this kind of technology and even more difficult to value it. We shall consider this later in the sections on technology transfer (pp. 278 and 280).

Technology and global competitiveness

Design technology
Many examples can be given of the link between technology and international competitiveness. In the consumer electronics industry, for example, international competitiveness depends to a significant extent on the continual introduction of new products incorporating new technology (e.g., VCRs, digital audio tapes, personal computers, electronic calculators, personal hi-fi systems, remote control and flat screen TVs). Similarly, in the pharmaceutical industry, the development and introduction of new drugs is a major determinant of transnational competitiveness – as in the case of Glaxo with its anti-ulcer drug Zantac and Hoffman-La-Roche with its anti-depressant drugs valium and librium.

Process technology
International competitiveness is also closely linked to new process developments, with one of the earliest examples being the pioneering of mass production technology by Ford. In the textile and clothing industry, producers in developed countries have responded to the flood of low-cost textile imports from developing countries by introducing increasingly automated production techniques.

Some businesses are more capable of generating a stock of proprietary information than they are of achieving commercial success. Others discover that their technology is more readily exploited by others who learn from their errors. In other cases, the company's international investment is

largely motivated by the desire to acquire technology skills as a basis for a future stream of innovations.

Technology strategy

The components of a technology strategy

In order to exploit the opportunities and counter the challenges posed by technology, many transnational companies develop a technology strategy. Many businesses have some sort of 'IT strategy' that is rather limited in scope; here we suggest that this should be linked with a wider strategic approach to managing technology as a strategic asset. As with any other functional strategy (such as a human resource strategy), a technology strategy should be consistent with the overall corporate strategy and the objectives underlying that strategy. The components of the strategy will vary from one business to another but in general will include:

- technology audit;
- sourcing new technology;
- exploiting technology;
- protecting the competitive advantage.

We consider each of these components in turn.

Technology audit

This activity is similar to the general internal analysis of the business described in Chapter 3. The purpose of such an audit (also known as an *innovation* audit) is to identify the specific technological competences within the business and match these against the opportunities the business intends to pursue in its corporate strategy. The outcome of the audit should be an estimate of the potential of the business to obtain a competitive advantage from the technology in one or more of the ways described earlier in this chapter. The audit should also identify technology 'gaps' that have to be filled. This information will be used to determine the level of investment in technological development required to meet corporate objectives and where that investment should be directed.

Goodman and Lawless (1994) described three systematic approaches to carrying out an audit that, when taken together, can present a useful picture of the business.

Table 10.1 Technology categories

Category	Description	Investment level
Base	Technological foundation of business; widely available to competitors.	Needs little
Key	Technologies with the greatest impact on competitive performance.	Systematically built
Pacing	Technologies in early development which have the demonstrated potential to alter the basis of competition.	Selective investment
Emerging	Technologies with long-term promise to alter the basis of competition.	Monitored

Source: adapted from Goodman and Lawless (1994)

Technological innovation process audit
The aim of this is to construct a risk profile for existing and new projects by assessing the length and depth of the company's experience in its chosen technologies, its markets, project organization, the far environment and the industry structure. This can assist management in deciding which technological areas are more likely to be successful and which should perhaps be avoided, as the risk of failure may be considered unacceptable.

Innovative comparison audit
This is an analysis of the business's innovative abilities compared with competitors. It requires an examination of the company's track record in new products, R&D staff capabilities, R&D performance, idea generation, time to commercialize (i.e., time to market), costs/benefits of R&D and relationships between R&D and other key functional areas.

Technological position audit
This reviews the technologies needed by the business and places them in one of four categories as shown in Table 10.1. For each category, the table shows a suggested level of investment that might be appropriate.

Sourcing new technology

Development or transfer?
Having identified weaknesses or gaps in its technology capabilities, management has a number of options to build new capabilities. The basic decision is to develop in-house or look externally. Some authors have discussed how the decision should be made; one example is the discussion

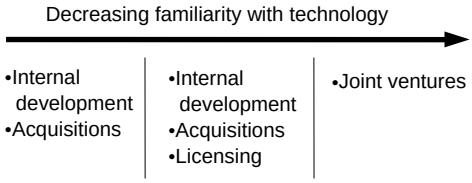

Figure 10.3 Optimum entry methods for new technologies
Source: adapted from Roberts and Berry (1985)

in Roberts and Berry (1985). The key variable is the familiarity of the company with the technology, ranging from already making some use of the technology to simply being aware of the technology but without any practical experience. Figure 10.3 summarizes the recommended approaches.

Roberts and Berry (1985) noted that joint ventures were often between a large business with an established market position and a small business with a new technology seeking entry to market. It is interesting to note that acquisition is not a recommended method when the company is unfamiliar with the technology – failure rates tend to be high in such circumstances.

For most large transnationals (especially those operating in technology-intensive industries), new technology emerges mainly from the results of internally generated R&D. It is important to be aware, however, that there are a range of alternative sources of technology available to a business where a distinction is made between internal and external sources, both domestic and foreign. While large transnationals may rely mainly on internal R&D, smaller and non-dominant transnationals may focus on external sources of technology transfer and accumulation, since these will reduce the high capital expenditures involved.

Recent years have seen a rapid growth in the use made of these alternative forms of technology acquisition and development given the pace of technology change, shortening product life cycles and the intensity of global competition. For example, foreign acquisitions of US companies have increased rapidly (in both number and value) since the late 1970s. Although motivated mainly by the need to gain access to US markets and existing distribution outlets, many US acquisitions have been motivated (at least in part) by the desire to acquire US technology (Hamill, 1988). Similarly, recent years have seen the growing importance of joint government/industry-sponsored research initiatives, mainly in the electronics industry and in various forms of international collaboration between organizations of different nationalities, including strategic alliances.

While the objectives of these various options are similar (i.e., technology development and transfer), the management implications of internal and external forms of technology acquisition differ significantly.

Some of the major management decisions that need to be taken in the case of internally generated R&D include:

- the level of R&D expenditure;
- the focus of R&D effort;
- the location of R&D (i.e., the centralization/decentralization issue);
- the nature of R&D undertaken at subsidiary level;
- the transfer and diffusion of R&D results throughout the global network.

External forms of technology involve partnerships and collaboration between unrelated concerns. The major managerial issues involved, therefore, relate to the planning, negotiation and organization of collaborative agreements (this issue is examined in more detail in Chapter 14).

Problems with technology transfer

The problems associated with the successful transfer of technology into an organization are closely related to those in any merger or acquisition and require careful management. We have already mentioned that technology can exist both as a tangible and as an intangible asset. Simply acquiring a few product samples and manufacturing drawings does little more than permit the company, at best, to manufacture a copy of the original product. If the acquiring business is unfamiliar with the technology, it is also necessary to acquire the underlying knowledge that went into the design of the product. Only then can the business expect to be able to continue the product and process innovations discussed earlier that are an essential part of achieving a sustainable competitive advantage. The business therefore needs to have available the key technologists in the source organization either as new employees of the business or on some kind of consultancy basis to educate the current employees.

Another problem can be caused by the acquiring company not having the appropriate expertise to manufacture the product in a reliable way. Once again the acquirer may have to go through a substantial learning period. The difficulties may be increased if the source company is small and entrepreneurial; as we have already seen, production processes in such companies may be inefficient and poorly documented.

A further problem in technology transfer is caused by the nature of

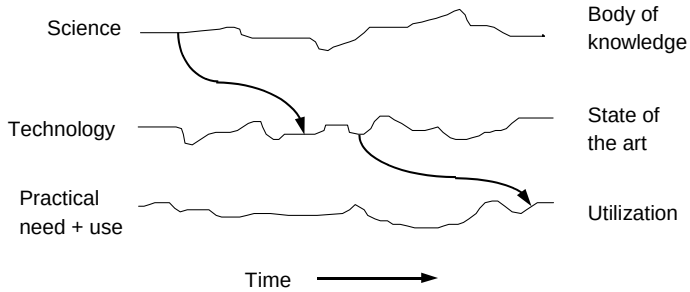

Figure 10.4 Science, technology and the utilization of their products
Source: Allen (1984)

technology itself – something between science and its practical application. The relationship is shown schematically in Figure 10.4.

The nature, location and timescales of the three types of activity can be very different. Acquisition of a technology that is still in the experimental stage is risky; there may be culture clashes between the technologists in the business and the scientists who carried out the original research. The problems are similar to the clashes that may occur between technologists in an R&D department and the engineers in a manufacturing department. All parties need to have a good understanding of each others' needs and problems for the transfer to be successful.

Exploiting new technology

The process of technology development and acquisition (discussed in the previous section) represents only the first stage in effectively managing technology within the transnational business. There are many companies who have successfully generated new proprietary technology, but who have failed to exploit such know-how commercially. In order to commercially exploit new technology know-how, two other stages need to be covered in the company's technology strategy.

First, effective organizational channels need to be established for transferring technology throughout the transnational network. Second, the organization needs to determine the most effective foreign market entry and development strategy for exploiting the newly acquired technology know-how. This (second point) involves an assessment of the relative merits of exporting, licensing, joint ventures, FDI (foreign direct investment), etc. (see Chapter 7).

The two key issues relating to the process of technology diffusion within the transnational are the location of R&D activity and the organizational structure.

Location of R&D activity

Most transnationals adopt a qualified policy of centralization in R&D. Where decentralization does occur, overseas R&D units tend to take the form of technology transfer units to assist in the transfer of technology from parent to foreign subsidiary (Hakanson, 1983; Ronstadt, 1977, 1978). The importance of these units is that technology can rarely be transferred without some form of modification. There is evidence (Davidson, 1980) to suggest that the speed, rate and extent of technology transfer have accelerated over time, reflecting the transnational's need to apply new technology throughout the international network almost immediately in order to obtain (even a brief) competitive advantage. In these circumstances, the transnational's competitive position is enhanced if its key subsidiaries have some development capability and can handle much of their own adaptation. As a result, this is perhaps one of the strongest motivations for a measure of R&D decentralization in recent years.

Structure and technology exploitation

The organizational structure of the transnational plays an important role in its ability to transfer technology. Davidson (1983), for example, found that the transfer performance of companies organized along matrix lines was superior to those with alternative organizational structures, especially those with global product divisions. He argued that, in this context, accumulated experience and information is better exploited in more centralized structures. Thus, global matrix companies tend to transfer new products more rapidly and more extensively to foreign subsidiaries.

Systems to support technology exploitation

There have been a number of attempts to address the question of appropriate systems for the management and transfer of technology within the business. One of the earliest and most comprehensive, by Burns and Stalker (1961), noted the need to move from mechanistic to organic models of organization of work in the transfer into new technologies. Many transnationals are frequently, if not constantly, in that change process. Gresov (1984) captured this position quite effectively for transnationals. Recognizing that the successful management of technology

involves the two distinct processes of innovation and implementation, he observes two organizational dilemmas. Where the business is centralized, implementation is usually improved at the expense of innovation; with a complex organizational design the converse is true.

Similarly with an organization's culture. A homogeneous culture favours implementation at the cost of innovation, with the reverse holding true for a heterogeneous organizational culture. Gresov (1984) suggested that it may, for instance, be possible to compensate for the poorer adoptive capacity of the centralized structure by encouraging and promoting cultural heterogeneity. Similarly, by extending aspects of homogeneous organizational culture, the implementation weaknesses of the complex structural form might be improved. The resulting trade-off may produce a solution that improves the company's overall capacity to manage its technology.

Protecting the competitive advantage

If possession and application of one or more key technologies give a business a significant competitive advantage, the business needs to consider how it can ensure that such technologies remain proprietary for as long as possible. We mentioned earlier that it is easier for process technologies to be kept secret than for technologies that are embedded within the final product. Even so, the company would be wise to consider how it can maintain the value of its intellectual property. The business has two main courses of action: it can apply for a patent or it may choose to keep the technology as a trade secret.

Patents

If the technology and its application are considered sufficiently novel, the company may be granted a patent that gives the company exclusive rights to the benefits of the technology for a certain period (20 years in the USA). There are, however, some disadvantages in gaining a patent:

- In return for the patent, the company must publish openly a detailed explanation of the technology and its application. This information is freely available to competitors who may use it to develop alternative forms of technology that they themselves can patent. Once the patent expires no further protection is possible.
- Although 20 years may seem a long time the actual time during which the company can profit from the technology may be much less (e.g., it can

take several years after the patent is filed for new compounds developed by pharmaceutical companies to enter the market).

- If the patent is contested by another company the cost of patent litigation can be high.
- The cost of filing an application and keeping the patent in force in several countries can be high; however, for a transnational of any size this should not be a serious problem.
- Different countries have different patent systems, so each patent application may have to be adapted. This problem is being reduced by increasing co-operation between governments (e.g., only one application is necessary for protection in all the member countries of the EU).
- It is not possible to gain such protection in some countries, so competitors there are free to sell goods using the technology in such countries.

However, the benefits in owning a patent are considerable. The protection offered by the patent means that it has measurable *value*. This means that it can be used as an instrument of negotiation (e.g., the company may grant a licence to a competitor allowing it to use the technology in return for royalty payments). This was the approach used by Pilkington after it developed the float glass technology in the 1960s. The company received substantial payments from competitors throughout the world for many years without having to make substantial capital investments itself. However, this approach was later criticized as being too risk-averse (Stopford and Turner, 1985).

When patents expire

The patent on the world's best-selling drug expired in July 1997. The patent was taken out by the product's developers (British drug company Glaxo) in 1977, although because of the development time the product wasn't actually launched until 1983. The legal patent enabled Glaxo (and Glaxo in its later guises, including after 1995 Glaxo Wellcome) to enjoy sole manufacturing and distribution rights on the drug throughout the world. All forms of legal substitution were prohibited and the superior performance of Zantac against other anti-ulcer treatments made it the best-selling drug up to that point with annual sales exceeding £2.5 billion.

Several firms attempted to challenge the patent before its expiry. Most notably, Canadian generic drug manufacturer Novopharm appealed to the legal authorities in the USA in the early 1990s to manufacture a form of the drug's basic molecule, ranitidine hydrochloride. Glaxo spent a lot of money fighting off this legal challenge and, although it was technically successful in doing so, Novopharm did begin producing its generic form several months before the final expiry of the patent. Other firms sued by Glaxo for patent infringement included Geneva Pharma (a Novartis group company), Roxane (part of Boehringer Ingelheim) and Torpharm.

These four generic firms were geared up to start producing ranitidine in the summer of 1997. Because ranitidine was protected under patent, its molecular structure and pharmacokinetic mechanism were not secret – they were disclosed as part of initial patent application. When generic production started, competition was described as 'cut-throat'. As a profit earner for Glaxo, ranitidine had had its day but it was relaunched at half strength (75-mg tablets as opposed to 150-mg tablets) as a treatment for heartburn (Zantac 75).

Trade secrets

If the company believes that it can keep the technology secret for a substantial length of time, then it can obtain the benefits of the technology without the drawbacks of the patent approach. This approach is particularly useful when the company can bring the product to market rapidly, so that even if competitors can copy the technology the company still has a substantial lead. However, the company should maintain certified records to prove that it developed the technology first to prevent a competitor obtaining a patent for themselves.

Comparisons of transnational technological performance

Comparing US and Japanese performance

Transnationals have differential rates of success in maintaining technological advantage. Over recent years there has been much discussion about different levels of innovation and their influence on competitiveness.

Much of this has been motivated by the decline in US and European competitiveness in many fields and by the growth of Japanese exports. While some of the explanations for these changes lie at the macro-level, managers of transnationals are increasingly sensitive to company-specific dimensions.

On national comparisons, Johnson (1984) compared the R&D strategies of Japanese and US companies to determine whether differences in them had contributed to different competitive positions. He noted that Japanese businesses:

- invested more heavily in applied research and product development (and less in basic research projects);
- concentrate more on building pre-existing products and technologies developed by other companies in the same or related industries than on the development of new, unproven products of technologies; and
- they tended to follow the products or technologies of other businesses, rather than trying to be first.

This pattern of difference is by now well established, of course, and Johnson showed that over the period 1965–81 Japanese companies pursuing such strategies had a substantially higher private rate of return than their US counterparts. In seeking explanations for this, he emphasized the importance of differential government subsidiaries and tax incentives for R&D in the two countries. He also indicated that the US government's strict enforcement of the patent system has deterred many US companies from taking advantage of opportunities to build on the products and technologies of their foreign competitors.

Commentary on different home nation support environments for technology has become an increasingly important dimension of this debate. Daneke (1984), for example, contrasted US and Japanese policy approaches using illustrations from the biotechnology industry. Japanese businesses have benefited from their government's policy of making biotechnology a national priority, providing direct public financing for private sector R&D and the commercialization of its output, compared with the (less effective) US motivation of tax incentives. Daneke believed that US governmental policy will effectively drive a wedge between the successful and entrepreneurial aspects of biotechnology, allowing Japanese and European transnationals to take the lead.

Learning good practice

Another important aspect of comparative work has inevitably been that of the identification of lessons from practice at a corporate level. Here again there are illustrations from the literature. Maidique and Hayes (1984) examined a large sample of US high-technology companies, including many transnationals, in an endeavour to trace the origins of their successful technology management.

They found that five themes emerged, and while none of the companies showed excellence in all areas at any one time, neither was any one of them less successful in all of them:

- *Business focus*. This was clearly related to success, with the examples of IBM, Boeing, Intel (integrated circuits), Genentech (genetic engineering) being cited as among those whose sales were largely in single or clearly related product groups.
- *Adaptability*. Having a long-term focus, but also with the capability for rapid change. Not strategically immobile.
- *Organizational cohesion*. Widely regarded as critical in successful high-technology companies. Reflected for example, in Hewlett-Packard's 50 divisions; Texas Instruments with some 30 divisions and 250 tactical action programmes.
- *Sense of integrity*. Desire to maintain positive stable associations with all interest groups.
- *'Hands-on' top management*. Deep involvement in the assessment process of technological advance.

Information and communication technologies

The effects of ICT

Technological change, particularly the development of ICT, has been among the most important driving forces behind globalization. While developments in transport have played a major role in internationalizing industries and markets, by making it possible to transfer resources and goods between countries and continents, it is ICT probably more than any other single factor which has caused globalization. Developments like satellite television have helped to bring about convergence of customer wants and needs. ICT has had an even more significant impact on the

ability of businesses to co-ordinate value-adding activities across national boundaries in remote geographical locations while still permitting local responsiveness when and where it may be required.

The key to successful global strategy can often be found in ICT. The technology is important because of the role that it plays in the processes of organizational learning and in knowledge management (Stonehouse and Pemberton, 1999). ICT is both a powerful competitive weapon and a major integrating force for the business. ICT can assist in building and leveraging core competences, in reducing costs and in differentiating products. The impact of ICT has not however been entirely positive, and it is cited as a major cause of hypercompetition and environmental turbulence (Chakravarthy, 1997).

Ironically, it is ICT in the context of organizational learning and knowledge management which offers the best hope to businesses seeking to acquire and sustain competitive advantage in turbulent environments (Stonehouse and Pemberton, 1999). This section examines the changes that have taken place in ICT and their impact on the global strategies of transnationals.

Developments in ICT

ICT alone has not driven the globalization of business activity, but without recent developments in ICT it is difficult to see how globalization could have developed to such an extent. For many years, the level of technology was a major factor for inhibiting those businesses seeking to achieve superior performance through their distinctive global architecture and co-ordination. According to Dicken (1992) 'both the geographical and organizational scale at which any human activity can occur is directly related to the available media of transport and communication.' The physical barriers to the movement of materials and products have been substantially reduced by improvements in transport technology. They have revolutionized logistics and resulted in global shrinkage, opening up the possibility of new configurations to transnationals.

Of even greater significance to the globalization of business activity have been the developments in ICT. In this context, 'convergent IT' (Hall and Preston, 1988), or the integration of computers and telecommunications into a unified system for the processing and interchange of business information, has been of singular importance. This convergence has opened

new opportunities to transnationals for the acquisition of global competitive advantage.

The two most important contributions to the development of convergent IT have been in the areas of computing power and connectivity. There has been a 'radical change in information architecture' (Laudon and Laudon, 1991). There has been a move from centralized to distributed processing via PCs and workstations. Most of these have processing display and storage capabilities well in excess of some of their mainframe predecessors. Helms and Wright (1992) predicted that by the year 2000 over 15 million personal computers will be installed in businesses with 40% connected through far-reaching networks. In fact, this figure was greatly exceeded, such is the pace of change in ICT. The average personal computer has immeasurably more processing power and speed than the most powerful mainframe in the 1970s and at a tiny fraction of the cost. Thus, not only has computing power increased beyond recognition in the last 30 years, but information and knowledge have also become relatively cheap and far more accessible as resources.

Accompanying developments in software have the potential to empower individual managers and at a price that is no longer prohibitive. Spreadsheets, databases, word processors and the like have made powerful business software accessible to all managers. One of the major problems faced by managers in international enterprises is the volume and complexity of data which have to be analysed before decisions can be made. In this respect, decision support systems (DSS), expert systems, neural networks, multimedia, intelligent databases and artificial intelligence all have an important role to play. Parsaye (1989) stated that 'The implementation of intelligent databases was inconceivable prior to the implementation of hypermedia systems, advanced microcomputer workstations and expert systems. Now that these technologies have matured, intelligent databases can be used to respond to the needs of data rich and information poor users.' Software developments, allied to hardware, are at the root of executive information systems (EIS) and strategic information systems (SIS). From complex, conflicting and incomplete data such systems help to produce the information and knowledge which support improved decision making and enhance organizational responsiveness in increasingly chaotic and hypercompetitive environments.

The value of this individual power has been augmented by developments in connectivity. Local area networks and wide area networks are the basis of this connectivity. Developments in telecommunications, like satellite and

cable links, have drastically improved inter and intra-company communications. They have made possible increased co-ordination of geographically dispersed organizations. Equally, they have improved linkages in the value chain between businesses, their suppliers and distributors. It is these developments that have made possible the development of the Internet, which has already had a dramatic impact on business activity, particularly on the links between businesses and their customers.

ICT and transnational strategy

The technological developments in ICT, particularly those that have improved networking and connectivity, have important implications for the architecture of transnational organizations, for the management of knowledge and for co-ordination of activities and for flexibility and responsiveness. According to Frankovich (1998) 'Any business seeking to globalise its operations has a major IT challenge on its hands. Never has the intelligent application of technology been more important to improving business performance.'

In Chapter 6 we identified several potential sources of global competitive advantage centred on the core competences, generic and transnational strategies of the organization. Knowledge and information have become the major resources underpinning competitive advantage (see Chapter 15). ICT plays a vital role in the collection of information, its manipulation, analysis, storage and interpretation and in the generation of new organizational knowledge which forms the basis of core competences. ICT has provided the infrastructure needed to support network organizational structures that can be important to both organizational learning and transnational business (Bartlett and Ghoshal, 1995; Stonehouse and Pemberton, 1999).

Core competences can be based on knowledge of customers and their needs, knowledge of technology and how to employ it in distinctive ways, knowledge of products and processes, etc. Microsoft's core competences are based on its knowledge of how to build and market operating systems and software. Equally, Microsoft's competitive advantage is based on its knowledge of computer hardware and networking, and its knowledge of the companies that produce those products. Microsoft has leveraged its competences in personal computer operating systems and software, and built new associated competences in order to build competitive advantage

in computer networking and Internet software. Such competence building and leveraging is largely knowledge-based.

ICT has also assisted the process of building collaborative business networks that are also a valuable source of competitive advantage. Network members can concentrate on their individual core competences, and by pooling them together in network activities synergy is created. ICT has made it possible to integrate network activities far more effectively and efficiently, leading to the development of what are often called *virtual corporations* (Davidow and Malone, 1992). In the airline industry, alliances use ICT to co-ordinate and integrate flight schedules, bookings and prices.

As we saw in Chapter 6, according to Porter's model of global strategy (Porter, 1986a, 1990) competitive advantage is viewed as arising from the *configuration of organizational activities* (i.e., where and in how many nations each activity in the value chain is performed) and *co-ordination* (how dispersed international activities are co-ordinated). ICT has transformed the ability of transnationals to co-ordinate their activities in geographically remote locations. This has increased the range of alternative configurations of activities available to them, thus making it possible to gain global competitive advantage by choosing distinctive configurations for value-adding activities. In addition, ICT has made it possible to achieve co-ordination and integration at the same time as maintaining a high degree of flexibility and responsiveness.

Configuring ICT for transnational business

According to Frankovich (1998), IT in global business is typically configured in four basic ways:

- *Centralised:* strong control from headquarters;
- *Replicated:* identical country systems;
- *Autonomous:* dissimilar and uncoordinated country systems;
- *Integrated:* compatible and co-ordinated systems.

There is no ideal configuration for ICT and the configuration chosen will depend on the transnational strategy of the organization. The globalization drivers (Yip, 1992) will dictate the extent to which local responsiveness is required. A centralized configuration will suffer from lack of flexibility and is likely to hinder responsiveness. A replicated configuration will include unnecessary duplication. When responsiveness is the priority,

an autonomous configuration may well be chosen, but this will hinder the co-ordination of global activities. A truly transnational strategy is likely to be associated with an integrated configuration where there is co-ordination combined with a degree of local variation to allow for local responsiveness.

Discussion and review questions

1. Define what is meant by the word 'technology'.
2. How can technology make products more competitive?
3. Explain how technology can assist in making production more competitive.
4. What is a technology audit and what does it contain?
5. Define and distinguish between technology development and technology transfer.
6. When might a company, having made a technological innovation, use a patent and when might it keep its development secret?
7. What is included in ICT and how has it contributed to globalization?
8. What is convergent IT and why has it been a major cause of globalization?

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