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The Management of TECHNOLOGICAL INNOVATION

Completely
Revised and
Updated

Mark Dodgson, David Gann, and Ammon Salter

STRATEGY AND PRACTICE

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4 Innovation Strategy

Introduction

Of all the aspects of MTI, innovation strategy is the most challenging. Firms can be very good at the various activities involved in MTI, such as R & D or operations, which are discussed later in the book, but this counts for little unless it is supported by a well-grounded innovation strategy that guides firms' choices, prioritizations, and sequences. There is little value in being highly efficient at developing or delivering new products and services if they are the wrong products and services for the firm and its markets. Well-chosen new products and services deliver value, build the technological base of the firm, develop its capabilities, improve its processes, and add to its reputation and brands. An innovation strategy helps firms decide, in a cumulative and sustainable manner, about the type of innovation that best match corporate objectives. It should react to the importance and challenges of MTI described in Chapter 1, reflect the contextual issues affecting MTI discussed in Chapter 2, and respond to the different features and aspects of technological innovation analysed in Chapter 3.

This chapter defines what an innovation strategy is, explaining why it is important, and how it relates to other aspects of corporate strategy in firms. Its primary focus is the formulation of an innovation strategy through the innovative capabilities of searching and selecting. It discusses the limitations of trying to use conventional corporate strategy frameworks and tools to define and guide radical, emergent, and unstructured innovation processes, such as those often found in new technology-based firms and in technological entrepreneurship generally. The implementation of strategy, involving configuring and deploying capabilities is explored more fully in subsequent chapters. In practice the formulation and implementation of strategy are undertaken iteratively and are intimately connected and informed by learning. The chapter begins by addressing the importance of formulating an innovation strategy. It then examines innovation strategies in practice by describing some types. This is followed by a discussion of searching and selecting capabilities. The chapter concludes with a review of the returns from innovation strategy, and consideration of the particular issues of innovation strategy in small and medium-sized firms.

What is an innovation strategy?

An innovation strategy guides decisions on how resources are to be used to meet a firm's objectives for innovation and thereby deliver value and build competitive advantage. Its crafting is supported by a number of innovative capabilities that steer the configuration and reconfiguration of a firm's resources. It entails judgement about which kinds of innovation processes (discussed in Chapter 3) are most appropriate for the firm's circumstances and ambitions. An innovation strategy identifies the technologies and markets the firm should best develop and exploit to create and capture value. It does so within the limits of the resources available to the firm to support current and future innovation efforts and its evolving corporate strategy, organization, and culture.

When considering innovation strategy it is helpful to think of the military distinction between strategy and tactics (although it would be unwise to take the analogy too far—strategy is not warfare). In military parlance, 'tactical' refers to the specific means by which battles are won. 'Strategic' refers to how wars are won: whether, where, and when to fight battles; preparing for war by understanding the nature of external threats and opportunities; and ensuring that sufficient resources and capabilities are collected, organized, and deployed in a timely manner in order to succeed. Within an innovation perspective, tactical issues relate to how firms manage R & D activities, develop new products and services, and improve operations. At a higher level, strategic matters include analysis of the firm's competitive and technological environment, and assessment of its external challenges and opportunities and where its distinctive advantages lie. It involves prioritizing and developing the right technological innovations by ensuring that appropriate resources, capabilities, and processes are used to their best effect in delivering value. As with the understanding of the nature of corporate strategy vis-à-vis innovation strategy, it is not concerned with individual issues, but with comprehensive and coherent approaches to how business issues fit together (Hambrick and Frederickson 2001).

Innovation strategy is different to mainstream business strategy because it needs to comprehensively accommodate uncertainty. As such, and as discussed later, many common approaches to business strategy are inappropriate for innovative businesses. Continuing the military analogy, innovation strategies cannot simply follow an army field manual of prescriptive plans, but must function within Clausewitz's 'fog of war' with uncertainty about your own capabilities, and the capabilities and intent of adversaries. Some uncertainty (unknowable futures) is always present in strategic management of incremental innovation, but is a major strategic factor in radical innovation. Conventional strategy analysis tools such as Porter's five forces industry analysis (see discussion later) are useful for low levels of uncertainty but as uncertainty increases, the key elements of successful strategy become search and responsiveness, helping firms to react to unforeseen events (Courtney, Kirkland, and Viguerie 1997). Under conditions



Figure 4.1. A simple model of innovation strategy

of high uncertainty, the use of many common strategy tools can be misleading and even dangerous.

Figure 4.1 shows a simple model of four interrelated elements involved in innovation strategy, including:

- The enacted strategy itself, including its targets and 'fit' with overall company strategy, existing innovation efforts, and the context in which it operates. The identified targets are the technologies and markets that managers believe will create and deliver best value for their firms.
- The resources available for innovation: the assets a firm owns and to which it has preferential and secured access.
- The innovative capabilities that guide and enable those resources to be assessed, configured, and reconfigured.
- The innovation processes used to deliver results: the combinations of management and organization around R & D, new product and service development, operations, and commercialization that deliver innovation.

Innovation strategy helps to focus attention on how these resources, capabilities, and processes are best developed and deployed to meet corporate objectives.

There are often more opportunities for innovation than resources available, and choices have to be made. Choices should be linked to anticipated economic benefits and the ability to appropriate returns from innovation (see Chapter 9). They need to fit with overall corporate strategy, deciding whether or not innovation targets complement the firm's available resources and existing innovation portfolio and whether ambitions match its organizational structure and culture. The choices made should include attention to issues of timing: whether, for example, a firm aims to be a proactive

innovator or to be a reactive follower. These decisions help prioritize resource allocation, providing a focus for marshalling and integrating different components of innovation processes and guiding them towards specific markets and customers within the competitive environment.

RESOURCES FOR INNOVATION

A firm's resources used in innovation strategy include:

- Financial resources and appetite for and tolerance of risk.
- Human resources and their capacities for innovation.
- Technological resources, both physical (plant and equipment) and intellectual (knowledge, patents, trademarks).
- Marketing resources (ownership and market penetration of brands, access to lead customers, knowledge of markets).
- Organizational resources (the routines, procedures, practices, and policies within the firm, which, when combined, craft processes).
- Networking resources (partners, suppliers, customers, communities within which the firm operates, and the level of adhesion and trust within them).

INNOVATIVE CAPABILITIES

There is a growing literature in the field of corporate strategy on the topic of 'dynamic capabilities', defined as the 'capacity of an organization to purposefully create, extend, or modify its resource base' (Helfat et al. 2007: 4). Innovative capabilities are similarly defined in this book as bundles and patterns of skills used by firms to formulate and implement an innovation strategy involving the creation, extension, and modification of those resources used for innovation. Numerous dynamic capabilities of firms are identified in the literature; here we consider four—searching, selecting, configuring, and deploying (Helfat et al. 2007)—that focus specifically on supporting innovation.

Innovative capabilities include:

- Searching—seeking and assessing market and technology opportunities and considering the threats changes in markets and technologies pose.
- Selecting—choosing amongst future options, based on an evaluation of available resources, the probability of value creation, and the results of search activities.
- Configuring—ensuring the coordination and integration of innovation efforts.
- Deploying—delivering internally generated and acquired innovations on time and to budget, and protecting and delivering value from innovation.

There is also a 'meta level' encompassing innovative capability:

- Learning—improving the performance of innovation processes through experimentation and experience.

INNOVATION PROCESSES

Innovation strategy involves deciding upon the most appropriate innovation processes for the firm's context and targets—whether these processes are relatively simple or complex (see the discussion later and Chapter 3 on the various generations of innovation process). An innovation strategy helps firms decide on the right things to do; their innovation processes help them do things in the right ways (see Box 4.1). Subsequent chapters of this book examine the various elements of the innovation process, including the development and maintenance of supportive networks and communities, technological collaboration, R & D, creating new products and services, operations, and generating economic returns through commercialization.

Box 4.1 Dancing elephants

Even the largest and most cumbersome organizations can respond to changes in strategy. In his autobiography, Lou Gerstner, former CEO of IBM, describes how IBM undertook a fundamental strategic repositioning in the 1990s. The title of his book, *Who Says Elephants Can't Dance?*, alludes to the way that even the largest, monolithic organizations can change strategies in a dramatic and effective fashion. In 1993, IBM was in deep trouble. Its annual net losses had reached a record \$8 billion. The computer market was focused primarily on desktops and it was extremely competitive. Gerstner joined IBM in 1993 and, with a strong customer-oriented background, he decided to focus on business applications across the enterprise. With help from his colleagues, he recognized that one of IBM's enduring strengths was its ability to provide integrated solutions for customers, representing a total package of support, not individual parts or components. IBM successfully transformed itself into an integrated business solutions company, combining its strengths in solutions, services, products, and technologies. It sold its PC business and bought a major consulting firm. IBM accomplished a complete transformation in its strategy.

Sweden's Ericsson is another example of a large company that radically changed its strategy (Davies 2003). During the 1970s and 1980s Ericsson was known as a broad-based manufacturer of public telecoms equipment. During the 1990s it focused on the mobile communications market and was so successful that by 1999, 40 per cent of the world's subscribers were connected to Ericsson systems. During the mid-1990s, Ericsson manufactured and sold mobile handsets, mobile subsystems and systems, radio base stations, mobile switches, operating systems, and customer databases. In 1996, Ericsson's Corporate Executive Committee completed the largest planning study in the company's history. It pointed to the trends of deregulation and greater competition in telecoms forcing suppliers to get closer to customers. Telecom operators were demanding suppliers assume greater responsibility for network design, build, and operation.

As a result of this increased awareness, Ericsson's strategy changed fundamentally from manufacturing into higher value-added services, systems integration, and operations.

The company now offers 'turnkey' solutions to design, build, and operate mobile phone networks (Davies 2003). It is a complete supplier and integrator of mobile systems. It also has a global services business, offering services and business consulting to support customers' network operations. It has outsourced its products, including exchange equipment, 3G radio base stations, and mobile handsets to other suppliers such as Flextronics and its joint venture, Sony-Ericsson.

Why is innovation strategy important?

The reasons why innovation is a strategic management issue is because it is intimately linked to the capacity of the firm to deliver value:

- Creating and appropriating returns from innovations is a key source of competitive advantage for a firm.
- Complex, risky, and expensive activities, such as R & D, product and services innovation design, operations, networking, and collaboration, can hamper a firm's competitive position and may result in piecemeal, short-term focused, and potentially conflicting outcomes unless they are guided by choices that build synergies and grow expertise cumulatively.
- Globalization of technology and markets, with many potential new customers, suppliers, partners, and competitors in different parts of the world, requires companies to take a strategic approach to their innovation activities to provide focus within an ever-expanding set of opportunities and threats.
- Organizational structures and innovation processes that firms adopt to encourage technological innovation need to relate to the corporate strategy pursued by the firm, and vice versa; for example, R & D can be organized according to whether the firm aims to support an innovation leader or follower position.
- Unless firms can articulate their long-term strategic aims for innovation, it is difficult for them to communicate with and benefit from public-sector science and technology policies in areas such as basic science, regulation, and standards creation. They are also less likely to be able to build long-term technological collaborations with partners or to find patient investors (see the discussion later and Chapter 9).
- A firm that identifies innovation as a strategic activity is more likely to attract creative workers in search of exciting opportunities in the 'war over talent'.

Innovation strategy in practice

There are no blueprints for innovation strategy. Managers need to nurture the most meaningful approaches to strategizing for the specific circumstances within which they conduct their business. Innovation strategy development and use can vary markedly depending upon whether the firm is new or well established, large or small, centralized or dispersed in its organization, deals in simple or complex products and services, operates within well-defined or uncertain technological and market circumstances, with a major or minor impact on society, safety, and the environment. It also varies according

to the characteristics of the sectors and innovation systems in which it operates. The challenge for managers is to appreciate and work within the opportunities and constraints of being able to create and implement innovation strategy in their own specific circumstances, which, as we have seen in previous chapters, are often complex and uncertain.

In some firms, strategy is not written down, remaining implicit in the ideas of a few senior managers, and only partially communicated to staff, customers, and suppliers. In other firms, strategy is set out and documented explicitly, and communicated overtly within and outside the business. Explicit strategies for innovation describe objectives and targets and the specific resources, capabilities, and processes required to meet them. Such deliberate strategies are more commonly a feature of well-established sectors and stable business environments. Strategies that are less specific and more emergent are more commonplace in rapidly changing or emerging sectors and markets, in the context of radical innovation, or in the early stages of a product life cycle where there is a high degree of uncertainty. In all cases sound, enacted innovation strategies usually possess the following features:

- Statements on the role of innovation in meeting corporate strategic objectives, creating and delivering value, and building sustainable competitive advantage.
- As accurate as possible an understanding of market trends and technological and competitive circumstances and their impact on innovation positions.
- Articulation of the firm's innovation ambitions and long-term objectives.
- Recognition of gaps between current performance and future expectations in relation to innovation.
- Plans for developing and mobilizing resources and innovative capabilities in a timely manner.
- Appreciation of the most appropriate innovation processes for meeting objectives.

An innovation strategy usually involves a mix of approaches. Parts of the business, for example, may have a relatively straightforward innovation process, involving simple research-push or responding to customer demands. Other parts of the business may be far more complex and difficult to manage: for example, being a user of the fifth-generation process described in Chapter 3. It is important to recall that complexity of innovation strategy is defined here by the number of influential parties contributing to it and the emergent, unpredictable properties of outcomes. A 'simple' innovation process driven by huge investments in in-house science, for example, may turn out to be extraordinarily complicated, difficult, and risky (see Box 6.2). Greater complexity in innovation strategy definition is often found in large multidivision businesses where the development and implementation of strategy requires coordination if not consensus among corporate, divisional, and functional activities, as is demonstrated in Chapter 5 on R & D.

Box 4.2 The move from technology strategy to innovation strategy

Recognition of the broad corporate context within which innovation takes place is acknowledged in the MTI literature, which has evolved over the past twenty years from analysis of 'technology' strategy to analysis of 'innovation' strategy. This partly reflects the change in focus to looking at broader aspects than just technology, and partly a change in terminology—looking at the same things (technology) using a different language and set of dimensions. A number of books and articles in the 1980s and mid-1990s examined technology strategy from an organizational or operational perspective (Porter 1985; Teece 1987; Dodgson 1989; Pavitt 1990; Loveridge and Pitt 1990; Granstrand, Hakansson, and Sjolander 1992; Dussauge, Hart, and Ramanantsoa 1993; Goodman and Lawless 1994; Coombs 1994; Brown 1996). During the 1990s and 2000s, business schools adopted innovation as a core field of study because of its impact on competitive advantage. The focus on technological innovation extended beyond operations and engineering management and organizational matters to encapsulate associated changes in business models and corporate strategies (Burgelman et al. 1995; Dodgson 2000; Tidd, Bessant, and Pavitt 2005; Schilling 2005; Chesbrough 2003). During this time, innovation strategy became a more widely used and understood term, and has become encompassed by subjects such as marketing. It nevertheless retains its antecedents in being concerned primarily with technological innovation and the conditions that encourage its effective management.

Whether an innovation strategy is explicit or implicit, broad or detailed, prescriptive or emergent, and whatever its objectives and timing, its formulation and application are bounded by the firm's culture, norms, and values. Strategy emerges from and is implemented within organizations that possess distinct beliefs and routines and, therefore, needs to fit with them. The continued success of 3M is attributed to its culture of supporting innovation, seen in the deeply engrained traditions and customs revealed in the following statement from its Chairman, William McKnight in 1948:

As our business grows, it becomes increasingly necessary to delegate responsibility and encourage men and women to exercise their initiative. This requires considerable tolerance. Those men and women to whom we delegate authority and responsibility, if they are good people, are going to want to do their jobs in their own way.... Mistakes will be made.... Management that is destructively critical when mistakes are made kills initiative. And it's essential that we have many people with initiative if we are to continue to grow.

Given the high degree of failure in innovation, discussed in Chapter 7, a culture tolerant of failure and encouraging of learning from failure is a distinctive capability.

Developing an innovation strategy contributes to strengthening a firm's knowledge about customers and markets, science and technology, regulations, competition, suppliers, and available finance. This knowledge in itself helps to improve awareness of what can and what cannot be embraced and underpins the innovative capabilities that shape and guide the formulation of an innovation strategy and the selection and use of appropriate innovation processes. The remainder of this chapter describes the types of innovation strategies firms can pursue, with analysis of the kinds of innovative capabilities needed by firms. A number of tools and techniques can assist firms in

defining their innovation strategies and building their innovative capabilities and these are described, together with a commentary on how to use them, and their likely benefits and limitations.

Box 4.3 Insights from corporate strategy and planning

There are several schools of thought on strategy and the ability to make meaningful choices about the future, ranging from those that think planning is a futile activity to those that believe that future events can be shaped, managed, and measured. It is generally useful for managers to assess the level of uncertainty surrounding their decision-making so they can tailor strategy accordingly. Courtney, Kirkland, and Viguerie (1997) identify four levels of uncertainty which affect the ability to develop meaningful strategy:

Level 1. Clear enough evidence about likely future markets and competitive environments for new technology is available, and standard analytical tools can be used with confidence.

Level 2. A number of alternative futures exist. These can be described in scenarios, and decisions can be made about the alternatives to which one might respond.

Level 3. A wide range of possible future outcomes exists and it is not possible to develop discrete scenarios with any degree of certainty. Managers glean whatever evidence may be available and make decisions based on past experience and their personal judgements.

Level 4. There is real ambiguity about the future creating high levels of uncertainty, so managers base their decisions mainly on qualitative judgements.

Uncertainty and ambiguity in many innovation activities can lead to the view that it is not possible to produce a systematic strategy with clarity of purpose. This position uses what might be described as a *judgment-based approach* to strategy. It is adaptive, focusing on experts' intuition to make adjustments to strategic orientations and operations in pursuit of results. In such case, the degrees of uncertainty surrounding the firm's operating environment are typically at Level 3 or 4. In the early stages of more radical innovation, the nature of uncertainty arising from unpredictable events can result in the best-laid plans failing. In such circumstances, why try to plan and develop strategies for the future? Attempts to use formal measurement tools and techniques (described later), can cause complications in the form of irrelevant data and mistaken diagnoses, and lead to what is often described as analysis paralysis. Under such conditions it may be better to leave decision-making to the judgement and experience of experts responsible for different parts of the innovation process with a loose set of orientations and guiding principles, thereby reducing the extent to which they are conceptualized in detail. Hirschman and Lindblom (1962) conclude that in many uncertain projects there is little point in detailed ex ante planning and at best we can develop the science of 'muddling through' (Lindblom 1959). Problems with this 'leave-it-to-the-experts' approach are that a lack of articulation reduces the possibility of engagement of a wider group of stakeholders (see Chapter 5 and the earlier discussion on why innovation strategy is important), and transparency and accountability in decision-making. Another problem with the 'adaptive' approach is that managers can sometimes abandon any attempt at analytical rigour, resulting in misinformed judgements and decisions (Courtney, Kirkland, and Viguerie 1997). Firms can deal with high levels of uncertainty by keeping their options open, investing in flexibility, allowing quick adaptation to opportunities, whilst still demanding rigorous processes for option of development and management.

At the other end of the spectrum lies the 'measure-and-act', *rational approach* to strategy and planning, or what Whittington (1993) calls the 'Classical' approach, which encompasses much of Michael Porter's work on strategy. It is intellectually linked with the study of economics and the military, based on a belief that managers can make rational choices in response to technical opportunities and social, economic, and environmental needs. The use of resources can be optimized to provide the best overall solution based on current knowledge and past experience. Application of this approach to innovation strategies sees the systematic definition of goals, with a schedule of resources and plans for the use of capabilities and processes needed to achieve them. This technocratic approach is often found in operations and engineering management using tools and techniques for measuring and improving performance against clearly defined benchmarks and milestones. It is appropriate to use such techniques where capital investment is intense—putting the firm at risk financially speaking, market uncertainty is

low, and risk can be contained, such as in incremental innovation and continuous improvement. Radical innovation is often inherently more multidimensional and uncertain, creating instability with unique and novel outcomes that conflict with such exercises of technical rationality (Lester and Piore 2004). There are, nevertheless, some circumstances where firms have the confidence of their market position and technological capability through detailed analysis to make 'big bets' on future developments with the aim of shaping the market to benefit from FMA (Courtney et al. 1997; see Box 4.4).

Another approach, associated with management scholars such as Mintzberg (1994), argues that strategy is emergent, evolving from decisions that are crafted as internal and external events unfold. This *rational-adaptive approach* accepts uncertainty and the difficulty of measurement, but believes in the possibility of developing plans and using techniques to collect evidence where it is practical to do so. This position is closely related to what Whittington calls the 'Processual' approach, which recognizes that in practice, strategy is a messy process of learning, failing, and compromising, emphasizing the crafted nature of strategy within a firm's particular circumstances. An approach to innovation strategy formed from a combination of good judgement and practical techniques for gathering and analysing evidence is likely to be the most fruitful way forward in many situations, particularly where there are high degrees of uncertainty, as long as it leads to relatively rapid decision-making.

Types of innovation strategy

Describing different types of innovation strategy is an inevitably crude exercise. In reality firms rarely comply with ideal types. They display different features in different businesses at different times. As we show shortly, strategies evolve between types. Nevertheless, there are some broad categories of innovation strategy that can be described and used for analytical purposes, although it is important to remember their limitations. One of the most useful distinctions is between firms that seek first-mover and fast-follower advantages—see Box 4.4.

Courtney, Kirkland, and Viguerie (1997) offer three basic positions that firms might adopt in uncertain conditions in the light of analysis of the industries within which they operate and the choices they make about timing:

1. Taking big bets, investing heavily in a single new area or development with the prospect of major returns. This may occur in emergent technologies where there are very high levels of uncertainty, or where an existing firm has strong technological leadership and wishes to capitalize on first-mover or very fast-follower advantages.
2. Hedging bets, investing in a number of different options where there are expected to be reasonable returns. This may occur in firms operating in relatively stable markets, able to benefit from fast-follower positions.
3. Wait and see, adopting a 'watching brief' to keep options open or maintain a position in a market whilst others bear greater risks by taking a lead in developments of uncertain new technologies. This option is usually taken by firms that follow behind industry leaders and fast followers, but have the ability to benefit by delivering cost-savings by producing cheaper goods and services.

Box 4.4 First-mover/fast-follower advantages

Lead times over competitors or FMA can provide key strategic advantages and means for firms to capture returns to innovation. Innovations may provide temporary monopolies to firms first into the market. First movers may be able to gain extra market share and capture high returns before the entry of competing products or services (Lieberman and Montgomery 1998; Suarez and Lanzolla 2005). They may also shape their customers' expectations of the form and function of a product or service, thereby influencing cost structures. In some industries, being first may allow the innovation to lock in customers to products or services and make it expensive for customers to switch to those of competitors. It may enable the firm to gain a head start over competitors in building up manufacturing, distribution, and provision of sales support.

Many successful firms specialize in being fast followers, able to learn from the experiences of the first generation of innovators and quickly follow behind them in the market (Schnaars 1994). Indeed, the names associated with numbers of well-known products are not those of the innovators: ballpoint pens, for example, were not developed by Bic, but by Reynolds and Eversharp; and 35-mm cameras were developed by Contrax and Exacta, not Nikon and Canon (Schnaars 1994).

There are some advantages in being a first mover, especially in capturing market share, but FMA vary across industries and geographic markets. These advantages also dissipate over time, but they can be enhanced by longer lead times before competitive entry. In particular, time of entry appears to be less important than access to complementary assets when assessing the potential of FMA to capture returns to an innovation (see Chapter 9).

Timing of entry in a market often depends on the existing resources and capabilities of the firm. Firms with many complementary assets may delay entry into a market for years and then successfully enter and overcome incumbents. This delay allows them to learn from the failures of others and wait until the market settles to the point that entry is likely to be highly rewarding. An example of delayed entry can be seen in Dell's move into printers. Originally Dell did not offer printers on its highly successful website. However, it eventually began offering Lexmark printers—renamed as Dell printers—as part of its computing sales package. This allowed it to utilize its extensive website to sell a wider range of products and capture a major share of the printer market. Another option for large firms is simply to acquire the first mover. An example of this approach can be seen in News International's purchase of MySpace in 2006. MySpace was one of the first successful social networking sites and its acquisition enabled News International to gain FMA.

A number of studies have developed more detailed typologies of technology and innovation strategy (Freeman and Soete 1997; Goodman and Lawless 1994). Here we distinguish *proactive strategies*, involving technological and market leadership with a strong research orientation, which are often pursued by firms that enjoy returns from FMA and are prepared to take big bets; *active strategies*, which involve defending existing technologies and markets, but with the preparedness to respond quickly once markets and technologies are proven and where bets are hedged; *reactive strategies*, which are usually pursued by 'follower' and 'imitative' firms who respond slowly to innovation and play the cost-cutting game; and *passive strategies* in which firms only engage in innovation once it is demanded by customers and is risk free—see Table 4.1.

Examples of firms using proactive strategies include DuPont and Apple. DuPont has had over 200 years of technology leadership, including the development of cellophane (1923); nylon (1935); Teflon (1938); Lycra (1962); Dymel (which replaced chlorofluorocarbons, 1990); and solae (soy protein, 2001). Apple has produced the Macintosh and the iPod, and its offensive strategy was encapsulated in a statement by Steve Jobs in an

Table 4.1. Some ideal type innovation strategies

	Proactive	Active	Reactive	Passive
Objectives	Technological and market leadership	Not being first to innovate, but being prepared to follow quickly	Wait and see. Follow a long way behind	Do what is demanded by customers or dominant firms
Type of technological innovation	Radical and incremental	Mainly incremental	Entirely incremental	Occasionally incremental
Knowledge sources	Science; in-house R & D; Collaboration with technology leaders; demanding lead customers	In-house R & D; Collaboration with technology leaders, customers, and suppliers	Competitors; customers; purchase of licenses	Customers
Innovation expenditure	Basic and applied R & D; products and services new to the world; operations; education and training	Applied R & D; products and services new to the firm; operations; marketing; education and training	Focus on operations	No formal activities
Risk acceptance	High-risk projects included in portfolio. Take big bets	Medium–low risk projects. Hedge bets	Projects all low risk. Wait and see.	No risks taken. No bets.
Main forms of appropriability	IPRs; complementary assets; secrecy; speed	Complementary assets; speed	None	None
Typical firms	DuPont; Apple; Qantas; Singapore Airlines	Microsoft; Dell; BA	European and Asian budget airlines, such as Ryanair and Air Asia	Third- and fourth-tier automotive suppliers

interview in *The Times* (September 29, 2003: 23), when he said, ‘Our strategy is to innovate, that’s what we love to do. We’re the first with things most of the time. . . . Apple makes money because it innovates.’ Qantas and Singapore Airlines are proactive innovators—seen in their early introduction of flat beds in Business Class and ‘video on demand’ in in-flight entertainment systems.

Microsoft is a firm that conventionally uses an active strategy. Its Windows built upon Apple’s Macintosh and Xerox’s graphical user interface; Explorer copied Netscape; Xbox learned from Nintendo, Sega, and Sony’s products. British Airways has an active innovation strategy; for example, it introduced flat beds in Business Class relatively soon after its competitors did. Dell follows a classic reactive strategy in the technology used in its products, but its production and distribution model is highly proactive. Ryanair and Air Asia have successfully copied the model of the USA’s Southwest Airlines ‘no frills’ service, supported by Internet booking. Airbus is an example of a firm that changed its strategy from active to proactive. It was created in 1970 essentially to be a European imitation of Boeing. However, it developed a number of industry firsts, such as ‘fly-by-wire’ in 1984, and now competes head-to-head on innovation with Boeing.

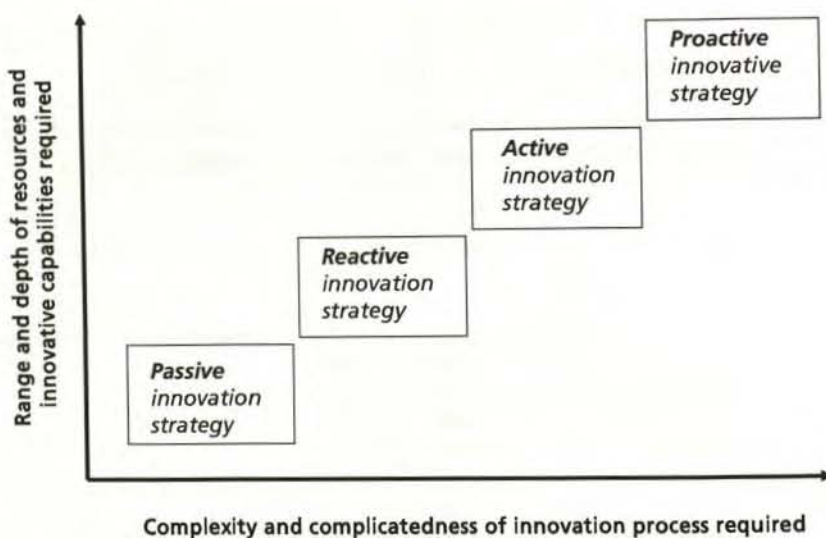


Figure 4.2. Four levels of innovation strategy

Examples of passive strategies can be found amongst many supplier firms in the auto industry. Whilst some major so-called first-tier auto suppliers, such as Bosch in Germany, NipponDenso in Japan, and Magna International in Canada, can be highly active innovators, other firms further down the supply chain are usually entirely dependent on building to the specifications of others.

Figure 4.2 shows the relationship between these types of innovation strategy and the levels and range of resources and capabilities required and complexity and complicatedness of innovation process needed to support them.

Formulating an innovation strategy

Processes of formulating and implementing an innovation strategy are iterative and dynamic, drawing on evidence from the external environment and appraisal of the opportunities, constraints, and limitations of internal resources, capabilities, and processes. Making choices about which creative ideas to pursue involves trade-offs which shape the direction of the firm and outcomes from particular investments. They involve choices about which technology paths to pursue and which customers to target, what is offered to those customers by way of solutions and value propositions, tasks to be performed by the business and those to be outsourced, and configuration of resources to perform these tasks to create, capture, and retain value. The formulation of an innovation strategy is assisted by the appropriate use of various kinds of tools and techniques, and a clear appreciation of which tools to use and when to use them—see Box 4.5.

Box 4.5 Choosing the right tools

Innovation strategy formulation involves making choices about which tools to use and when to use them. This box provides some broad guidance on making sensible choices about gathering and analysing evidence and monitoring activities to inform MTI decision-making. As we have seen, however, innovation can be inherently uncertain and reliable evidence is often difficult to obtain and decisions usually involve judgement based on experience.

A plethora of tools and techniques is available to support decision-making, including techniques for performance measurement and evaluation of cost benefit. Many are adapted from general strategy and project management. Choosing the right technique, using it at the right time, and understanding the benefits and limitations of qualitative and quantitative data present major challenges in MTI. It must be remembered that the reliability of results from data-gathering and analytical exercises is likely to diminish in more radical innovation environments where novelty and uncertainty are higher. In contrast, the use of tools to set targets, measure and monitor performance in incremental innovation, and continuous improvement environments is commonplace—see Chapters 7 and 8. A distinction needs to be made between tools and techniques that assist decision-makers on what to do, as inputs into strategy, and those that assist with how to do it, which are more tactical and operational. A key requirement is for managers to have a well-grounded perspective on the level of risk and uncertainty in possible future courses of action. Failure to do so can lead to major mistakes in choice of tools and techniques.

Figure 4.3 provides some examples of tools and techniques used to assist innovation strategy. They are not exclusive; many different methods exist. The examples—which are described in more detail throughout this and following chapters—are selected to be broadly illustrative of the ways tools are used in innovation strategy. The particular tools depicted in the figure are in the 'what to do' categories, and those in the larger box are in the 'how to do it' categories. Some tools are used in several phases of the innovation process.

There are no hard and fast rules about which to use and when to use them, but some tools are more helpful than others at particular stages of innovation strategy development. Reliance on particular techniques and their results can focus managers' attention narrowly on detailed issues that do not allow decisions to be made in a way that connects with the wider business context. In general it is better to

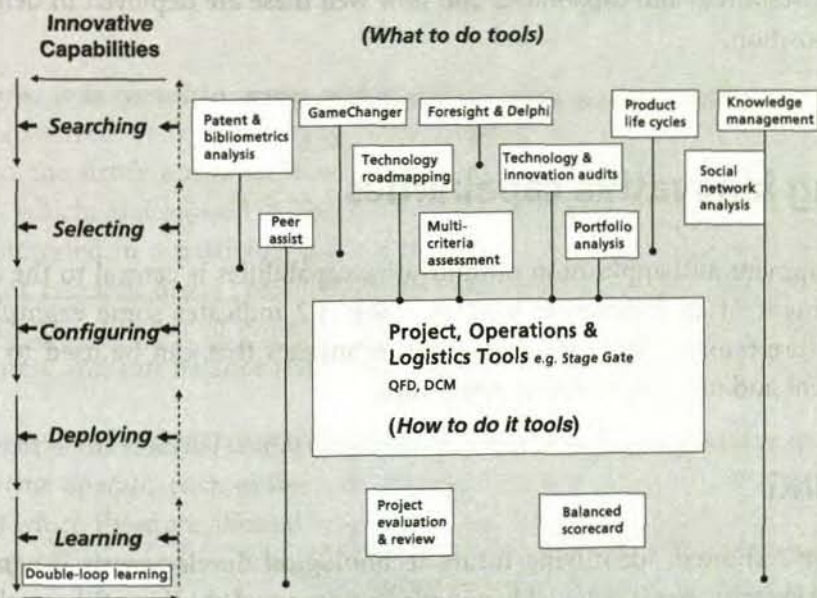


Figure 4.3. Some examples of tools and techniques supporting innovative capabilities

keep data gathering, measurement, and analysis as simple as possible and to see the results of tools as an input to decision-making rather than letting them drive the direction of future events. Overly elaborate instruments can use up scarce resources and may not provide results that are any better than simple approaches. In either case, firms need the capacity to absorb and make use of results in a systematic fashion. The choice of a particular tool therefore has to fit within a wider framework of decision-making and capability in the firm. Some tools will need to be used repeatedly in particular innovation processes; others evolve as the process develops.

In general, tools and techniques that support strategic thinking are useful if they provide a means for managers to reflect upon issues and decisions in what Schön (1991) describes as reflective development, using a common language across disciplines and functions involved in innovation processes. For this reason, the double-loop learning processes described later are particularly useful in helping firms develop capabilities and avoid investigating unproductive ideas again and again.

Developing an innovation strategy involves an assessment of a firm's position in the value chain (see Chapter 9) to understand what the firm is good at, why its customers like and buy its products and services, and how they value the ways it does business: that is, its value proposition. It is equally important to reflect upon why potential customers do not buy from the firm and how competitors gain market share. Wider analysis of market, technological, and sectoral trends is also an essential ingredient of strategy. Clear appreciation of current circumstances—ranging from whether they are entirely predictable or unpredictable—is a starting point for a firm's innovation strategy. This external analysis is usually crafted alongside the firm's understanding of its internal resources and capabilities and how well these are deployed in delivering its value proposition.

Building innovative capabilities

The development and application of innovative capabilities is central to the definition and enactment of an innovation strategy. Table 4.2 indicates some examples of the analytical frameworks, concepts, tools, and techniques that can be used to assist the development and use of innovative capabilities.

SEARCHING

As Chapter 2 showed, identifying future technological developments is a necessarily speculative exercise, but it is valuable nonetheless. Forward-thinking firms welcome any information, guidance, or advice on likely future developments or scenarios in their areas of science and technology, and on the trajectories their technology is likely to follow (Coombs 1994). As well as trying to understand the path that current technologies

Table 4.2. Innovative capabilities, analytical frameworks, and tools and techniques

Innovative Capability	Key objectives	Analytical frameworks/concepts (some examples)	Tools & techniques (some examples)
<i>Searching</i>	Seeking and assessing market and technology opportunities and threats	Technological trajectories, Sustaining or disruptive innovation, Radical-incremental innovation, Lead customers/suppliers	Forecasting/Foresight, Delphi, Bibliometrics, Technology road maps
<i>Selecting</i>	Choosing amongst future options, based on evaluation of available resources and results of search activities	Life cycle analysis, Core competencies/technologies, Platform technologies, First-mover/fast-follower advantage	Technology and Innovation Audits, Social network analysis, Portfolio analysis, Peer Assist, Gamechanger, Multi-criteria assessment
<i>Configuring</i>	Ensuring the coordination and integration of innovation efforts	Lean Thinking, Integrated Solutions, Innovation brokerage, Balanced teams, Agile manufacturing	Technology Plans, R & D alignment tools, Quality Function Deployment, User tool kits
<i>Deploying</i>	Delivering internally generated and acquired innovations. Protecting and delivering value from innovation	Complementary assets, Dominant designs, Market for ideas or products, Appropriability regimes	IPR portfolio management, Standards setting, Real options
<i>Learning</i>	Improving the performance of innovation processes	Learning curves, High-level learning	Post-project evaluations, Strategic reviews, Balanced Scorecard

might follow, it is useful to assess which technologies in other industries might be usefully transferred. It is also necessary to think about how emerging technologies might affect the firm's position. Search is assisted by the conduct of basic research in companies, which, as discussed in Chapter 6, sends messages to external researchers that they are interested in a particular science or technology. Research investments create receptors for research being conducted externally. Some firms use scientific advisory boards with membership of eminent individuals who understand the nature of the firm's business and can balance their long-term views with more immediate business needs.

Assessment of the external context includes consideration of issues such as the systems in which firms operate, such as the NIS, and the networks to which firms belong, and the ways in which these are affected by globalization (see Chapters 2 and 5).

A number of analytical frameworks and concepts are useful in guiding search activities. Some were discussed in Chapter 3, including the notions of sustaining and disruptive innovations, and the differences between radical and incremental innovations. Other tools and methods that can be used include Foresight, Delphi, and Shell's GameChanger (see Box 4.6).

Box 4.6 Foresight, Delphi, and Gamechanger**Foresight**

Foresight brings together key people to assess ideas to look beyond normal planning horizons and identify potential opportunities from science and technology, together with recommendations for action. Foresight usually focuses on a particular topic, a broad thematic area of emerging science or technology, such as nanotechnology, or a particular social or economic issue, such as tackling obesity. It uses a range of techniques including trend analysis and modelling and simulation.

Foresight studies are used periodically for high-level planning and strategic development and include:

- Reviews of the scientific or technological domain, its current international position, and forecasts about the next stages of development.
- Vision statements about likely future developments based upon understanding key drivers, trends, and likely impacts.
- Recommendations for research funders, the scientific and technological community, and government and regulatory authorities.
- Creation of networks of experts capable of maintaining a watching brief on developments in the area.

The success of Foresight exercises is often evaluated according to the extent to which they have informed stakeholders and communities, and influenced policy-makers and businesses. Accurate predictions of science and technology future have always been elusive, and Foresight exercises will never provide completely reliable guides, but they help to raise awareness across different communities, gaining some convergence in expectations, and providing valuable insights for strategic planning.

Delphi

Delphi is a qualitative approach to technology forecasting based on eliciting, coordinating, and synthesizing expert opinion. It dates back to the mid-1940s and Project RAND, which later became the RAND Corporation. Project RAND included a commission for the US Air Force to forecast the likely impact of technological change in the military sector, with a particular focus on intercontinental warfare. RAND experts were asked to provide opinion on the probability, frequency, and intensity of enemy attacks and the consequences of the deployment of different technologies. Other experts were invited to provide anonymous feedback on initial results and the exercise was repeated until a consensus emerged.

The Delphi technique is mainly used to make informed, intuitive judgements about scientific and technical possibilities and their social, economic, and environmental implications. Organizations use it on a periodic basis, particularly when they are in a phase of strategy development or renewal. In its simplest form, expert opinions are elicited through carefully designed questionnaires interspersed with information to guide respondents' thinking.

The Delphi method aims to achieve a convergence of expert opinion on the likelihood of scientific or technological developments and their expected time horizons and resource requirements. In some cases—such as with climate change, investment in renewable technologies, and genetics—rather than achieving consensus, a range of opinions and polarized results emerges.

During the 1980s NEC successfully used an approach to technology forecasting that involved the identification of over thirty core technologies followed by attempts to predict developments in their underlying basic technologies. The core technologies provided the basis for future research and applications. For example, NEC identified pattern recognition as a core technology. It then attempted to predict changes in the underlying basic technologies of pattern recognition, and any new product opportunities which might emerge from those changes (Irvine 1988).

GameChanger

Shell's GameChanger provides a means for people inside and outside the business to come up with new ideas that 'change the rules of the game' for the company. The process encourages people to come up with new ideas and provides funds and advice to entrepreneurs on how to develop these ideas

further. It enables investment in radically new, early-stage ideas in the energy and transport/mobility industries, taking them, where appropriate, to the 'proof of concept' stage.

The GameChanger process began by exploring and supporting ideas that were generated by Shell's own employees. It has subsequently been used by academics, independent research organizations, and individual entrepreneurs.

GameChanger is managed by a central department of full-time technology and business specialists, operating a process outside the constraints and priorities of Shell's day-to-day business operations. It also has teams in each of Shell's operating businesses. In 2005 GameChanger had funds of around \$20 million to allocate.

The process involves a few simple steps and rules. Following the submission of an idea it is 'pre-screened' by a member of the GameChanger team who focuses on four key criteria: novelty, possible value, why it may be important for Shell, and whether it appears to have a credible development plan. If the idea looks interesting it is assigned to a GameChanger sponsor who seeks out Shell staff to 'champion' the idea. If a suitable champion is secured, the idea is put to a 'screening panel', which quickly makes a decision on whether formal proposal should be developed. If it proceeds, the idea is developed further by its originator and the Shell champion and a more detailed proposal is put to an 'extended panel' which undertakes to make a decision in between twenty-four and forty-eight hours. Success at this stage often leads to investment in the proposal and if it is of a technical nature it may be developed in Shell Technology Ventures: <http://www.shelltechnologyventures.com>. The tools therefore assist in both 'Search' and 'Select' innovation support activities.

The GameChanger team is responsible for monitoring emerging technologies and social and regulatory trends that might fundamentally impact on the business. One example has been work on the potential of ionic liquids to provide a new class of solvents with low volatility, which, because they do not evaporate, offer considerable environmental advantages.

SELECTING

Innovative capabilities include the way firms select technologies that will provide the future basis of market competitiveness. The selection of new technologies entails choosing which technologies are core to the firm, where it needs a proprietary position, and which are related and complementary. Choices need to be made on which technologies to concentrate on developing internally, and which to access externally, through purchase or collaboration. Decisions also need to be made on which technologies owned are exploited internally and which are licensed or spun-off.

A number of analytical frameworks and concepts are useful in guiding the development of capabilities for selecting technologies and markets, including: first-mover/fast-follower advantage (discussed earlier), platform technologies (discussed in Chapter 7), core competencies/technologies, and the product life cycle.

Core competencies/technologies

Core competence is a term used in the strategic management literature for those central elements that define the firm's ability to compete (Prahalad and Hamel 1994). Competencies are argued to have strategic potential when they are:

- Valuable—exploit opportunities and/or neutralize threats in a firm's environment.
- Rare—the number of firms that possess them is less than that needed to generate perfect competition in an industry.
- Imperfectly imitable—because of their complexity, or the uniqueness of the conditions under which they were acquired.
- Have no strategically equivalent substitutes—no alternative ways of achieving the same results (Ciborra and Andreu 1998; Barney 1991, 2001).

Competencies can have a technological basis. Differential competencies potentially allow a firm to gain benefits over its competitors.

For firms selecting future technological investments around core technologies it is worth referring to studies that demonstrate:

- The importance of cumulative know-how, and the value of building on existing competencies (Prahalad and Hamel 1994; Pavitt 1990).
- The riskiness and difficulty associated with complete technological diversification. Incremental diversification is the least difficult and risky and more likely to be successful (Roberts 1991).
- The danger of core competencies becoming core rigidities, creating engrained practices that cannot evolve to deal with new circumstances (Leonard-Barton 1995).

Honda provides an example of the way firms can think about core competencies. It produces a variety of products, but its core expertise lies in the design and manufacture of engines and power trains, and it has developed its product range around these competencies (Fig. 4.4). Once core competencies have been determined, it is possible to consider their technological basis (Fig. 4.5). Using this form of analysis, it can be seen that Honda's innovation strategy involves the supplementation and improvement of these technologies that contribute to its core competencies.

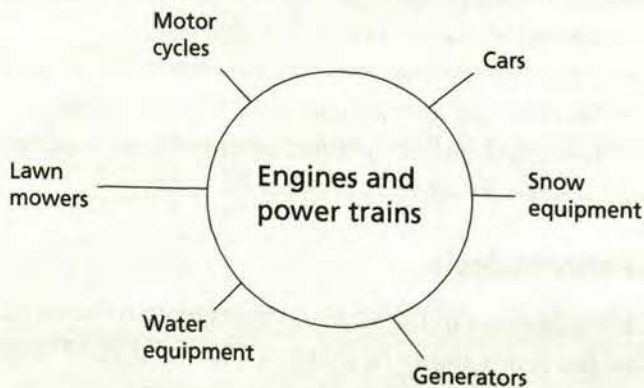


Figure 4.4. Honda's core competencies

Box 4.7 McLaren Motorsport

McLaren, the Formula 1 (F1) motor sport company, has a strategy driven by one simple performance indicator—winning races. The business model needed to fund this endeavour focuses the company on a strategy of managing its brand and the advertising revenue it generates. It has two main business streams: design, development, production, and racing F1 cars; and production of a limited range of prestige sports cars, codeveloped with Mercedes (known as the McLaren SLR, selling for around \$500,000 each in 2007). The F1 business generates sponsorship from companies advertising their own products and services. In 2007, McLaren's main sponsors were Vodafone and Mercedes. To win F1 races, the company knows that it needs to pay attention to every detail of the innovation process, starting with lessons from feedback from drivers and electronic monitoring systems of the existing range of cars (McLaren's and its competitors'). Races are simulated, and the performance of every component of the machine is analysed using virtual prototyping technologies. Results from these exercises inform choices about which materials to use, and how they should be designed, engineered, and produced. Everything McLaren does is aimed at reinforcing the strategy built on its brand of being first on the racetrack and therefore a world-class engineering company. The McLaren Technology Centre, based in Woking, UK, employs around a thousand engineers. It is at this centre that cars in both business streams are designed and manufactured. The centre itself was designed by Lord Norman Foster and embodies the McLaren ethos and strategy of developing and using the most advanced technologies (<http://www.mclaren.com/technologycentre/>). McLaren's approach to innovation strategy is dominated by its understanding of its core technological competencies and the value this ultimately confers on its sponsors. These competences (see Fig. 4.6), determine the technologies needed to build and deliver racing cars and high-end sports cars (see Chapter 8). In recent years, McLaren's strategy has evolved to expand the services it offers in related markets based on its technological and engineering strengths for delivering very accurate and perfectly engineered machines capable of winning races and breaking records. This has led to the launch of new business lines: McLaren Applied Technologies, and McLaren Electronic Systems.

Sumitomo Electric Industries provides an example of successful related diversification over an extended period. According to Kenney and Florida (1994: 319):

[T]he company's original core business in the late nineteenth century was copper mining and smelting. During the early part of the twentieth century Sumitomo Electric used its skills in smelting to move its business focus progressively into copper wire manufacture. In the immediate

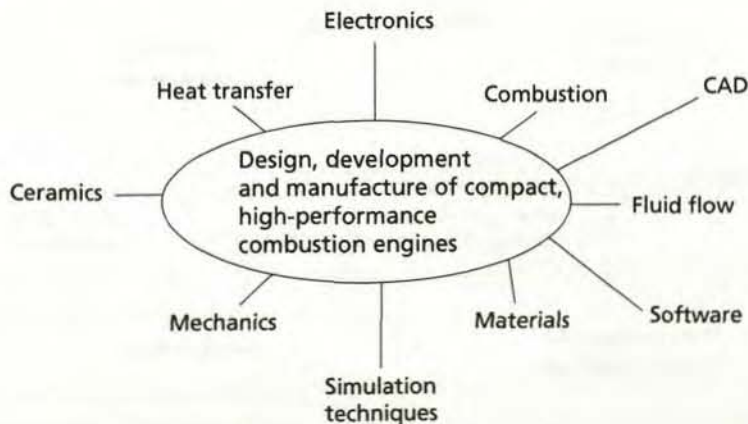


Figure 4.5. Honda's core technological competencies

postwar era the company drew upon its technological base in metals and wire to move into special steel wires, in wire coatings to move into rubber and plastic products, and in electronics to move into electronic materials and antenna systems. By the 1960s, the company moved into progressively more complex systems technologies such as integrated electronics systems and disc brakes. In the 1970s and 1980s, Sumitomo used its built-up technological competencies to move into high-technology electronic systems (e.g., workstations) and automotive electrical systems. At each stage in its development, Sumitomo leveraged internal technological capabilities developed through R & D to underpin diversification and growth by entering new fields.

3M is another firm that historically developed around core technologies. Its original core technologies, developed in the 1920s and 1930s, of abrasives, adhesives, and coating-bonding have been continually developed and added to by four new core technologies: software, instrumentation, imaging, and 'non-woven' products (e.g., fabric and film). As Quinn (1992) argued, these core technologies (some of which were acquired rather than developed internally) have historically enabled the company to develop a range of products, which led to continued commercial success. In contrast, when the company attempted to diversify away from them, the results were less successful.

GE selects 10–12 of what it calls 'enabling technologies', including ceramics, organic chemistry, solid-state physics, and combinatorial chemistry. It promotes the use of technological knowledge across its business divisions: so, for example, its expertise in ceramics is used in medical scanners, lighting, and turbine blades for both power systems and aircraft engines. Its expertise in computational fluid dynamics is used in simulations of x-ray tubes and airflow through jet engines.

P&G's business has historically evolved from connections in technology such as between candles and soap, from the animal fat in soap to the first all-vegetable shortening. This led to discoveries in emulsifiers and surfactants, used today in products such as shampoos and liquid detergents.

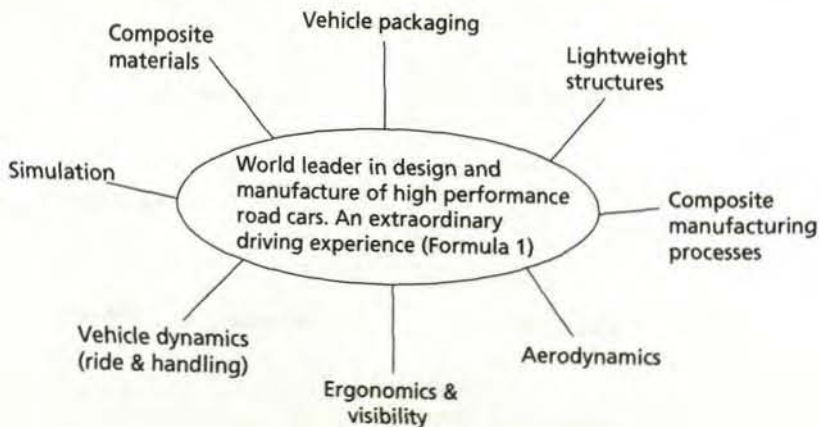


Figure 4.6. McLaren Racing's core technological competencies (see Box 4.7)

Box 4.8 Innovation in prams—finding new combinations

Developing safe vehicles for transporting children is a demanding task. Parents require security, flexibility, and ease-of-use in prams. Children do not like to sit still and rarely listen to instructions. The history of prams and strollers shows the way technologies are recombined to create innovation.

The first baby carriage was developed in 1733 by William Kent, an English landscape and furniture designer, for the Duke of Devonshire's children. The baby carriage or perambulator (pram) was designed to be drawn by a small animal as the child rested in a shell-shaped seat. This early pram was a toy and it was not until 1848 that Charles Burton, an American inventor, created the first functional, human-controlled pram to transport his children. In the late 1800s there were significant improvements in pram design, increasing consumer demand. Queen Victoria was a notable early user. The growth of the pram market led to a surge in patents and innovations. The most significant innovation was William Richardson's introduction in 1889 of a 360-degree movable seat, which allowed parents or nurses to see their child while they were pushing the pram. From the early 1920s, prams became more widely diffused and became a popular consumer item. Silver Cross, based in Leeds, UK, was considered at this time to manufacture the 'Rolls Royce of prams'. During the Second World War, however, the Silver Cross factory was requisitioned for the production of parts for the Royal Air Force. The experience of working with newer, lightweight materials, such as aluminium, in the war stimulated the introduction of these materials into Silver Cross prams. In the 1950s and 1960s, Silver Cross and others were able to lower the weight of prams significantly by using aluminium.

In 1965, Owen MacLaren, a former aeronautical engineer and test pilot for the *Supermarine Spitfire*, transformed the children's transportation market by introducing the world's first folding stroller. Whilst working in the aerospace sector, MacLaren had developed antiskid brakes and landing gear for aircraft in severe weather conditions. In 1944, he established his own firm making aircraft parts. In 1961 he developed his first consumer product, a portable aluminium-frame picnic chair. MacLaren got the idea for the stroller from his family. His daughter was married to an executive at Pan Am, a leading airline, and travelled widely. It was difficult for her to travel with her child and traditional pram. MacLaren used his insights and experiences from aerospace to develop an alternative solution. His stroller was lightweight and easy to use. It could be folded up and carried like an umbrella. The product was an immediate success, leading to sales of over 600,000 by 1976, half of which were exported.

Since the 1980s, there have been many new innovations in child transport, including the three-wheel 'jogging' stroller, 'three-in-one' travel systems, and exchangeable car seats. One of the most successful of the new generations of strollers has been the Bugaboo, which emerged from a student project at the Design Academy in Eindhoven, the Netherlands, in 1999. The Bugaboo has become a design icon of the 2000s, appearing in 'Sex in the City'.

Source: Gapper 2006.

Canon is an example of a firm that strategically adopts, adapts, and refines generic technologies and recombines them in unique ways. Each new product in Canon involves a combination of existing technologies and technology new to the firm. Its photocopier cartridge technology, for example, involved combining its expertise in camera and office equipment technology with newly acquired knowledge in electrophotographic processes and photosensitive materials. Canon's strategy has led to the development of specialized, proprietary photographic photocopier, and printer products that are not easily imitated (Sandoz 1997).

Innovation is evolutionary, and an important means of understanding that evolution is captured in Box 4.8. This broad theory can assist in the searching for, and selection of, innovation opportunities.

CONFIGURING AND DEPLOYING

Configuring innovation entails acquiring new technological resources, coordinating and integrating all the various activities involved in the innovation process, and aligning the firm's strategies. This innovative capability will be examined in subsequent chapters. Innovative capabilities include the effective deployment and implementation of technology. Implementation is much easier when there is broad agreement about the importance of particular technologies and their relevance for the company's future. Reaching such agreement is assisted by the new paradigm of management, and its approach to strategy, outlined in Chapter 2. This approach focuses on gaining consensus and commitment to decisions. Whilst this process may be lengthier than simple top-management fiat, implementation of decisions is faster as there is usually less opposition to decisions that are fully understood.

LEARNING

The ways firms learn, and use that learning, have long been understood to be key elements of corporate strategies (see Chapter 2). 'Technological learning' is an important element of firms' development and survival. Learning can be described as the ways firms build, supplement, and organize knowledge around their capabilities and processes and within their cultures, and adapt and develop organizational efficiency through improving their use. The need to learn is commonly explained by a requirement for adaptation and improved efficiency in times of change. In turbulent environments learning can be seen as a purposive quest of firms to retain and improve competitiveness, productivity, and innovativeness. The greater the uncertainties facing firms, the greater will be the need for learning. Learning can be seen to have occurred when organizations perform in changed and better ways, and when strategies are better defined, more appropriate, and effectively implemented. The goals of learning are useful outcomes, which include, at best, improved competitive performance, at worst, survival.

Firms need to learn for a number of reasons. They need to learn to develop better value propositions to respond to changes in the external environment, for example, to the rapid and comprehensive changes occurring in technology, described in Chapter 2. They also need to learn so as to overcome strategic and organizational tendencies towards introspection and parochialism (Morgan 1986), which can be particularly disadvantageous in turbulent and rapidly changing circumstances.

Nevertheless, firms do learn, survive, and improve comparative performance. This learning happens beyond the 'everyday' adaptation and improvement organizations can achieve in their existing competencies through learning by 'doing' (Arrow 1962) and 'using' (Rosenberg 1982), and encompasses 'higher' level learning (Fiol and Lyles 1985) which questions the validity of current competencies and facilitates the construction of new ones. This is described in the management literature as 'generative' as opposed

to 'adaptive' learning (Senge 1990), and by Argyris and Schön (1978) as 'double-loop' learning (error-detection-correction-modification) as compared to 'single-loop' learning (error-detection-correction). It is a key element of a firm's innovative capabilities.

In conditions of rapid and disruptive market and technological change, firms can be argued to need 'higher level' learning because existing 'lower level' learning focuses on current systems, products, and technologies and not on new competencies and opportunities. However, such learning is constrained. Much of the management, innovation, and business economics literature points to the conservatism of the strategies firms adopt, reflecting what companies are currently best at, rather than what changing markets require. The emphasis of much of this literature is that 'history matters', and that what a firm can in effect do in the future is strongly influenced by its past and its collective learning.

Firms purposefully adopt strategies and structures that encourage learning (Senge 1990; Malerba 1992; Dodgson 1991a). They learn through the activities of key individuals or 'boundary spanners' (Michael 1973—see Chapter 6), by executive succession (Tushman, Virany, and Romanelli 1986) and through recruitment and training programmes. Important in this process is the way they develop shared cultures that facilitate learning because of common languages and repositories (Schein 1985). Furthermore, the management strategy literature has long pointed to the ways firms not only react to external change, but also proactively seek to shape the environment in which they operate and learn (Ansoff 1968; Chandler 1962).

A major mechanism by which firms learn about technology is through their internal R & D efforts (see Chapter 6). Firms also learn from a wide range of other activities, particularly from marketing and operations and from the iterative interactions between corporate functions and operations.

Companies are increasingly creating a new managerial role to assist them develop and implement innovation strategies—the Innovation Director (see Box 4.9).

Returns from innovation strategy

The benefits of an innovation strategy are improved performance in the ways firms create and deliver value and enhance their competitive advantage, which can be assessed in a variety of ways. The extent to which an innovation strategy is driven by profit maximizing or broader objectives depends upon the specific circumstances of the firm and its corporate strategy. Maximizing profits or shareholder returns might ensure continuing investment in the firm, and offer protection from unwelcome takeover bids, but may place pressures on quarterly business performance, which can be inimical to longer-term innovation efforts and spending. In a different context, founders of small technology-based firms may deliberately target an exit strategy of selling their technical

Box 4.9 Role of the Innovation Director

A new and exciting role is emerging in many businesses—that of Innovation Director. The work is stimulating and involves understanding and awareness of many aspects of the business. They need a deep understanding of their business' existing resources and capabilities and the technologies that underpin current activities. They need to look outside to understand what their competitors, suppliers, key customers, and research partners are doing. They need to 'read the tea leaves' using techniques such as Foresight, to advise other senior decision-makers on which areas to invest new technologies. Innovation Directors need to go beyond the identification of potential new opportunities and threats to establishing the mechanisms to support innovation. This means creating the new technological order whilst simultaneously understanding and supporting the existing norms and practices that create the value that produces the resources to invest in innovation.

Firms whose businesses rely heavily on technology or scientific activities have generally placed strategic importance on the role of R & D, appointing research and technology directors to senior positions with responsibility for investment in and delivery of innovation. One indication of the growing strategic importance of technological innovation is that a wider range of firms are appointing Chief Technology Officers (CTO), or Chief Innovation Officers (CIO) to senior executive roles within their businesses.

The changing nature of innovation described in Chapter 3 has widened the roles of those that traditionally would have been responsible for R & D. Decisions about partnerships with suppliers, choices over which clients to prioritize in development work, what to do about intellectual property, the role of regulations and standards, and how to improve performance from investments in future products and services, are being widely discussed at main board level in many types of firms. The role of the CTO first emerged in the USA in the 1980s as an extension of the R & D function, in recognition of the wider sets of issues that confront innovative firms. In small enterprises and start-up companies the CTO title is increasingly used to signify a wide-ranging role covering all technical and scientific issues. By the mid-2000s, firms could be seen to be increasing the visibility and strategic content of their innovation activities by creating new roles in innovation management. Companies from Shell and Schlumberger in the oil and gas business to Cadbury Schweppes in confectionary, Citibank in financial services and Laing O'Rourke in construction and civil engineering have appointed CIOs to direct these activities. These posts report to the main executive board and in some cases have a seat on the board, rather than having discrete, functional reporting lines within R & D.

What does the role of the Innovation Director actually involve? There are no hard and fast definitions of the role, but it typically encompasses strategy, implementation, internal communications, and external relations. Key skills involve the ability to span boundaries—disciplines and functional lines of activity—and to broker the exchange of ideas and development between different teams and business units.

Strategy skills

The key strategy skills focusing on the corporate level include the following:

- *Formulating* strategy to the extent that firms have an articulated strategy for innovation (see earlier discussion); this falls within the remit of the Innovation Director.
- *Leading and championing* new product and service development—being an advocate of innovation across the organization. This entails continuous and dynamic interactions with other senior decision-makers—in R & D and marketing, for example—and especially with the CEO.
- *Policy compliance and engagement* ensuring that technological innovation is considered within the context of current and possible future regulatory frameworks, standards, environmental conditions, and corporate governance and social responsibility.
- *Searching* for new ideas and ensuring that the business is networked to other institutions where there are likely to be opportunities to learn and spot new ideas. Assessing innovation opportunities, drivers, and constraints. Commissioning competitor analysis, providing future forecasts and technology road maps to enable other senior decision-makers to understand how technology is developed and deployed in the business.
- *Selecting* projects using a variety of techniques such as portfolio analysis and MCA.

- *Configuring* innovation investments. Brokering new value-creation opportunities between business units and with external partners. Organizing resources for experimentation and development work and developing programmes for delivery, including the management of portfolios of projects. Integrating activities between projects, business units, and the corporate functions of the firm.
- *Deploying* innovation to deliver value. Protecting and exploiting IP and commercializing developments ensuring that clear paths to market are in place with relevant marketing and sales functions in the business.
- *Learning* to improve innovation performance. This also includes promoting an environment which is conducive to innovation, nurturing, and mentoring innovators, providing room for failure, and encouraging reviews and learning processes.

Operational skills

The key implementation skills focusing on the business or project level include:

- *Resourcing*; overseeing research, technical, and design staff, including recruiting, training, and mentoring. Financial planning and resource allocation. Technology support, including linking with IT, knowledge management, and virtual laboratories.
- *Coordinating* research, development, design, engineering, and prototyping activities across the organization.
- *Networking*, internally with technical support, design, operations, marketing and sales, legal, and financial departments; externally—fostering relationships and partnerships with lead users, key suppliers, science and technology providers, standards bodies, regulators, press, public relations, and lobby groups.
- *Delivering* new products and services to the required specification and within budget, overseeing project management and review processes.
- *Auditing* performance, setting benchmarks, milestones, targets, and key indicators to provide feedback.

The success of an Innovation Director is usually measured by the success of the firm's innovative performance. These measures may include the success rates of new commercialized products, productivity improvements in existing processes, the number of new product launches, and external awards. The Innovation Director may also be judged by the effectiveness of internal management processes, such as the ways in which technical resources are mobilized and developed within and among projects, business units, and central support services. The appointment of an Innovation Director should not diminish the responsibility of Boards of Directors, CEOs, or line managers for innovation.

capabilities to a larger acquisitive firm after a few years. Meanwhile, privately owned medium to large firms may be prepared to make longer-term innovation investments that are generally discouraged by stock markets keen on quarterly returns in the case of publicly traded companies. As we shall see in Chapters 7, 8, and 9, innovation investments deliver value in a number of ways, bringing a range of benefits to the firm, such as enhanced customer loyalty and the possession of business options. Other beneficial outcomes might be derived from improving the overall performance of the networks, communities, and supply chains to which the firm belongs. Given the high degree of mobility of skilled and creative workers, improving employee satisfaction within the company can also prove a welcome outcome. This diversity of benefit is one of the reasons why, as we showed in Chapter 3, there are profound problems involved in measuring the returns to innovation. These difficulties are seen in the application of one of the best-known approaches to assessing returns described in Box 4.10.

Box 4.10 Balanced scorecard

The balanced scorecard was developed by Robert Kaplan and David Norton in the early 1990s to create a set of business performance indicators that link to corporate strategy (Kaplan and Norton 1992). Their aim was to provide a measurement system that associates four indicators tracking key elements of business performance. The balanced scorecard was developed to broaden business performance metrics from what were perceived as narrow financial measures, to encompass operational performance indicators, including customer perspectives, internal business process perspectives, and innovation and learning activities. It places emphasis on strategy and vision, rather than on purely business controls for reporting and directing performance.

The balanced scorecard can be used to help align specific innovation goals and their measurement with other key firm performance measures. These are integrated and linked to the overall strategic direction of the firm. Innovation activities are measured and valued as one of the core strategic drivers of business performance. The balanced scorecard is used in strategy development and alignment on a periodic basis. It provides visibility of goals and measures in core business processes linking these to customer perspectives and financial performance to enable decisions about future investments in product or process innovation. It is also useful in providing additional metrics to the normal financial measures in annual reports.

Management chooses a number of goals for each of four segments of the scorecard—finance, business process, customer perspectives, learning and growth. Measures are assigned to each goal and benchmark data are collected on a regular basis to provide evidence within each segment. The segments can be weighted to enable assessment of the likely relative impact of performance in one segment on the others. This provides a mechanism to assist in decision-making that links potential positive and negative impacts across different areas of activity, thus enabling a more holistic perspective to be taken in strategic decision-making.

Early users of the balanced scorecard include Mobil Oil and Brown and Root in the 1990s. Mobil used the technique to assess why it was underperforming industry norms on profitability in its Refining Division. Brown and Root used the technique to assist in aligning vision and strategy of two companies that were merged to install oil platforms in the North Sea in 1992. Other users include Hilton Hotels and Wells Fargo Bank.

The balanced scorecard can provide benefits to decision-makers because it makes explicit measurements that focus on operational and organizational issues aligning them to financial indicators and strategies designed to drive performance improvement. The scorecard identifies operational strengths and weaknesses across corporate programmes such as quality management, operations and logistics, customer service, and R & D.

The use of the balanced scorecard approach, however, has a number of limitations. If it is to prove successful, it must be embedded in the decision-making machinery of the firm and this requires sustained senior management support and attention, particularly if it is to be integrated with corporate strategy. It may take several years before goals and measures and their linkages in each segment are properly understood, by which time some metrics will have changed. Moreover, the ability to develop a robust tool will depend upon the quality of data that can be consistently collected on each measure. Keeping a balanced scorecard up to date can therefore be a complex activity.

Quantifiable evidence may not be available or appropriate to collect in some areas of activity such as innovation and learning. This problem was recognized in the original design of the balanced scorecard, which attempts to link tangible and intangible assets; but mixing subjective, qualitative evidence on some attributes with quantitative evidence such as financial data remains challenging for most firms. Ideally a balanced scorecard will be designed to relate data about past performance with how the organization is positioned to meet future targets. This is very difficult to achieve because in most organizations it is difficult to understand the frequency with which historical data must be captured and analysed if it is to provide a useful reflection on performance.

Whilst the overall vision of a holistic and balanced set of performance indicators is seductive for many business leaders, the cost and difficulty of setting up and maintaining such a system often detracts from its use.

Summary and conclusions

This chapter discussed the nature and importance of innovation strategy. Innovation strategy is notoriously difficult both to practise and analyse. Few companies have consistently managed to develop technological innovation in a strategic manner (Christensen 1997). Without downplaying the complications involved in the development of innovation strategy, this chapter has presented a relatively simple analysis. Innovation strategy involves decisions about which technologies and markets provide the best opportunities for delivering value and building competitive advantage. These decisions are taken within the context of, and fit within, the firm's corporate strategy and its available resources, and guide the selection of the innovation processes used and its various activities, such as R & D and operations. Innovative capabilities are those bundles of skills that contribute to innovation strategy by guiding the resources used for innovation and enabling their reconfiguration. Innovation strategy also encompasses choices about innovation processes and how they are most suited to particular competitive circumstances.

The chapter has presented some basic tools that companies can use to assess innovation opportunities. It has highlighted the need to ensure that the right tools are used and their results are interpreted cautiously. There are dangers in radical, disruptive, and emergent business environments in using many frameworks from the strategic

management literature, and many established tools and techniques are simply not applicable in highly uncertain innovation environments.

SMEs face specific issues in strategic MTI. These often relate to issues of managing growth and navigating the various thresholds that can constrain their development. As with large firms, the success of SMEs' innovation strategies depends to a large extent on their capacity to learn and to this extent they have comparative advantages in their capacity for fast learning, partly because of their flexibility, which explains why many large firms attempt to emulate their organizational advantages.