Developing an Innovation Strategy

CHAPTER 4


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LEARNING OBJECTIVES

After this chapter you should be able to:

- Understand the differences between conventional strategic management and innovation strategy.
- Identify how tangible and intangible resources and dynamic capabilities contribute to an innovation strategy.
- Assess how capabilities contribute to competitive advantage through innovation.

'A great deal of business success depends on generating new knowledge and on having the capabilities to react quickly and intelligently to this new knowledge . . . I believe that strategic thinking is a necessary but overrated element of business success. If you know how to design great motorcycle engines, I can teach you all you need to know about strategy in a few days. If you have a Ph.D. in strategy, years of labor are unlikely to give you the ability to design great new motorcycle engines.'

– Richard Rumelt (1996) California Management Review, ***38****, 110, on the continuing debate about the causes of Honda's success in the US motorcycle market.*

The earlier quotation from a distinguished professor of strategy appears on the surface not to be a strong endorsement of his particular trade. In fact, it offers indirect support for the central propositions of this chapter [1]:

1. **Firm-specific knowledge – including the capacity to exploit it – is an essential feature of competitive success.**
2. **An essential feature of corporate strategy should therefore be an innovation strategy, the purpose of which is deliberately to accumulate such firm-specific knowledge.**
3. **An innovation strategy must cope with an external environment that is complex and ever changing, with considerable uncertainties about present and future developments in technology, competitive threats and market (and non-market) demands.**
4. **Internal structures and processes must continuously balance potentially conflicting requirements:**
   a. **to identify and develop specialized knowledge within technological fields, business functions and product divisions;**
   b. **to exploit this knowledge through integration across technological fields, business functions and product divisions.**

Given complexity, continuous change and consequent uncertainty, we believe that the so-called rational approach to innovation strategy, still dominant in practice and in the teaching at many business schools, is less likely to be effective than an incremental approach that stresses continuous adjustment in the light of new knowledge and learning. We also argue that the approach pioneered by Michael Porter correctly identifies the nature of the competitive threats and opportunities that emerge from advances in technology and rightly stresses the importance of developing and protecting firm-specific technology in order to enable firms to position themselves against the competition. But it underestimates the power of technology to change the rules of the competitive game by modifying industry boundaries, developing new products and shifting barriers to entry. It also overestimates the capacity of senior management to identify and predict the important changes outside the firm, and to implement radical changes in competencies and organizational practices within the firm.

In this chapter, we develop what we think is the most useful framework for defining and implementing innovation strategy. We propose that such a framework is the one developed by David Teece and Gary Pisano. It gives central importance to the dynamic capabilities of firms and distinguishes three elements of corporate innovation strategy: (i) competitive and national positions, (ii) technological paths and (iii) organizational and managerial processes. We begin by summarizing the fundamental debate in corporate strategy between 'rationalist' and 'incrementalist' approaches and argue that the latter approach is more realistic, given the inevitable complexities and uncertainties in the innovation process.

4.1 'RATIONALIST' OR 'INCREMENTALIST' STRATEGIES FOR INNOVATION?

The long-standing debate between 'rational' and 'incremental' strategies is of central importance to the mobilization of technology and to the purposes of innovation strategy. We begin by reviewing the main terms of the debate and conclude that the supposedly clear distinction between strategies based on 'choice' or on 'implementation' breaks down when firms are making decisions in complex and fast-changing competitive environments. Under such circumstances, formal strategies must be seen as part of a wider process of continuous learning from experience and from others to cope with complexity and change.

Notions of corporate strategy first emerged in the 1960s. A lively debate has continued since then among the various 'schools' or theories. Here we discuss the two most influential: the 'rationalist' and the 'incrementalist'. The main protagonists are Ansoff of the rationalist school and Mintzberg among the incrementalists [2]. A face-to-face debate between the two in the 1990s can be found in the *Strategic Management Journal* and an excellent summary of the terms of the debate can be found in Whittington [3]. **Research Note 4.1** identifies current themes in innovation strategy.

RESEARCH NOTE 4.1 Research Themes in Innovation Strategy

A review of 342 research papers on the strategic management of innovation published between 1992 and 2010 identified major themes in the literature:

1. *Major intended and emergent initiatives* – the means, measures, and activities by which firms aim to induce performance improvements, including 'acquisition' and 'diversification', which are typically characterized by substantial deliberate planning, but it also includes means such as 'learning', which tend to exhibit a strong emergent component. Much of the research in this field focuses on new product development or technical projects, but relatively little research has examined the contributions of process and administrative innovations.
2. *Internal organization adopted* – such as 'practices', 'structure', 'process', 'organizing' and 'behaviour'. Most research in this area has been on structures and processes, but rather less on actual practices and behaviours. The related themes of routines, practices and processes appear to be fertile for future innovation research.
3. *Senior managers and ownership* – governance, 'CEO', 'top', 'directors', 'boards', 'agency' and 'ownership'. CEOs and boards are traditional foci of strategic management, perhaps overestimating the influences of individuals and agency. However, only eight of the 223 empirical studies include an independent variable related to ownership structure, suggesting this is underresearched. In addition, in innovation research, the associated themes of 'leadership' and 'implementation' are almost absent; in the 342 papers reviewed, the terms 'implementation' and 'leadership' appear only three and five times, respectively.
4. *Utilization of resources* – such as 'capability', 'knowledge', 'assets' and 'financial', which incorporates the resource-based view of the firm and dynamic capabilities approaches which are central to innovation research and practice. However, most of the research has examined how such resources contribute to innovation and other performance outcomes, rather than the processes and practices that support the creation and exploitation of resources and capabilities. In other words, in most studies, 'resources' are simply an independent variable, but rarely the dependent variable: of the 223 empirical studies reviewed, 'resources' was an independent variable in 108 cases, but a dependent variable in only three papers.
5. *Performance enhancement* – innovation outcomes such as 'growth', 'returns', 'performance' and 'advantage'. The most common outcomes assessed are based on new products and patents. However, the effects of process and organizational innovations are poorly represented, which suggests studies should include broader measures of innovation outcomes such as productivity improvement and value-added. Time-related outcomes are also underrepresented in the research, for example, the influence of innovation on firm longevity and survival, and the significance of lags between innovation, diffusion and appropriation of private and social benefits.
6. *External environments* – such as 'market', 'competition' and 'industry', which refer to the specific business environment of a firm, and by 'environment', 'uncertainty' and 'contingency', which represent more fundamental contingencies and contexts. Despite claims of generalizability, almost all the research reviewed was based on firms in high-technology sectors, and only eight of the studies were in medium to low technology industries. This significantly limits the relevance much research has on innovation strategy. Moreover, as most studies simply take into account only industry and country environmental contingencies, the results of such research only captures context-specific subsets of the actual underlying relationships, rather than the more fundamental contingencies such as uncertainty and complexity.

Source: Based on Keupp, M.M., M. Palmié, and O. Gassmann, The strategic management of innovation: A systematic review and paths for future research, *International Journal of Management Reviews*, 2012. **14**(4), 367–90.

RATIONALIST STRATEGY

'Rationalist' strategy has been heavily influenced by military experience, where strategy (in principle) consists of the following steps: (i) describe, understand and analyse the environment; (ii) determine a course of action in the light of the analysis; and (iii) carry out the decided course of action. This is a 'linear model' of rational action: appraise, determine and act. The corporate equivalent is SWOT: the analysis of corporate strengths and weaknesses in the light of external opportunities and threats. This approach is intended to help the firm to:

- Be conscious of trends in the competitive environment.
- Prepare for a changing future.
- Ensure that sufficient attention is focused on the longer term, given the pressures to concentrate on the day to day.
- Ensure coherence in objectives and actions in large, functionally specialized and geographically dispersed organizations.

However, as John Kay has pointed out, the military metaphor can be misleading [4]. Corporate objectives are different from military ones: namely, to establish a distinctive competence enabling them to satisfy customers better than the competition – and not to mobilize sufficient resources to destroy the enemy (with perhaps the exception of some Internet companies). Excessive concentration on the 'enemy' (i.e., corporate competitors) can result in strategies emphasizing large commitments of resources for the establishment of monopoly power, at the expense of profitable niche markets and of a commitment to satisfying customer needs. **Research Note 4.2** discusses the relationships between R&D spending and innovation performance.

RESEARCH NOTE 4.2 Innovation Strategy in the Real World

Since 2005 the international management consultants Booz Allen Hamilton have conducted a survey of the spending on and performance of innovation in the world's 1000 largest firms. The most recent survey found that there remain significant differences between spending on innovation across different sectors and regions. For example, the R&D intensity (R&D spending divided by sales, expressed as a %) was an average of 13% in the software and healthcare industries, 7% in electronics, but only 1–2% in more mature sectors. Of the 1000 companies studied, representing annual R&D expenditure of US $447 billion, 95% of this spending was in the USA, Europe and Japan.

However, like most studies of innovation and performance (see Chapter 12 for a review), they find no correlation between R&D spending, growth and financial or market performance. They argue that it is how the R&D is managed and translated into successful new processes, products and services which counts more. Overall they identify two factors that are common to those companies which consistently leverage their R&D spending: strong alignment between innovation and corporate strategies; and close attention to customer and market needs. This is not to suggest that there is any single optimum strategy for innovation, and instead they argue that three distinct clusters of good practice are observable:

- *Technology drivers*, which focus on scouting and developing new technologies and matching these to unmet needs, with strong project and risk management capabilities.
- *Need seekers*, which aim to be first to market, by identifying emerging customer needs, with strong design and product development capabilities.
- *Market readers*, which aim to be fast followers and conduct detailed competitors analysis, with strong process innovation.

They conclude that 'Is there a best innovation strategy? No . . . Is there a best innovation strategy for any given company? Yes . . . the key to innovation success has nothing to do with how much money you spend. It is directly related to the effort expended to align innovation with strategy and your customers and to manage the entire process with discipline and transparency' (p. 16).

Source: Based on Jaruzelski, B., J. Loehr, and R. Holman, *The Global Innovation 1000*, Booz Allen Hamilton Annual Innovation Survey. *Strategy and Business*, 2011. 65, https://www.strategy-business.com/article/11404.

More important, professional experts, including managers, have difficulties in appraising accurately their real situation, essentially for two reasons. First, their external environment is both *complex*, involving competitors, customers, regulators and so on; and *fast-changing*, including technical, economic, social and political change. It is therefore difficult enough to understand the essential features of the present, let alone to predict the future. **Case Study 4.1** provides examples of the failings of forecasting. Second, managers in large firms disagree on their firms' strengths and weaknesses in part because their knowledge of what goes on *inside* the firm is imperfect.

CASE STUDY 4.1 Strategizing in the Real World

'The war in Vietnam is going well and will succeed.'
– R. MacNamara, 1963

'I think there is a world market for about five computers.'
– T. Watson, 1948

'Gaiety is the most outstanding feature of the Soviet Union.'
– J. Stalin, 1935

'Prediction is very difficult, especially about the future.'
– N. Bohr

'I cannot conceive of any vital disaster happening to this vessel.'
– Captain of Titanic*, 1912*

The above quotes are from a paper by William Starbuck [5], in which he criticizes formal strategic planning:

First, formalization undercuts planning's contributions. Second, nearly all managers hold very inaccurate beliefs about their firms and market environments. Third, no one can forecast accurately over the long term . . . However, planners can make strategic planning more realistic and can use it to build healthier, more alert and responsive firms. They can make sensible forecasts and use them to foster alertness; exploit distinctive competencies, entry barriers and proprietary information; broaden managers' horizons and help them develop more realistic beliefs; and plan in ways that make it easier to change strategy later (p. 77).

As a consequence, internal corporate strengths and weaknesses are often difficult to identify before the benefit of practical experience, especially in new and fast-changing technological fields. For example:

- In the 1960s, the oil company Gulf defined its distinctive competencies as producing energy, and so decided to purchase a nuclear energy firm. The venture was unsuccessful, in part because the strengths of an oil company in finding, extracting, refining and distributing oil-based products, that is, geology and chemical-processing technologies, logistics and consumer marketing, were largely irrelevant to the design, construction and sale of nuclear reactors, where the key skills are in electromechanical technologies and in selling to relatively few, but often politicized, electrical utilities [6].
- In the 1960s and 1970s, many firms in the electrical industry bet heavily on the future of nuclear technology as a revolutionary breakthrough that would provide virtually costless energy. Nuclear energy failed to fulfil its promise and firms only recognized later that the main revolutionary opportunities and threats for them came from the virtually costless storage and manipulation of information provided by improvements in semiconductor and related technologies [7].
- In the 1980s, analysts and practitioners predicted that the 'convergence' of computer and communications technologies through digitalization would lower the barriers to entry of mainframe computer firms into telecommunications equipment, and vice versa. Many firms tried to diversify into the other market, often through acquisitions or alliances, for example, IBM bought Rohm and AT&T bought NCR. Most proved unsuccessful, in part because the software requirements in the telecommunications and office markets were so different [8].
- The 1990s similarly saw commitments in the fast-moving fields of ICT (information and communication technology) where initial expectations about opportunities and complementarities have been disappointed. For example, the investments of major media companies in the Internet in the late 1990s took more than a decade to prove profitable: problems remain in delivering products to consumers and in getting paid for them, and advertising remains ineffective [9]. There have been similar disappointments so far in the development of 'e-entertainment' [10].
- The Internet bubble, which began in the late 1990s but had burst by 2000, placed wildly optimistic and unrealistic valuations on new ventures utilizing e-commerce. In particular, most of the new e-commerce businesses selling to consumers which floated on the US and UK stock exchanges between 1998 and 2000 subsequently lost around 90% of their value, or were made bankrupt. Notorious failures of that period include Boo.com in the United Kingdom, which attempted to sell sports clothing via the Internet, and Pets.com in the United States, which attempted to sell pet food and accessories.

INCREMENTALIST STRATEGY

Given the conditions of uncertainty, 'incrementalists' argue that the complete understanding of complexity and change is impossible: our ability both to comprehend the present and to predict the future is therefore inevitably limited. As a consequence, successful practitioners – engineers, doctors and politicians, as well as business managers – do not, in general, follow strategies advocated by the rationalists, but incremental strategies which explicitly recognize that the firm has only very imperfect knowledge of its environment, of its own strengths and weaknesses, and of the likely rates and directions of change in the future. It must therefore be ready to adapt its strategy in the light of new information and understanding, which it must consciously seek to obtain. In such circumstances the most efficient procedure is to:

1. Make deliberate steps (or changes) towards the stated objective.
2. Measure and evaluate the effects of the steps (changes).
3. Adjust (if necessary) the objective and decide on the next step (change).

This sequence of behaviour goes by many names, such as incrementalism, trial and error, 'suck it and see' and muddling through and learning. When undertaken deliberately, and based on strong background knowledge, it has a more respectable veneer, such as:

- Symptom → diagnosis → treatment → diagnosis → adjust treatment → cure (for medical doctors dealing with patients).
- Design → development → test → adjust design → retest → operate (for engineers making product and process innovations).

Corporate strategies that do not recognize the complexities of the present, and the uncertainties associated with change and the future, will certainly be rigid, will probably be wrong and will potentially be disastrous if they are fully implemented. **Case Study 4.2** identifies some of the limits of the rational planning approach to strategy. But this is not a reason for rejecting analysis and rationality in innovation management. On the contrary, under conditions of

CASE STUDY 4.2 The Limits of Rational Strategizing

Jonathan Sapsed's thought-provoking analysis of corporate strategies of entry into new digital media [12] concludes that the rationalist approach to strategy in emerging industries is prone to failure. Because of the intrinsic uncertainty in such an area, it is impossible to forecast accurately and predict the circumstances on which rationalist strategy, for example, as recommended by Porter will be based. Sapsed's book includes case studies of companies that have followed the classical rational approach and subsequently found their strategies frustrated.

An example is Pearson, the large media conglomerate, which conducted a SWOT analysis in response to developments in digital media. The strategizing showed the group's strong assets in print publishing and broadcasting, but perceived weaknesses in new media. Having established its 'gaps' in capability Pearson then searched for an attractive multimedia firm to fill the gap. It expensively acquired Mindscape, a small Californian firm. The strategy failed with Mindscape being sold for a loss of £212 million four years later, and Pearson announcing exit from the emerging market of consumer multimedia.

The strategy failed for various reasons: First, unfamiliarity with the technology and market; second, a misjudged assessment of Mindscape's position; and third, a lack of awareness of the multimedia activities already within the group. The formal strategy exercises that preceded action were prone to misinterpretation and misinformation. The detachment from operations recommended by rationalist strategy exacerbated the information problems. The emphasis of rational strategy is not on assessing information arising from operations, but places great credence in detached, logical thought.

Sapsed argues that while formal strategizing is limited in what it can achieve, it may be viewed as a form of therapy for managers operating under uncertainty. It can enable disciplined thought on linking technologies to markets, and direct attention to new information and learning. It focuses minds on products, financial flows and anticipating options in the event of crisis or growth. Rather than determining future action, it can prepare the firm for unforeseen change.

complexity and continuous change, it can be argued that 'incrementalist' strategies are more rational (i.e., more efficient) than 'rationalist' strategies. Nor is it a reason for rejecting all notions of strategic planning. The original objectives of the 'rationalists' for strategic planning – set out above – remain entirely valid. Corporations, and especially big ones, without any strategies will be ill-equipped to deal with emerging opportunities and threats: as Pasteur observed '. . . chance favours only the prepared mind' [11].

IMPLICATIONS FOR MANAGEMENT

This debate has two sets of implications for managers. The first concerns the practice of corporate strategy, which should be seen as a form of corporate *learning, from analysis and experience, how to cope more effectively with complexity and change*. The implications for the processes of strategy formation are the following:

- Given uncertainty, explore the implications of a *range* of possible future trends.
- Ensure broad participation and informal channels of communication.
- Encourage the use of multiple sources of information, debate and scepticism.
- Expect to change strategies in the light of new (and often unexpected) evidence.

The second implication is that *successful management practice is never fully reproducible*. In a complex world, neither the most scrupulous practicing manager nor the most rigorous management scholar can be sure of identifying – let alone evaluating – all the necessary ingredients in real examples of successful management practice. In addition, the conditions of any (inevitably imperfect) reproduction of successful management practice will differ from the original, whether in terms of firm, country, sector, physical conditions, state of technical knowledge, or organizational skills and cultural norms.

Thus, in conditions of complexity and change – in other words, the conditions for managing innovation – there are no easily applicable recipes for successful management practice. This is one of the reasons why there are continuous swings in management fashion, as discussed in **Case Study 4.3**. Useful learning from the experience and analysis of others necessarily requires the following:

1. *A critical reading of the evidence underlying any claims to have identified the factors associated with management success*. Compare, for example, the explanations for the success of Honda in penetrating the US motorcycle market in the 1960s, given (i) by the Boston

CASE STUDY 4.3 Swings in Management Fashion

*'**Upsizing**. After a decade of telling companies to shrink, management theorists have started to sing the praises of corporate growth.'*

– Feature title from The Economist, February 10, 1996, p. 81

*'**Fire and forget?** Having spent the 1990s in the throes of restructuring, reengineering, and downsizing, American companies are worrying about corporate amnesia.'*

– Feature title from The Economist, April 20, 1996, pp. 69–70

Above two are untypical examples of swings in management fashion and practice that reflect the inability of any recipe for good management to reflect the complexities of the real thing and to put successful experiences in the past in the context of the function, firm, country, technology and so on. More recently, a survey of 475 global firms by Bain and Co. showed that the proportion of companies using management tools associated with *business process reengineering, core competencies* and *total quality management* has been declining since mid-1990s. But they still remain higher than the more recently developed tools associated with *knowledge management*, which have been less successful, especially outside North America (Management fashion: fading fads. *The Economist*, 22 April 2000, pp. 72–73).

Consulting Group: exploitation of cost reductions through manufacturing investment and production learning in deliberately targeted and specific market segments [13]; and (ii) by Richard Pascale: flexibility in product–market strategy in response to unplanned market signals, high-quality product design and manufacturing investment in response to market success [14]. The debate has recently been revived, although not resolved, in the *California Management Review* [15].

2. *A careful comparison of the context of successful management practice, with the context of the firm, industry, technology and country in which the practice might be reused*. For example, one robust conclusion from management research and experience is that the major ingredients in the successful implementation of innovation are effective linkages among functions within the firm and with outside sources of relevant scientific and marketing knowledge. Although very useful to management, this knowledge has its limits. Conclusions from a drug firm that the key linkages are between university research and product development are profoundly misleading for an automobile firm, where the key linkages are among the product development, the manufacturing and the supply chain. And even within each of these industries, important linkages may change over time. In the drug industry, the key academic disciplines are shifting from chemistry to include more biology. And in automobiles, computing and associated skills have become important for the development of 'virtual prototypes' and for linkages between product development, manufacturing and the supply chain [16].

Research Note 4.3 discusses Blue Ocean strategies as a specific example of more radical innovation.

RESEARCH NOTE 4.3 Blue Ocean Innovation Strategies

For the past decade, INSEAD professors W. Chan Kim and Renée Mauborgne have researched innovation strategies, including work on new market spaces and value innovation. Their most recent contribution is the idea of Blue Ocean Strategies.

By definition, Blue Ocean represents all potential markets that currently do not exist and must be created. In a few cases, whole new industries are created, such as those spawned by the Internet; but in most cases, they are created by challenging the boundaries of existing industries and markets. Therefore, both incumbents and new entrants can play a role.

They distinguish Blue Ocean strategies by comparing them to traditional strategic thinking, which they refer to as Red Ocean strategies:

- Create uncontested market space, rather than compete in existing market space.
- Make the competition irrelevant, rather than beat competitors.
- Create and capture new demand, rather than fight for existing markets and customers.
- Break the traditional value/cost trade-off: Align the whole system of a company's activities in pursuit of both differentiation and low cost.

In many cases, a Blue Ocean is created where a company creates value by simultaneously reducing costs and offering something new or different. In their study of 108 company strategies, they found that only 14% of innovations created new markets, whereas 86% were incremental line extensions. However, the 14% of Blue Ocean innovations accounted for 38% of revenues and 61% of profits.

The key to creating successful Blue Oceans is to identify and serve uncontested markets, and therefore benchmarking or imitating competitors is counterproductive. It often involves a radically different business model, offering a different value proposition at lower cost. It may be facilitated by technological or other radical innovations, but in most cases, this is not the driver.

Sources: Kim W.C. and R. Mauborgne, Blue Ocean strategy: From theory to practice. *California Management Review*, 2005. **47**(3), Spring, 105–21; *Blue Ocean strategy: How to create uncontested market space and make the competition irrelevant*, 2004, Boston, MA: Harvard Business School; Blue Ocean strategy, *Harvard Business Review*, **82**(10), October, 76–84.

4.2 INNOVATION 'LEADERSHIP' VERSUS 'FOLLOWERSHIP'

According to conventional strategic management prescriptions, firms must also decide between two market strategies [17]:

1. Innovation 'leadership' – where firms aim at being first to market, based on technological leadership. This requires a strong corporate commitment to creativity and risk-taking, with close linkages both to major sources of relevant new knowledge and to the needs and responses of customers.
2. Innovation 'followership' – where firms aim at being late to market, based on imitating (learning) from the experience of technological leaders. This requires a strong commitment to competitor analysis and intelligence, to reverse engineering (i.e., testing, evaluating and taking to pieces competitors' products, in order to understand how they work, how they are made and why they appeal to customers) and to cost cutting and learning in manufacturing.

However, in practice, the distinction between 'innovator' and 'follower' is much less clear. For example, a study of the product strategies of 2273 firms found that market pioneers continue to have high expenditures on R&D, but that this subsequent R&D is most likely to be aimed at minor, incremental innovations. A pattern emerges where pioneer firms do not maintain their historical strategy of innovation leadership, but instead focus on leveraging their competencies in minor incremental innovations. Conversely, late entrant firms appear to pursue one of two very different strategies. The first is based on competencies other than R&D and new product development – for example, superior distribution or greater promotion or support. The second, more interesting strategy is to focus on major new product development projects in an effort to compete with the pioneer firm [18]. **Research Note 4.4** discusses the influence of different innovation strategies on firm performance.

RESEARCH NOTE 4.4 Innovation Strategy and Performance

This study investigated the strategy–innovation relationship in manufacturing SMEs, based upon a sample of 226. The research examined technological, marketing and organizational dimensions of innovation, and how these were associated with different standard Miles and Snow strategic orientations such as low-cost, differentiated defender, prospector and analyser. The study found a strong alignment between different strategic postures and types of innovation:

- Technology-based innovation was strongest in the firms adopting an analyser strategy, followed by differentiated defenders.
- Market-based innovation was most common in firms in the analyser and prospector strategic categories, with prospectors having a greater emphasis on product innovation.
- No significant associations or differences were found for organizational innovation, except for process innovation, where analyser strategy, followed by differentiated defenders.

Source: Based on Chereau, P., Strategic management of innovation in manufacturing SMEs: The predictive validity of strategy-innovation relationship, *International Journal of Innovation Management*, 2015. **19**(1), 1550002.

However, this example also reveals the essential weaknesses of Porter's framework for analysis and action. As Martin Fransman has pointed out, technical personnel in firms like IBM in the 1970s were well aware of trends in semiconductor technology, and their possible effects on the competitive position of mainframe producers [19]. IBM in fact made at least one major contribution to developments in the revolutionary new technology: RISC microprocessors. Yet, in spite of this knowledge, none of the established firms proved capable over the next 20 years of achieving the primary objective of strategy, as defined by Porter: '. . . to find a position . . . where a company can best defend itself against these competitive forces or can influence them in its favour'.

Like most mainstream industrial economics, Porter's framework underestimates the power of technological change to transform industrial structures, and overestimates the power of managers to decide and implement innovation strategies. Or, to put it another way, it underestimates the importance of *technological trajectories*, and of the firm-specific *technological and organizational competencies* to exploit them. Large firms in mainframe computers could not control the semiconductor trajectory. Although they had the necessary technological competencies, their organizational competencies were geared to selling expensive products in a focused market, rather than a proliferating range of cheap products in an increasing range of (as yet) unfocused markets.

These shortcomings of Porter's framework in its treatment of corporate technology and organization led it to underestimate the constraints on individual firms in choosing their innovation strategies. In particular, a firm's *established product base* and related technological competencies will influence the range of technological fields and industrial sectors in which it can hope to compete in future. Chemical-based firms do not diversify into making electronic products, and vice versa. It is very difficult (but not impossible) for a firm manufacturing traditional textiles to have an innovation strategy to develop and make computers [20]. In addition, opportunities are always emerging from advances in knowledge, so that:

- Firms and technologies do not fit tidily into preordained and static industrial structures. In particular, firms in the chemical, electrical and electronic industries are typically active in a number of product markets and also create new ones like personal computers. Really new innovations (as distinct from radical or incremental), which involve some discontinuity in the technological or marketing base of a firm, are actually very common [21].
- Technological advances can increase opportunities for profitable innovation in so-called mature sectors. See, for example, the opportunities generated over the past 15 years by applications of IT in marketing, distribution and coordination in such firms as Benetton [22]. See also the increasing opportunities for technology-based innovation in traditional service activities like banking, following massive investments in IT equipment and related software competencies [23].
- Firms do not become stuck in the middle as Porter predicted. John Kay has shown that firms with medium costs and medium quality compared to the competition achieve higher returns on investment than those with either low–low or high–high strategies [24]. Furthermore, some firms achieve a combination of high quality and low cost compared to competitors and this reaps high financial returns. These and related issues of product strategy will be discussed in Chapter 10. **Research Note 4.5** contrasts the success of first mover and follower strategies.

RESEARCH NOTE 4.5 Blue Ocean and First-mover Innovation Strategies

The first-mover or Blue Ocean strategy focuses on the creation of new markets through differentiation and claims monopoly profits flow from this. Others argue that this is too risky and that the optimum innovation strategy is the Fast Second, or follower. However, Buisson and Silberzahn (2010) examined 24 innovation cases and found that neither strategy was inherently superior. Instead, they argue that market domination is achieved by using four kinds of breakthroughs, separately or simultaneously.

They use two dimensions to classify various products: whether a product represents a submarket creation or not and whether a product achieved effective domination, to create four quadrants, for example:

- Dyson's bag-less vacuum cleaner, Piaggio's MP3 three-wheeled scooter and Nestlé's Nespresso personal espresso machine are examples of submarket creation and domination.
- Apple's iPod MP3 player and Google's search engine are examples of market domination of a pre-existing submarket: the MP3 reader market in the iPod case and the search engine market in Google's case.
- Apple's Newton PDA is a well-known example of failed domination attempt for a pre-existing submarket: although Apple's CEO introduced the term PDA at the Consumer Electronic Show on January 7, 1992, the Casio PF-1515536,

recognized as the first PDA, had been released almost 10 years earlier, in May 1983.

- Motorola's Iridium is the mobile satellite market creation attempt by Motorola. Iridium started service on November 1, 1998, but went into Chapter 11 on August 13, 1999. The IBM Simon Personal Communicator, the result of a joint-venture between IBM and BellSouth, is the less-known first smartphone attempt.

Their study suggests that innovation leading to sub-market domination is not the result of Blue Ocean or Fast Second strategies, but rather is achieved by using four kinds of breakthroughs, separately or simultaneously:

- *Technological breakthrough:* A new technology that ends up dominating the incumbent technology.
- *Business model breakthrough:* A new way to create value through the exploitation of business opportunities.
- *Design breakthrough:* A new way to design a product without changing it profoundly. This is related to the interface between the product and the customer, which is an important factor of adoption.
- *Process breakthrough:* A new way to do things (manufacturing, logistics, value chain, etc.).

Further support for this work is provided by a study of high-growth firms, or gazelles. Lindiča et al. (2012) analysed data on 500 firms and found that Blue Ocean strategies are not associated with higher growth and that the key to high growth is not necessarily to create a new market, but to be the first to develop and exploit that market. Amazon.com and Apple are good examples, neither of which were the first in the market but were the first to truly develop and exploit it. Moreover, they found that technological innovation is not sufficient for high growth and that value or business model innovation is a more significant factor.

Sources: Buisson, B. and P. Silberzahn, Blue Ocean or fast second innovation? *International Journal of Innovation Management*, 2010. **14**(3), 359–78; Lindiča, J., M. Bavdaža, and H. Kovačič, Higher growth through the Blue Ocean strategy: Implications for economic policy, *Research Policy*, 2012. **41**(5), 928–38.

There is also little place in Porter's framework for the problems of *implementing* a strategy:

- Organizations that are large and specialized must be capable of learning and changing in response to new and often unforeseen opportunities and threats. This does not happen automatically, but must be consciously managed. In particular, the continuous transfer of knowledge and information across functional and divisional boundaries is essential for successful innovation. Studies confirm that the explicit management of competencies across different business divisions can help to create radical innovations, but that such interactions demand attention to leadership roles, team composition and informal networks [25].
- Elements of Porter's framework have been contradicted as a result of organizational and related technological changes. The benefits of nonadversarial relations with both suppliers and customers have become apparent. Instead of bargaining in what appears to be a zero-sum game, cooperative links with customers and suppliers can increase competitiveness, by improving both the value of innovations to customers and the efficiency with which they are supplied [26].

According to a survey of innovation strategies in Europe's largest firms, just over 35% replied that the technical knowledge they obtain from their suppliers and customers is very important for their own innovative activities [27].

Christensen and Raynor provide a balanced summary of the relative merits of the rational versus incremental approaches to strategy:

> *. . . core competence, as used by many managers, is a dangerously inward-looking notion. Competitiveness is far more about doing what customers value, than doing what you think you're good at . . . the problem with the core competence/not your core competence categorization is that what might seem to be a noncore activity today might become an absolutely critical competence to have mastered in a proprietary way in the future, and vice versa . . . emergent processes should dominate in circumstances in which the future is hard to read and it is not clear what the right strategy should be . . . the deliberate strategy process should dominate once a winning strategy has become clear, because in those circumstances effective execution often spells the difference between success and failure [28].*

4.3 THE DYNAMIC CAPABILITIES OF FIRMS

Teece and Pisano [29] integrate the various dimensions of innovation strategy identified above into what they call the 'dynamic capabilities' approach to corporate strategy, which underlines the importance of dynamic change and corporate learning:

> This source of competitive advantage, dynamic capabilities, emphasizes two aspects. First, it refers to the shifting character of the environment; second, it emphasizes the key role of strategic management in appropriately adapting, integrating and reconfiguring internal and external organizational skills, resources and functional competencies towards a changing environment (p. 537).
>
> To be strategic, a capability must be honed to a user need (so that there are customers), unique (so that the products/services can be priced without too much regard for the competition) and difficult to replicate (so that profits will not be competed away) (p. 539).
>
> We advance the argument that the strategic dimensions of the firm are its managerial and organizational *processes*, its present *position* and the *paths* available to it. By managerial *processes*, we refer to the way things are done in the firm, or what might be referred to as its 'routines' or patterns of current practice and learning. By *position*, we refer to its current endowment of technology and intellectual property, as well as its customer base and upstream relations with suppliers. By *paths*, we refer to the strategic alternatives available to the firm and the attractiveness of the opportunities which lie ahead (pp. 537–541, our italics).

INSTITUTIONS: FINANCE, MANAGEMENT AND CORPORATE GOVERNANCE

Firms' innovative behaviours are strongly influenced by the competencies of their managers and the ways in which their performance is judged and rewarded (and punished). Methods of judgement and reward vary considerably among countries, according to their national systems of corporate governance: in other words, the systems for exercising and changing corporate ownership and control. In broad terms, we can distinguish two systems: one that is practiced in the United States and the United Kingdom and the other in Japan, Germany, and its neighbours, such as Sweden and Switzerland. In his book, *Capitalism against Capitalism*, Michel Albert calls the first the 'Anglo-Saxon' and the second the 'Nippon–Rhineland' variety [30]. A lively debate continues about the essential characteristics and performance of the two systems, in terms of innovation and other performance variables. **Table 4.1** is based on a variety of sources and tries to identify the main differences that affect innovative performance.

In the United Kingdom and the United States, corporate ownership (shareholders) is separated from corporate control (managers), and the two are mediated through an active stock market. Investors can be persuaded to hold shares only if there is an expectation of increasing profits and share values. They can shift their investments relatively easily. On the other hand, in countries with governance structures like those of Germany or Japan, banks, suppliers and customers are more heavily locked into the firms in which they invest.

Table 4.1 The Effects of Corporate Governance on Innovation

Characteristics	Anglo-Saxon	Nippon–Rhineland
Ownership	Individuals, pension funds, insurers	Companies, individuals, banks
Control management	Dispersed, arm's length business schools (USA), accountants (UK)	Concentrated, close and direct engineers with business training
Evaluation of R&D investments	Published information	Insider knowledge
Strengths	Responsive to radically new technological opportunities Efficient use of capital	Higher priority to R&D than to dividends for shareholders Remedial investment in failing firms
Weaknesses	Short-termism Inability to evaluate firm-specific intangible assets	Slow to deal with poor investment choices Slow to exploit radically new technologies

These differences contribute to different patterns of investment and innovation. For example, the US system has since been more effective in generating resources to exploit radically new opportunities in IT and biotechnology, whereas countries strongly influenced by German and Japanese traditions persisted in investing heavily in R&D in established industries and technologies, such as capital equipment and automotive. Japanese firms have proved unable to repeat in telecommunications, software, microprocessors and computing their technological and competitive successes in consumer electronics [31]. German firms have been slow to exploit radically new possibilities in IT and biotechnology [32], and there have been criticisms of expensive and unrewarding choices in corporate strategy, like the entry of Daimler-Benz into aerospace [33].

National systems of innovation clearly influence the rate and direction of innovation of domestic firms, and vice versa, but larger firms also learn and exploit innovation from other countries, as shown in **Table 4.2**. Firms have at least three reasons for monitoring and learning from the development of technological, production and organizational competencies of other national systems of innovation, and especially from those that are growing and strong:

1. They will be the sources of firms with a strong capacity to compete through innovation. For example, beyond Japan, other East Asian countries have developed strong innovation systems, in particular, technology-based firms in South Korea and Taiwan.

2. They are also potential sources of improvement in the corporate management of innovation and in national systems of innovation. However, as we shall see below, understanding, interpreting and learning general lessons from foreign systems of innovation are a difficult task. Effectiveness in innovation has become bound up with wider national, cultural and ideological interests, which makes it more difficult to separate fact from belief. Both the business press and business education are dominated by the English language and Anglo-Saxon examples.

3. Finally, firms can benefit more specifically from the technology generated in foreign systems of innovation. A high proportion of large European firms attach great importance to foreign sources of technical knowledge, whether obtained through affiliated firms (i.e., direct foreign investment) and joint ventures, links with suppliers and customers or reverse engineering. In general, they find it is more difficult to learn from Japan than from North America and elsewhere in Europe, probably because of greater distances – physical, linguistic and cultural. Conversely, East Asian firms have been very effective over the past 25 years in making these channels an essential feature of their rapid technological learning. **Case Study 4.4** provides examples of how firms from latecomer nations come to dominate emerging sectors.

Table 4.2 Relative Importance of National and Overseas Sources of Technical Knowledge (% Firms Judging Source as Being 'Very Important')

	Home Country	Other Europe	North America	Japan
Affiliated firms	48.9	42.9	48.2	33.6
Joint ventures	36.6	35.0	39.7	29.4
Independent suppliers	45.7	40.3	30.8	24.1
Independent customers	51.2	42.2	34.8	27.5
Public research	51.1	26.3	28.3	12.9
Reverse engineering	45.3	45.9	40.0	40.0

Source: Arundel, A., G. van der Paal, and L. Soete, *Innovation strategies of Europe's largest industrial firms*, PACE Report, MERIT, 1995, University of Limbourg, Maastricht, Anthony Arundel.

CASE STUDY 4.4 Technology Strategies of Latecomer Firms in East Asia

The spectacular modernization in the past 25 years of the East Asian 'dragon' countries – Hong Kong, South Korea, Singapore and Taiwan – has led to lively debate about its causes. Michael Hobday has provided important new insights into how business firms in these countries succeeded in rapid learning and technological catch up, in spite of underdeveloped domestic systems of science and technology, and a lack of technologically sophisticated domestic customers.

Government policies provided the favourable general economic climate: export orientation; basic and vocational education, with strong emphasis on industrial needs; and a stable economy, with low inflation and high savings. However, of major importance were the strategies and policies of specific business firms for the effective assimilation of foreign technology.

The main mechanism for catching up was the same in electronics, footwear, bicycles, sewing machines and automobiles, namely, the 'OEM' (original equipment manufacturer) system. OEM is a specific form of subcontracting, where firms in catching-up countries produce goods to the exact specification of a foreign trans-national company (TNC) normally based in a richer and technologically more advanced country. For the TNC, the purpose is to cut costs, and to this end it offers assistance to the latecomer firms in quality control, choice of equipment and engineering and management training.

OEM began in the 1960s and became more sophisticated in the 1970s. The next stage in the mid-1980s was ODM (own design and manufacture), where the latecomer firms learned to design products for the buyer. The last stage was OBM (own brand manufacture), where latecomer firms market their own products under their own brand name (e.g., Samsung, Acer) and compete head on with the leaders.

For each stage of catching up, the company's technology position must be matched with a corresponding market position, as shown below:

Stage	Technology Position	Market Position
1.	Assembly skills Basic production Mature products	Passive importer pull Cheap labour Distribution by buyers
2.	Incremental process change Reverse engineering	Active sales to foreign buyer Quality and cost-based
3.	Full production skills Process innovation Product design	Advanced production sales International marketing department Markets own design
4.	R&D Product innovation	Product marketing push Own-brand product range and sales
5.	Frontier R&D R&D linked to market needs Advanced innovation	Own-brand push In-house market research Independent distribution

Source: Hobday M., *Innovation in East Asia: The Challenge to Japan*. 1995, Edward Elgar, Cheltenham.

The slow but significant internationalization of R&D is also a means by which firms can learn from foreign systems of innovation. There are many reasons why multinational companies choose to locate R&D outside their home country, including regulatory regime and incentives, lower cost or more specialist human resources, and proximity to lead suppliers or customers, but in many cases a significant motive is to gain access to national or regional innovation networks. Overall, the proportion of R&D expenditure made outside the home nation has grown from less than 15% in 1995 to more than 30% by 2019. However, some countries are more advanced in internationalizing their R&D than others, as shown in **Figure 4.1**. In this respect, European firms are the most internationalized and the Japanese the least.

LEARNING AND IMITATING

While information on competitors' innovations is relatively cheap and easy to obtain, corporate experience shows that knowledge of how to replicate competitors' product and process innovations is much more costly and time-consuming to acquire. Such imitation typically costs between 60% and 70% of the original, and typically takes three years to achieve [34].

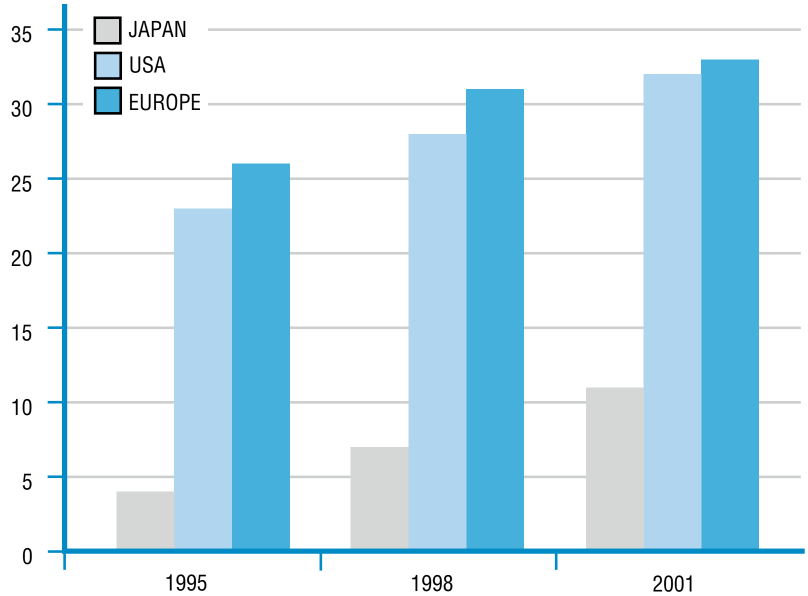

FIGURE 4.1 Internationalization of R&D by region (% R&D expenditure outside home region)

Source: Data derived from Edler, J., F. Meyer-Krahmer, and G. Reger, Changes in the strategic management of technology: Results of a global benchmarking study. *R&D Management*, 2002. **32**(2), 149–64.

These conclusions are illustrated by the examples of Japanese and Korean firms, where very effective imitation has been sustained by heavy and firm-specific investments in education, training and R&D [35]. As **Table 4.3** shows, R&D managers' report that the most important methods of learning about competitors' innovations were independent R&D, reverse engineering and licensing, all of which are expensive compared to reading publications and the patent literature. Useful and usable knowledge does not come cheap. A similar and more recent survey of innovation strategy in more than 500 large European firms also found that nearly half reported the great importance of the technical knowledge they accumulated through the reverse engineering of competitors' products [36].

More formal approaches to technology intelligence gathering are less widespread, and the use of different approaches varies by company and sector, as shown in **Figure 4.2**. For example, in the pharmaceutical sector, where much of the knowledge is highly codified in publications and patents, these sources of information are scanned routinely, and the proximity to the science base is reflected in the widespread use of expert panels. In electronics, product technology

Table 4.3 Effectiveness of Methods of Learning About Competitors

Method of Learning	Overall Sample	Means*
	Processes	Products
Independent R&D	4.76	5.00
Reverse engineering	4.07	4.83
Licensing	4.58	4.62
Hiring employees from innovating firm	4.02	4.08
Publications or open technical meetings	4.07	4.07
Patent disclosures	3.88	4.01
Consultations with employees of the innovating firm	3.64	3.64

*Range: 1 = not at all effective; 7 = very effective.

Source: Levin, R. et al., Appropriating the returns from industrial research and development. *Brookings Papers on Economic Activity*, 1987. **3**, 783–820. The Brookings Institution.

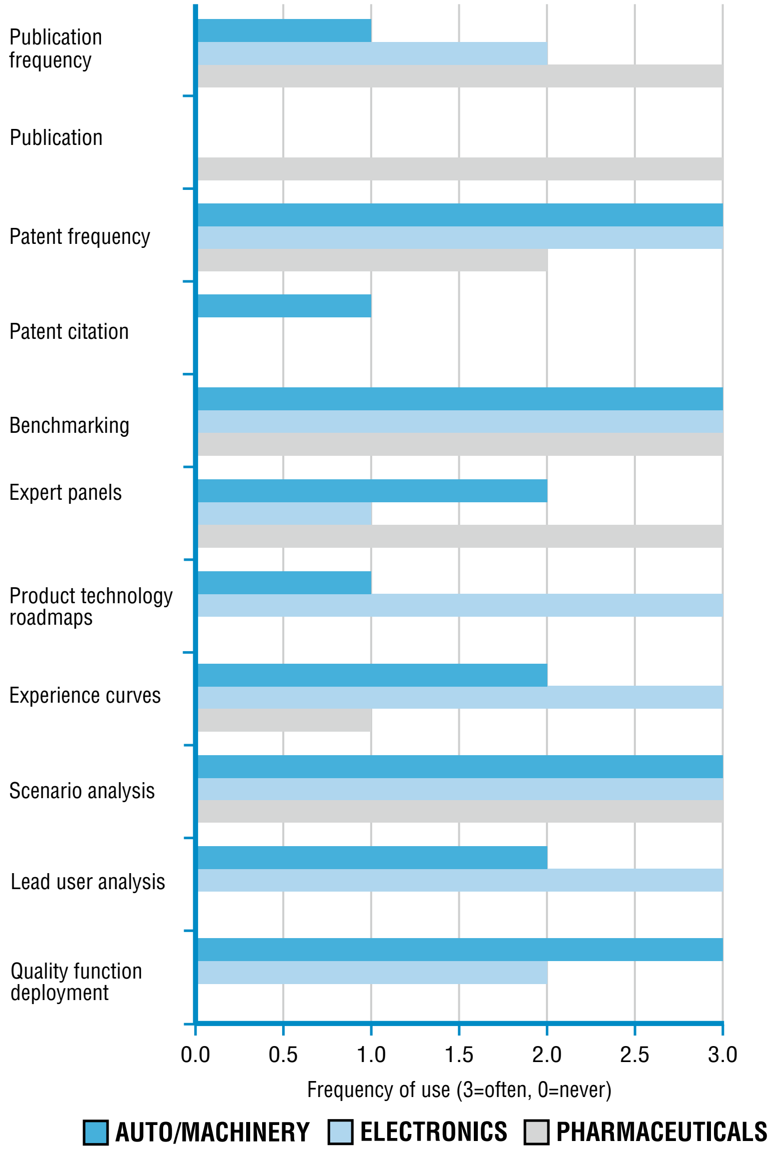

FIGURE 4.2 Use of technology intelligence methods by sector

Source: Data derived from Lichtenthaler, E., Technological intelligence processes in leading European and North American multinationals. *R&D Management*, 2004. **34**(2), 121–34.

roadmaps are commonly used along with the lead users. Surprisingly (according to this study of 26 large firms), long-established and proven methods such as Delphi studies, S-curve analysis and patent citations are not in widespread use.

4.4 APPROPRIATING THE BENEFITS FROM INNOVATION

Technological leadership in firms does not necessarily translate itself into economic benefits [37]. Teece argues that the capacity of the firm to appropriate the benefits of its investment in technology depends on two factors: (i) the firm's capacity to translate its technological advantage into commercially viable products or processes and (ii) the firm's capacity to defend its advantage against imitators. Thus, effective patent protection enabled Pilkington to defend its technological breakthrough in glass making and stopped Kodak imitating Polaroid's instant photography. Lack of commitment of complementary assets in production and marketing resulted in the failure of EMI and Xerox to reap commercial benefits from their breakthroughs in medical scanning and personal computing technologies. In video recorders, Matsushita succeeded against the more innovative Sony in imposing its standard, in part because of a more liberal licensing policy towards competitors.

Some of the factors that enable a firm to benefit commercially from its own technological lead can be strongly shaped by its management: for example, the provision of complementary assets to exploit the lead. Other factors can be influenced only slightly by the firm's management and depend much more on the general nature of the technology, the product market and the regime of intellectual property rights: for example, the strength of patent protection. We identify nine factors that influence the firm's capacity to benefit commercially from its technology:

1. Secrecy
2. Accumulated tacit knowledge
3. Lead times and after-sales service
4. The learning curve
5. Complementary assets
6. Product complexity
7. Standards
8. Pioneering radical new products
9. Strength of patent protection

We begin with those over which management has some degree of discretion for action and move on to those where its range of choices is more limited.

1. *Secrecy* is considered an effective form of protection by industrial managers, especially for process innovations. However, it is unlikely to provide absolute protection, because some process characteristics can be identified from an analysis of the final product, and because process engineers are a professional community, who talk to each other and move from one firm to another, and the information and knowledge inevitably leak out [38]. Moreover, there is evidence that, in some sectors, firms that share their knowledge with their national system of innovation outperform those that do not, and that those that interact most with global innovation systems have the highest innovative performance [39]. Specifically, firms that regularly have their research (publications and patents) cited by foreign competitors are rated more innovative than others, after controlling for the level of R&D. In some cases, this is because sharing knowledge with the global system of innovation may influence standards and dominant designs (see later) and can help attract and maintain research staff, alliance partners and other critical resources.

2. *Accumulated tacit knowledge* can be long and difficult to imitate, especially when it is closely integrated in specific firms and regions. Examples include product design skills, ranging from those of Zara in clothing design to those of Rolls-Royce in aircraft engines.

3. *Lead times and after-sales service* are considered by practitioners as the major sources of protection against imitation, especially for product innovations. Taken together with a strong commitment to product development, they can establish brand loyalty and credibility, accelerate the feedback from customer use to product improvement, generate learning-curve cost advantages and therefore increase the costs of entry for imitators. Based on the survey of large European firms, **Table 4.4** shows that there are considerable differences among sectors in product development lead times, reflecting differences both in the strength of patent protection and in product complexity.

Table 4.4 Inter-industry Differences in Product Development Lead Times

Industry	% of Firms Noting >5 years for Development and Marketing of Alternative to a Significant Product Innovation
All	11.0
Pharmaceuticals	57.5
Aerospace	26.3
Chemicals	17.2
Petroleum products	13.6
Instruments	10.0
Automobiles	7.3
Machinery	5.7
Electrical equipment	5.3
Basic metals	4.2
Utilities	3.7
Glass, cement and ceramics	0
Plastics and rubber	0
Food	0
Telecommunication equipment	0
Computers	0
Fabricated metals	0

Source: Arundel, A., G. van der Paal, and L. Soete, *Innovation strategies of Europe's largest industrial firms*, PACE Report, MERIT, 1995, University of Limbourg, Maastricht. Anthony Arundel.

4. *The learning curve* in production generates both lower costs and a particular and powerful form of accumulated and largely tacit knowledge that is well recognized by practitioners. In certain industries and technologies (e.g., semiconductors, continuous processes), the first-comer advantages are potentially large, given the major possibilities for reducing unit costs with increasing cumulative production. However, such 'experience curves' are not automatic and require continuous investment in training and learning.

5. *Complementary assets*. The effective commercialization of an innovation very often depends on assets (or competencies) in production, marketing and after-sales to complement those in technology. For example, Teece argues that strong complementary assets enabled IBM to catch up in the personal computer market [40]. Similarly, Apple's aesthetic design capability is complemented by strong brand marketing and content rights management.

6. *Product complexity.* However, Teece was writing in the mid-1980s, and IBM's performance in personal computers has been less than impressive since then. Previously, IBM could rely on the size and complexity of its mainframe computers as an effective barrier against imitation, given the long lead times required to design and build copy products. With the advent of the microprocessor and standard software, these technological barriers to imitation disappeared and IBM was faced in the late 1980s with strong competition from IBM 'clones', made in the United States and in East Asia. Boeing and Airbus have faced no such threat to their positions in large civilian aircraft, since the costs and lead times for imitation remain very high. Product complexity is recognized by managers as an effective barrier to imitation.

7. *Standards*. The widespread acceptance of a company's product standard widens its own market and raises barriers against competitors. Carl Shapiro and Hal Varian have written the

standard text on the competitive dynamics of the Internet economy [41], where standards compatibility is an essential feature of market growth, and 'standards wars' an essential feature of the competitive process. The market leader normally has the advantage in a standards war, but this can be overturned through radical technological change, or a superior response to customers' needs [42]. Competing firms can adopt either 'evolutionary' strategies minimizing switching costs for customers (e.g., backward compatibility with earlier generations of the product) or 'revolutionary' strategies based on greatly superior performance–price characteristics, such that customers are willing to accept higher switching costs [43]. Standards wars are made less bitter and dramatic when the costs to the losers of adapting to the winning standard are relatively small. This is discussed in **Research Note 4.6**.

RESEARCH NOTE 4.6 Standards and 'Winner Takes All' Industries

Charles Hill has gone so far as to argue that standards competition creates 'winner takes all' industries [44]. This results from the so-called 'increasing returns to adoption', where the incentive for customers to adopt a standard increases with the number of users who have already adopted it, because of the greater availability of complementary and compatible goods and services (e.g., content programs for video recorders and computer application programs for operating systems). While the experiences of Microsoft and Intel in personal computers give credence to this conclusion, it does not always hold. The complete victory of the VHS standard has not stopped the loser (Sony) from a successful business in the video market, based on its rival's standard [45]. Similarly, IBM has not benefited massively (some would say at all), compared to its competitors, from the success of its own personal computer standard [46]. In both cases, rival producers have been able to copy the standard and to prevent 'winner takes all', because the costs to producers of changing to other standards have been relatively small. This can happen when the technology of a standard is licensed to rivals, in order to encourage adoption. It can also happen when technical differences between rival standards are relatively small. When this is the case (e.g., in TV and mobile phones), the same firms will often be active in many standards.

A recent review by Fernando Suarez of the literature on standards criticized much of the research as being 'ex-post', and therefore offering few insights into the 'ex-ante' dynamics of standards formation most relevant to managers [47]. It identifies that both firm-level and environmental factors influence the standards setting:

- *Firm-level factors*: technological superiority, complementary assets, installed base, credibility, strategic manoeuvring, including entry timing, licensing, alliances, managing, market expectations.
- *Environmental factors*: regulation, network effects, switching costs, appropriability regime, number of stakeholders and level of competition versus cooperation. The appropriability regime refers to the legal and technological features of the environment that allow the owner of a technology to benefit from the technology. A strong or tight regime makes it more difficult for a rival firm to imitate or acquire the technology.

Different factors will have an influence at different phases of the standards process. In the early phases, aimed at demonstrating technical feasibility, factors such as the technological superiority, complementary assets and credibility of the firm are most important, combined with the number and nature of other firms and appropriability regime. In the next phase, creating a market, strategic manoeuvring and regulation are most important. In the decisive phase, the most significant factors are the installed base, complementary assets, credibility and influence of switching costs and network effects. However, in practice, it is not always easy to trace such ex-ante factors to ex-post success in successfully establishing a standard (see **Table 4.5**). This is one reason why increasing collaboration is occurring earlier in the standards process, rather than the more historical 'winner takes all' standards battles in the later stages [48]. Research in the telecommunications and other complex technological environments, where system-wide compatibility is necessary, confirms that early advocates of standards via alliances are more likely to create standards and achieve dominant positions in the industry network (see also Case Study 4.5 on Ericsson and the GSM standard) [49]. In contrast, the failure of Philips and Sony to establish

Table 4.5 Cases of Standardization and Innovation Success and Failure

Standard	Outcome	Key Actors and Technology
Betamax	Failure	Sony, pioneering technology
VHS	Success	Matsushita and JVC alliance, follower technology
CD	Success	Sony and Philips alliance for hardware, Columbia and Polygram for content
DCC	Failure	Philips, digital evolution of analogue cassette
Minidisc	Failure	Sony competitor to DCC, relaunched after DCC withdrawn, limited subsequent success
MS-DOS	Success	Microsoft and IBM
Navigator	Failure	Netscape was a pioneer and early standard for Internet browsers, but Microsoft's Explorer overtook this position, followed by the dominance of Google's Chrome and Apple's Safari browsers
Android	Success	Google and the Open Handset Alliance, co-exists with Apple's iOS standard

Source: Updated from Chiesa, V. and G. Toletti, Standards-setting in the multimedia sector. *International Journal of Innovation Management*, 2003. **7**(3), 281–308.

their respective analogue video standards, and subsequent recordable digital media standards, compared to the success of VHS, CD and DVD standards, which were the result of early alliances. Where strong appropriability regimes exist, compatibility standards may be less important than customer interface standards, which help to 'lock-in' customers [50]. Apple's graphic user interface is a good example of this trade-off.

8. *Pioneering radical new products*. It is not necessarily a great advantage to be a technological leader in the early stages of the development of radically new products, when the product performance characteristics, and features valued by users, are not always clear, either to the producers or to the users themselves. Especially for consumer products, valued features emerge only gradually through a process of dynamic competition, which involves a considerable amount of trial, error and learning by both producers and users. New features valued by the users in one product can easily be recognized by competitors and incorporated in subsequent products. That is why market leadership in the early stages of the development of personal computers was so volatile, and why pioneers are often displaced by new entrants [51]. In such circumstances, product development must be closely coupled with the ability to monitor competitors' products and to learn from customers. According to research by Tellis and Golder, pioneers in radical consumer innovations rarely succeed in establishing long-term market positions. Success goes to so-called 'early entrants' with the vision, patience and flexibility to establish a mass consumer market [52]. As a result, studies suggest that the success of product pioneers ranges between 25% (for consumer products) and 53% (for high-technology products), depending on the technological and market conditions. For example, studies of the PIMS (Profit Impact of Market Strategy) database indicate that (surviving) product pioneers tend to have higher quality and a broader product line than followers, whereas followers tend to compete on price, despite having a cost disadvantage. A pioneer strategy appears more successful in markets where the purchasing frequency is high, or where distribution is important (e.g., fast-moving consumer goods), but confers no advantage where there are frequent product changes or high advertising expenditure (e.g., consumer durables) [53].

9. Strength of patent protection can, as we have already seen in the earlier described examples, be a strong determinant of the relative commercial benefits to innovators and imitators. **Table 4.6** summarizes the results of the surveys of the judgements of managers in large European and US firms about the strength of patent protection. The firms' sectors are ordered according to the first column of figures, showing the strength of patent protection

Table 4.6 Inter-industry Differences in the Effectiveness of Patenting

Industry	Products		Processes	
	Europe	USA	Europe	USA
Drugs	4.8	4.6	4.3	3.5
Plastic materials	4.8	4.6	3.4	3.3
Cosmetics	4.6	2.9	3.9	2.1
Plastic products	3.9	3.5	2.9	2.3
Motor vehicle parts	3.9	3.2	3.0	2.6
Medical instruments	3.8	3.4	2.1	2.3
Semiconductors	3.8	3.2	3.7	2.3
Aircraft and parts	3.8	2.7	2.8	2.2
Communication equipment	3.6	2.6	2.4	2.2
Steel mill products	3.5	3.6	3.5	2.5
Measuring devices	3.3	2.8	2.2	2.6
Petroleum refining	3.1	3.1	3.6	3.5
Pulp and paper	2.6	2.4	3.1	1.9

Range: 1 = not at all effective; 5 = very effective.
Note: Some industries omitted because of lack of Europe–USA comparability.
Sources: Arundel, A., G. van de Paal, and L. Soete, Innovation strategies of Europe's largest industrial firms, PACE Report, MERIT, 1995, University of Limbourg; Maastricht and Levin, R. et al., Appropriating the returns from industrial research and development. *Brookings Papers on Economic Activity*, 1987. **3**, 783–820. Reproduced by permission of Anthony Arundel.

for product innovations for European firms. Patents are judged to be more effective in protecting product innovations than process innovations in all sectors except petroleum refining, probably reflecting the importance of improvements in chemical catalysts for increasing process efficiency. It also shows that patent protection is rated more highly in chemical-related sectors (especially drugs) than in other sectors. This is because it is more difficult in general to 'invent round' a clearly specified chemical formula than round other forms of invention. **Case Study 4.5** discusses the relative competitive advantages of standards, patents and first-mover strategies.

CASE STUDY 4.5 Standards, Intellectual Property and First-mover Advantages: The Case of GSM

The development of the global system for mobile communications (GSM) standard began around 1982. Around 140 patents formed the essential intellectual property behind the GSM standard. In terms of the numbers of patents, Motorola dominated with 27, followed by Nokia (19) and Alcatel (14). Philips had also an initial strong position with 13 essential patents, but later made a strategic decision to exit the mobile telephony business. Ericsson was unusual in that it held only four essential patents for GSM, but later became the market leader. One reason for this was that Ericsson wrote the original proposal for GSM. Another reason is that it was second only to Philips in its position in the network of alliances between relevant firms. Motorola continued to patent after the basic technical decisions had been agreed, whereas the other firms did not. This allowed Motorola greater control over which markets GSM would be made available and also enabled it to influence licensing conditions and to gain access to others' technology. Subsequently, virtually all the GSM equipments were supplied by companies that participated in the cross-licensing of this essential intellectual property: Ericsson, Nokia, Siemens, Alcatel and Motorola, together accounting for around 85% of the market for switching systems and stations, a market worth US $100 billion.

As the GSM standard moved beyond Europe, North American suppliers such as Nortel and Lucent began to license the technology to offer such systems, but never achieved the success of the five pioneers. Most recently, Japanese firms have licensed the technology to provide GSM-based systems. Royalties for such technology can be high, representing up to 29% of the cost of a GSM handset.

Source: Based on Bekkers R., G. Duysters, and B. Verspagen, Intellectual property rights, strategic technology agreements and market structure. *Research Policy*, 2002. **31**, 1141–61.

Radical, new technologies are now posing new challenges for the protection of intellectual property, including the patenting system. The number of patents granted to protect software technology is growing in the United States and so are the number of financial institutions getting involved in patenting for the first time [54]. Debate and controversy surround important issues, such as the possible effects of digital technology on copyright protection [55], the validity of patents to protect living organisms and the appropriate breadth of patent protection in biotechnology [56].

Finally, we should note that firms can use more than one of the nine factors to defend their innovative lead. For example, in the pharmaceutical industry, secrecy is paramount during the early phases of research; however, in the later stages of research, patents become critical. Complementary assets such as global sales and distribution become more important at later stages. Despite all the merger and acquisitions in this sector, these factors, combined with the need for a significant critical mass of R&D, have resulted in relatively stable international positions of countries in pharmaceutical innovation over a period of some 70 years. Firms typically deploy all the useful means available to them to defend their innovations against imitation [57].

4.5 EXPLOITING TECHNOLOGICAL TRAJECTORIES

In this section, we focus on firms and broad technological trajectories [58]. This is because firms and industrial sectors differ greatly in their underlying technologies. For example, designing and making an automobile is not the same as designing and making a therapeutic drug, or a personal computer. We are dealing not with one *technology*, but with several *technologies*, each with its historical pattern of development, skill requirements and strategic implications. Therefore, it is a major challenge to develop a framework, for integrating changing technology into strategic analysis, that deals effectively with corporate and sectoral diversity. Later, we describe the framework that we have developed to help encompass diversity [59]. It has been strongly influenced by the analyses of the emergence of the major new technologies over the past 150 years by Chris Freeman and his colleagues [60] and by David Mowery and Nathan Rosenberg [61].

A number of studies have shown marked, similar and persistent differences among industrial sectors in the sources and directions of technological change. They can be summarized as follows:

- *Size of innovating firms*: typically *big* in chemicals, road vehicles, materials processing, aircraft and electronic products and *small* in machinery, instruments and software.
- *Basis of competition*: typically *price sensitive* in bulk materials and consumer products, but *performance sensitive* in ethical drugs and machinery.
- *Objectives of innovation*: typically *product* innovation in ethical drugs and machinery, *process* innovation in steel and *both* in automobiles.
- *Sources of innovation*: *suppliers* of equipment and other production inputs in agriculture and traditional manufacture (such as textiles); *customers* in instrument, machinery and software; *in-house* technological activities in chemicals, electronics, transport, machinery, instruments and software; and *basic research* in ethical drugs.

- *Locus of own innovation*: *R&D laboratories* in chemicals and electronics, *production engineering departments* in automobiles and bulk materials, *design offices* in machine building and *systems departments* in service industries (e.g., banks and supermarket chains).

In the face of such diversity, there are two opposite dangers. One is to generalize about the nature, source, directions and strategic implications of innovation on the basis of experience in one firm or in one sector. In this case, there is a strong probability that many of the conclusions will be misleading or plain wrong. The other danger is to say that all firms and sectors are different and that no generalizations can be made. In this case, there can be no cumulative development of useful knowledge. In order to avoid these twin dangers, we distinguish five major technological trajectories, each with its distinctive nature and sources of innovation, and with its distinctive implications for technology strategy and innovation management. In **Table 4.7**, we identify for each trajectory its typical core sectors, its major sources of technological accumulation and its main strategic management tasks.

Knowledge of these major technological trajectories can improve the analysis of particular companies' technological strategies, by helping answer the following questions:

- Where do the company's technologies come from?
- How do they contribute to competitive advantage?
- What are the major tasks of innovation strategy?
- Where are the likely opportunities and threats, and how can they be dealt with?

Although the above taxonomy has held up reasonably well to subsequent empirical tests, it inevitably simplifies [62]. For example, we can find 'supplier-dominated' firms in electronics and

Table 4.7 Five Major Technological Trajectories

	Supplier Dominated	Scale Intensive	Science Based	Information Intensive	Specialized Suppliers
Typical core products	Agriculture Services Traditional manufacture	Bulk materials Consumer durables Automobiles Civil engineering	Electronics Chemicals	Finance Retailing Publishing Travel	Machinery Instrument Software
Main sources of technology	Suppliers Production learning	Production engineering Production learning Suppliers Design offices	R&D Basic research	Software and systems departments Suppliers	Design Advanced users
Main tasks of innovation strategy					
Positions	Based on non-technological advantages	Cost-effective and safe complex products and processes	Develop technically related products	New products and services	Monitor and respond to user needs
Paths	Use of IT in finance and distribution	Incremental integration of new knowledge (e.g., virtual prototypes, new materials, B2B*)	Exploit basic science (e.g., molecular biology)	Design and operation of complex information processing systems	Matching changing technologies to user needs
Processes	Flexible response to user	Diffusion of best practice in design, production and distribution	Obtain complementary assets Redefine divisional boundaries	To match IT-based opportunities with user needs	Strong links with lead users

*B2B = business to business.

chemicals, but they are unlikely to be technological pacesetters. In addition, firms can belong in more than one trajectory. In particular, large firms in all sectors have capacities in *scale-intensive* (mainly mechanical and instrumentation) technologies, in order to ensure efficient production. Software technology is beginning to play a similarly pervasive role across all sectors (**Table 4.8**). **Research Note 4.7** identifies how digital technologies influence innovation strategies.

Table 4.8 Patterns of Innovation in the 'New' and 'Old' Economies

Variable	New Economy	Old Economy
R&D sets strategic vision of firm	5.14	3.56
R&D active participant in making corporate strategy	5.87	4.82
R&D responsible for developing new business	5.05	3.76
Transforming academic research into products	4.64	3.09
Accelerating regulatory approval	4.62	3.02
Reliability and systems engineering	5.49	4.79
Making products de facto standard	3.56	2.71
Anticipating complex client needs	4.95	3.94
Exploration with potential customers and lead users	5.25	4.41
Probing user needs with preliminary designs	4.72	3.59
Using roadmaps of product generations	4.51	3.26
Planned replacement of current products	3.56	2.53
Build coalition with commercialization partners	4.18	3.38
Working with suppliers to create complementary offers	4.32	3.61

Scale: 1 (low) – 7 (high); only statistically significant differences shown, n = 75 firms.
Source: Derived from Floricel, S. and R. Miller, An exploratory comparison of the management of innovation in the new and old economies. *R&D Management*, 2003. **33**(5), 501–25.

RESEARCH NOTE 4.7 Digital Capabilities for Innovation

There is no doubt that digital technologies have the potential for disruptive innovation in a wide range of sectors, both in manufacturing and services, and the commercial and social domains. However, popular commentaries on the potential of digital innovation to disrupt have suffered from two extreme positions: either simplistic technological determinism, often promoted by technology vendors, claiming that the impending widespread automation of products and services will provide step-changes in productivity and new products and services; or alternatively, very high-level broad discussions of business model innovation in traditional sectors. However, such arguments are not new, and similar claims were originally made for flexible programmable factory automation, and later for digital service innovation, but the actual impacts have not been universal, and therefore the outcomes of current digital technologies are likely to be highly differentiated. More fundamentally, neither a narrow technological perspective, nor broad business view, adequately captures the appropriate level of granularity necessary to understand the potential and challenges presented by digital innovation.

Innovation concepts, models and research provide greater insights into strategies for, and management of, digital innovation. For example, the growing prominence of platforms and ecosystems in digital innovation, especially through enabling technologies such as Artificial Intelligence (AI) and the Internet of Things (IoT), reinforces the need to develop or acquire complementary assets to function and capture value. Such complementary assets are central to the creation and delivery of value, and a broader ecosystems perspective is necessary to identify the entrepreneurial and collaborative opportunities enabled by these new technologies. Therefore, the focus shifts from the potential for digitalization of products and services, to the creation of broader platform-based innovations.

Platforms and product and service families are powerful ways for companies to recoup their high initial investments in technology by deploying the technology across numerous applications and markets. This strategy is not new or unique to digital innovation. Aircraft engine makers like Rolls-Royce and General Electric work with families of core designs which they stretch and adapt to suit different needs. Car makers produce models which although apparently different in style make use of common components and floor pans or chassis. Semiconductor manufacturers like Intel and AMD spread the huge cost of developing new generations of chip across many product variants. In the digital domain, examples of this platform strategy include all the so-called FAANGs – Facebook, Apple, Amazon, Netflix and Google. However, within the broad platform approach, each of these companies has developed distinct and different combinations of technological, process, product and service innovation.

Source: J. Tidd, *Digital Disruptive Innovation*. World Scientific: London, 2020.

4.6 DEVELOPING FIRM-SPECIFIC COMPETENCIES

The ability of firms to track and exploit the technological trajectories depends on their specific technological and organizational competencies and on the difficulties that competitors have in imitating them. The notion of firm-specific competencies has become increasingly influential among economists, trying to explain why firms are different and how they change over time, but also among managers and consultants, trying to identify the causes of competitive success [63].

HAMEL AND PRAHALAD ON COMPETENCIES

The most influential business analysts promoting and developing the notion of 'core competencies' have been Gary Hamel and C. K. Prahalad [64]. Their basic ideas can be summarized as follows:

1. The sustainable competitive advantage of firms resides not in their products but in their *core competencies*: 'The real sources of advantage are to be found in management's ability to consolidate corporate-wide technologies and production skills into competencies that empower individual businesses to adapt quickly to changing opportunities' (p. 81).

2. Core competencies feed into more than one core product, which in turn feed into more than one business unit. They use the metaphor of the tree:

   End products = Leaves, flowers and fruit

   Business units = Smaller branches

   Core products = Trunk and major limbs

   Core competencies = Root systems

   Examples of core competencies include Apple in design, Amazon in logistics and 3M in coatings and adhesives. See **Case Study 4.6** for examples of how core competencies map onto products.

3. The importance of associated organizational competencies is also recognized: 'Core competence is communication, involvement and a deep commitment to working across organizational boundaries' (1990, p. 82).

4. Core competencies require focus: 'Few companies are likely to build world leadership in more than five or six fundamental competencies. A company that compiles a list of 20 to 30 capabilities has probably not produced a list of core competencies' (1990, p. 84).

5. As **Table 4.9** shows, the notion of core competencies suggests that large and multidivisional firms should be viewed not only as a collection of strategic business units (SBUs) but also as

CASE STUDY 4.6 Core Competencies at Canon

Product	Competencies		
	Precision Mechanics	Fine Optics	Microelectronics
Basic camera	X	X	
Compact fashion camera	X	X	
Electronic camera	X	X	
EOS autofocus camera	X	X	X
Video still camera	X	X	X
Laser beam printer	X	X	X
Colour video printer	X		X
Bubble jet printer	X		X
Basic fax	X		X
Laser fax	X		X
Calculator			X
Plain paper copier	X	X	X
Colour copier	X	X	X
Laser copier	X	X	X
Colour laser copier	X	X	X
Still video system	X	X	X
Laser imager	X	X	X
Cell analyser	X	X	X
Mask aligners	X		X
Stepper aligners	X		X
Excimer laser aligners	X	X	X

Source: Prahalad, C. and G. Hamel, The core competencies of the corporation. Harvard Business Review, May–June, 79–91. © 1990 Harvard Business School Publishing.

According to Christer Oskarsson [65]:

In the late 1950s . . . the time had come for Canon to apply its precision mechanical and optical technologies to other areas [than cameras] . . . such as business machines. By 1964 Canon had begun by developing the world's first 10-key fully electronic calculator . . . followed by entry into the coated paper copier market with the development of an electrofax copier model in 1965, and then into . . . the revolutionary Canon plain paper copier technology unveiled in 1968 . . . Following these successes of product diversification, Canon's product lines were built on a foundation of precision optics, precision engineering and electronics . . .

The main factors behind . . . increases in the numbers of products, technologies and markets . . . seem to be the rapid growth of information technology and electronics, technological transitions from analogue to digital technologies, technological fusion of audio and video technologies, and the technological fusion of electronics and physics to optronics (pp. 24–26).

bundles of competencies that do not necessarily fit tidily in one business unit. More specifically, the conventional multidivisional structure may facilitate efficient innovation within specific product markets, but may limit the scope for learning new competencies: firms with fewer divisional boundaries are associated with a strategy based on capabilities broadening, whereas firms with many divisional boundaries are associated with a strategy based on the deepening of capabilities [66].

Table 4.9 Two Views of Corporate Structure: Strategic Business Units and Core Competencies

	Strategic Business Unit	Core Competencies
Basis for competition	Competitiveness of today's products	Inter-firm competition to build competencies
Corporate structure	Portfolio of businesses in related product markets	Portfolio of competencies, core products and business
Status of business unit	Autonomy: SBU 'owns' all resources other than cash	SBU is a potential reservoir of core competencies
Resource allocation	SBUs are unit of analysis. Capital allocated to SBUs	SBUs and competencies are unit of analysis. Top management allocates capital and talent
Value added of top management	Optimizing returns through trade-offs among SBUs	Enunciating strategic architecture and building future competencies

ASSESSMENT OF THE CORE COMPETENCIES APPROACH

The great strength of the approach proposed by Hamel and Prahalad is that it places the cumulative development of firm-specific technological competencies at the centre of the agenda of corporate strategy. Although they have done so by highlighting practice in contemporary firms, their descriptions reflect what has been happening in successful firms in science-based industries since the beginning of the twentieth century. For example, Gottfried Plumpe has shown that the world's leading company in the exploitation of the revolution in organic chemistry in the 1920s – IG Farben in Germany – had already established numerous 'technical committees' at the corporate level, in order to exploit emerging technological opportunities that cut across divisional boundaries [67]. These enabled the firm to diversify progressively out of dyestuffs into plastics, pharmaceutical and other related chemical products. Other histories of businesses in chemicals and electrical products tell similar stories [68]. In particular, they show that the competence-based view of the corporation has major implications for the organization of R&D, for methods of resource allocation and for strategy determination, to which we shall return later. In the meantime, their approach does have limitations and leaves at least three key questions unanswered.

a. **Differing potentials for technology-based diversification?** It is not clear whether the corporate core competencies in all industries offer a basis for product diversification. Compare the recent historical experience of most large chemical and electronics firms, where product diversification based on technology has been the norm, with that of most steel and textile firms, where technology-related product diversification has proved very difficult [69].

b. **Multi-technology firms?** Recommendations that firms should concentrate resources on a few fundamental (or 'distinctive') world-beating technological competencies are potentially misleading. Large firms are typically active in a wide range of technologies, in only a few of which do they achieve a 'distinctive' world-beating position [70]. In other technological fields, a background technological competence is necessary to enable the firm to coordinate and benefit from outside linkages, especially with suppliers of components, subsystems, materials and production machinery. In industries with complex products or production processes, a high proportion of a firm's technological competencies is deployed in such background competencies, as shown in **Table 4.10** [71].

For example, in terms of innovation strategy, it is important to distinguish firms where IT is a core technology and a source of distinctive competitive advantage (e.g., Cisco, the supplier of Internet equipment) from firms where it is a background technology, requiring major changes but available to all competitors from specialized suppliers, and therefore unlikely to be a source

Table 4.10 The Strategic Function of Corporate Technologies

Strategic Functions	Definition	Typical Examples
Core or critical functions	Central to corporate competitiveness. Distinctive and difficult to imitate	Technologies for product design and development. Key elements of process technologies
Background or enabling	Broadly available to all competitors, but essential for efficient design, manufacture and delivery of corporate products	Production machinery, instruments, materials, components (software)
Emerging or key	Rapidly developing fields of knowledge presenting potential opportunities or threats, when combined with existing core and background technologies	Materials, biotechnology, ICT software

of distinctive and sustainable competitive advantage (e.g., Tesco, the UK supermarket chain). See Table 4.10.

In all industries, emerging (key) technologies can end up having pervasive and major impacts on firms' strategies and operations (e.g., software). A good example of how an emerging/key technology can transform a company is provided by the Swedish telecommunications firm Ericsson. **Table 4.11** traces the accumulation of technological competencies, with successive generations of mobile cellular phones and telecommunication cables.

In both cases, each new generation required competencies in a wider range of technological fields, and very few established competencies were made obsolete. The process of accumulation involved both increasing links with outside sources of knowledge, and greater expenditures on R&D, given greater product complexity. This was certainly not a process of concentration, but of diversification in both technology and product.

Table 4.11 Technological Accumulation Across Product Generations

Product and Generation	No. of Important Technologies				R&D Costs	% of Technologies Acquired Externally	Main Technological Fields (d)	No. of Patent Classes (e)
	(a)	(b)	Total	(c)	(base = 100)			
Cellular phones								
1. NMT-450	n.a.	n.a.	5	n.a.	100	12	E	17
2. NMT-900	5	5	10	0	200	28	EPM	25
3. GSM	9	5	14	1	500	29	EPMC	29
Telecommunication cables								
1. Coaxial	n.a.	n.a.	5	n.a.	100	30	EPM	14
2. Optical	4	6	10	1	500	47	EPCM	17

n.a. = not applicable.
Notes:
(a) No. of technologies from the previous generation.
(b) No. of new technologies, compared to previous generation.
(c) No. of technologies now obsolete from previous generation.
(d) 'Main' = >15% of total engineering stock. Categories are: E = electrical; P = physics; K = chemistry; M = mechanical; C = computers.
(e) Number of international patent classes (IPC) at four-digit level.
Source: Granstrand, O., Bohlin, E., Oskarsson, C., and Sjöberg, N. External technology acquisition in large multi-technology corporations. *R&D Management*, **22**(2), 111–134. © 1992 John Wiley & Sons.

For these reasons, the notion of 'core competencies' should perhaps be replaced for technology by the notion of 'distributed competencies', given that, in large firms, they are distributed:

- over a large number of technical fields;
- over a variety of organizational and physical locations within the corporation – in the R&D, production engineering and purchasing departments of the various divisions, and in the corporate laboratory;
- among different strategic objectives of the corporation, which include not only the establishment of a distinctive advantage in existing businesses (involving both core and background technologies) but also the exploration and establishment of new ones (involving emerging technologies). **Research Note 4.8** examines the relationships between four capabilities and innovation performance.

RESEARCH NOTE 4.8 Single or Multiple Capabilities?

This study asks whether organizations should focus on single capabilities, or combine them, thereby competing on multiple capabilities simultaneously. It empirically tests the relationship between innovation and four operational capabilities: cost efficiency, quality of products or services, speed of delivery and flexibility of operations, using a large-scale global survey of 1438 firms.

They find no evidence of trade-offs between the four operational capabilities, and that all four are significantly and positively associated with innovation performance, which supports the combined multiple- rather than single-capability approach. Moreover, both flexibility and delivery capabilities were comparatively stronger predictors of innovativeness than the more narrow operational focus on cost efficiency and quality capabilities.

Source: Based on Nand, A.A., P.J. Singh, and A. Bhattacharya, Do innovative organisations compete on single or multiple operational capabilities? *International Journal of Innovation Management*, 2014. **18**(3), 1440001.

c. **Core rigidities?** As Dorothy Leonard-Barton has pointed out, 'core competencies' can also become 'core rigidities' in the firm, when established competencies become too dominant [72]. In addition to sheer habit, this can happen because established competencies are central to today's products, and because large numbers of top managers may be trained in them. As a consequence, important new competencies may be neglected or underestimated (e.g., the threat to mainframes from mini- and microcomputers by management in mainframe companies). In addition, established innovation strengths may overshoot the target. In **Research Note 4.9**, Leonard-Barton gives a fascinating example from the Japanese automobile industry: how the highly successful 'heavyweight' product managers of the 1980s (see Chapter 10) overdid it in the

RESEARCH NOTE 4.9 Heavyweight Product Managers and Fat Product Designs

Some of the most admired features . . . identified . . . as conveying a competitive advantage [to Japanese automobile companies] were: (1) overlapping problem solving among the engineering and manufacturing functions, leading to shorter model change cycles; (2) small teams with broad task assignments, leading to high development productivity and shorter lead times; and (3) using a 'heavyweight' product manager – a competent individual with extensive project influence . . . who led a cohesive team with autonomy over product design decisions. By the early 1990s, many of these features had been emulated . . . by US automobile manufacturers, and the gap between US and Japanese companies in development lead time and productivity had virtually disappeared.

However . . . there was another reason for the loss of the Japanese competitive edge – 'fat product designs' . . . an excess in product variety, speed of model change and unnecessary options . . . 'overuse' of the same capability that created competitive advantages in the 1980s has been the source of the new problem in the 1990s. The formerly 'lean' Japanese producers such as Toyota had overshot their targets of customer satisfaction and overspecified their products, catering to a long 'laundry list' of features and carrying their quest for quality to an extreme that could not be cost-justified when the yen appreciated in 1993 . . . Moreover, the practice of using heavyweight managers to guide important projects led to excessive complexity of parts because these powerful individuals disliked sharing common parts with other car models.

Source: D. Leonard-Barton, *Wellsprings of knowledge*. Boston, MA: Harvard Business School Press, p. 33, 1995.

1990s. Many examples show that when 'core rigidities' become firmly entrenched, their removal often requires changes in top management.

DEVELOPING AND SUSTAINING COMPETENCIES

The final question about the notion of core competencies is very practical: how can management identify and develop them?

Definition and measurement. There is no widely accepted definition or method of measurement of competencies, whether technological or otherwise. One possible measure is the level of *functional performance* in a generic product, component or subsystem: in, for example, performance in the design, development, manufacture and performance of compact, high-performance combustion engines. As a strategic technological *target* for a firm like Honda, this obviously makes sense. But its achievement requires the combination of technological competencies from a wide variety of *fields* of knowledge, the composition of which changes (and increases) over time. Twenty years ago, they included mechanics (statics and dynamics), materials, heat transfer, combustion and fluid flow. Today, they also include ceramics, electronics, computer-aided design, simulation techniques and software. This is why a definition based on the measurement of the combination of competencies in different technological fields is more useful for formulating innovation strategy, and is in fact widely practiced in business [73].

Richard Hall goes some way towards identifying and measuring core competencies [74]. He distinguishes between intangible assets and intangible competencies. Assets include intellectual property rights and reputation. Competencies include the skills and know-how of employees, suppliers and distributors, and the collective attributes which constitute organizational culture. His empirical work, based on a survey and case studies, indicates that managers believe that the most significant of these intangible resources are company reputation and employee know-how, both of which may be a function of organizational culture. Thus, organizational culture, defined as the shared values and beliefs of members of an organizational unit, and the associated artefacts, becomes central to organizational learning.

Sidney Winter links the idea of competencies with his own notion of organizational 'routines', in an effort to contrast capabilities from other generic formulas for sustainable competitive advantage or managing change [75]. A *routine* is an organizational behaviour that is highly patterned, is learned, derived in part from tacit knowledge and with specific goals, and is repetitious. In contrast, dynamic capabilities typically involve long-term commitments to specialized resources and consist of patterned activity to relatively specific objectives. Therefore, dynamic capabilities involve both the exploitation of existing competencies and the development of new ones. For example, leveraging existing competencies through new product development can consist of de-linking existing technological or commercial competencies from a set of current products and linking them in a different way to create new products. However, new product development can also help to develop new competencies. For example, an existing technological competence may demand new commercial competencies to reach a new market, or conversely a new technological competence might be necessary to service an existing customer [76].

The trick is to get the right balance between exploitation of existing competencies and the exploitation and development of new competencies. Research suggests that over time some firms are more successful at this than others, and that a significant reason for this variation in performance is due to difference in the ability of managers to build, integrate and reconfigure organizational competencies and resources [77]. These 'dynamic' managerial capabilities are influenced by managerial cognition, human capital and social capital. Cognition refers to the beliefs and mental models which influence the decision making. These affect the knowledge and assumptions about future events, available alternatives and association between cause and effect. This will restrict a manager's field of vision and influence perceptions and interpretations. **Case Study 4.7** discusses the role of (limited) cognition in the case of Polaroid and digital imaging. Human capital refers to the learned skills that require some investment in education, training experience and socialization, and these can be generic or industry- or firm-specific. It is the firm-specific factors that appear to be the most significant in dynamic managerial capability, which can lead to different decisions when faced with the same environment. Social capital refers to the internal and external relationships that affect managers' access to information, their influence, control and power.

CASE STUDY 4.7 Capabilities and Cognition at Polaroid

Polaroid was a pioneer in the development of instant photography. It developed the first instant camera in 1948 and the first instant colour camera in 1963, and it introduced sonar automatic focusing in 1978. In addition to its competencies in silver halide chemistry, it had technological competencies in optics and electronics, and mass manufacturing, marketing and distribution expertise. The company was technology driven from its foundation in 1937, and the founder Edwin Land had 500 personal patents. When Kodak entered the instant photography market in 1976, Polaroid sued the company for patent infringement, and was awarded $924.5 million in damages. Polaroid consistently and successfully pursued a strategy of introducing new cameras, but made almost all its profits from the sale of the film (the so-called razor-blade marketing strategy also used by Gillette), and between 1948 and 1978 the average annual sales growth was 23%, and profit growth 17% per year.

Polaroid established an electronic imaging group as early as 1981, as it recognized the potential of the technology. However, digital technology was perceived as a potential technological shift, rather than as a market or business disruption. By 1986, the group had an annual research budget of $10 million, and by 1989, 42% of the R&D budget was devoted to digital imaging technologies. By 1990, 28% of the firm's patents related to digital technologies. Polaroid was therefore well positioned at that time to develop a digital camera business. However, it failed to translate prototypes into a commercial digital camera until 1996, by which time there were 40 other companies in the market, including many strong Japanese camera and electronics firms. A part of the problem was adapting the product development and marketing channels to the new product needs. However, other more fundamental problems related to long-held cognitions: a continued commitment to the razor-blade business model and pursuit of image quality. Profits from the new market for digital cameras were derived from the cameras rather than the consumables (film). Ironically, Polaroid had rejected the development of ink-jet printers, which rely on consumables for profits, because of the relatively low quality of their (early) outputs. Polaroid had a long tradition of improving its print quality to compete with conventional 35 mm film.

Source: Tripsas, M. and G. Gavetti, Capabilities, cognition, and inertia: Evidence from digital imaging. *Strategic Management Journal*, 2000. **21**(10), 1147–61.

Top management and 'strategic architecture' for the future. The importance given by Hamel and Prahalad to top management in determining the 'strategic architecture' for the development of future technological competencies is debatable. As *The Economist* has argued [78]:

> *'It is hardly surprising that companies which predict the future accurately make more money than those who do not. In fact, what firms want to know is what Mr Hamel and Mr Prahalad steadfastly fail to tell them: how to guess correctly. As if to compound their worries, the authors are oddly reticent about those who have gambled and lost.'*

The evidence in fact suggests that the successful development and exploitation of core competencies does not depend on management's ability to forecast accurately long-term technological and product developments: as **Case Study 4.8** illustrates, the record here is not at all impressive [79]. Instead, the importance of new technological opportunities and their commercial potential emerge not through a flash of genius (or a throw of the dice) from senior management, but gradually through an incremental corporate-wide process of learning in knowledge building and strategic positioning. New core competencies cannot be identified immediately and without trial and error [80]. It was through a long process of trial and error that Ericsson's new competence in mobile telephones first emerged [81]. As **Case Study 4.9** shows, it is also how Japanese firms developed and exploited their competencies in optoelectronics. **Research Note 4.10** discusses how different capabilities develop over time.

CASE STUDY 4.8 The Overvaluation of Technological Wonders

In 1986, Schnaars and Berenson published an assessment of the accuracy of forecasts of future growth markets since the 1960s, with the benefit of 20 or more years of hindsight [82]. The list of failures is as long as the list of successes. Below are some of the failures.

> The 1960s were a time of great economic prosperity and technological advancement in the United States . . . One of the most extensive and widely publicized studies of future growth markets was TRW Inc.'s 'Probe of the Future'. The results . . . appeared in many business publications in the late 1960s . . . Not all . . . were released. Of the ones that were released, nearly all were wrong! Nuclear-powered underwater recreation centres, a 500-kilowatt nuclear power plant on the moon, 3-D colour TV, robot soldiers, automatic vehicle control on the interstate system and plastic germproof houses were among some of the growth markets identified by this study.
>
> . . . In 1966, industry experts predicted that 'The shipping industry appears ready to enter the jet age'. By 1968, large cargo ships powered by gas turbine engines were expected to penetrate the commercial market. The benefits of this innovation were greater reliability, quicker engine starts and shorter docking times.
>
> . . . Even dentistry foresaw technological wonders . . . in 1968, the Director of the National Institute of Dental Research, a division of the US Public Health Service, predicted that 'in the next decade, both tooth decay and the most prevalent form of gum disease will come to a virtual end'. According to experts at this agency, by the late 1970s, false teeth and dentures would be 'anachronisms' replaced by plastic teeth implant technology. A vaccine against tooth decay would also be widely available and there would be little need for dental drilling.

CASE STUDY 4.9 Learning About Optoelectronics in Japanese Companies

Using a mixture of bibliometric and interview data, Kumiko Miyazaki traced the development and exploitation of optoelectronics technologies in Japanese firms. Her main conclusions were as follows:

> . . . Competence building is strongly related to a firm's past accomplishments. The notions of path dependency and cumulativeness have a strong foundation. Competence

building centers in key areas to enhance a firm's core capabilities.

. . . by examining the different types of papers related to semiconductor lasers over a 13-year period, it was found that in most firms there was a decrease in experimental type papers accompanied by a rise in papers marking 'new developments' or 'practical applications'.

The existence of a wedge pattern for most firms confirmed . . . that competence building is a cumulative and long process resulting from trial and error and experimentation, which may eventually lead to fruitful outcomes. The notion of search trajectories was tested using . . . INSPEC and patent data. Firms search over a broad range in basic and applied research and a narrower range in technology development . . . In other words, in the early phases of competence building, firms explore a broad range of technical possibilities, since they are not sure how the technology might be useful for them. As they gradually learn and accumulate their knowledge bases, firms are able to narrow the search process to find fruitful applications.

Source: Miyazaki, K., Search, learning and accumulation of technological competencies: The case of optoelectronics. *Industrial and Corporate Change*, 1994. **3**(3), 631–54.

RESEARCH NOTE 4.10 Development of Capabilities

This study examined the role of dynamic capabilities in the capability development process over time. It identified how dynamic capabilities modify operational capabilities through two different capability mechanisms, namely, transformation and substitution, beyond incremental development. New capabilities may be acquired to perform the same functions as prior capabilities (transformation), or new capabilities may make existing capabilities obsolete (substitution).

Operational capabilities can evolve over time without explicit development activities as knowledge accumulates through learning-by-doing and routines, so learning, change and adaptation do not necessarily need the intervention of dynamic capabilities. However, the function of dynamic capabilities is to take the lead in the development and steer the evolutionary path into new territories beyond the scope of incremental evolution. Therefore, dynamic capabilities start more radical development mechanisms than mere evolution and change a company's capabilities or resource base in an *intentional* and *deliberate* manner. They argue that dynamic capabilities enable, channel and foster the development of market and technological capabilities toward new strategic goals. All types of dynamic capabilities are linked with innovation-related operational capability development, not only the reconfiguring capabilities that by definition act to modify the resource base but also capabilities in sensing and seizing can foster the development of market and technological capabilities. Sensing and seizing capabilities may, indeed, indirectly result in the development of operational capabilities, while their initial purpose was to capture external knowledge and make innovative ideas into reality.

Many changes at the company-level over time involve decisions by corporate managers, and deployment of dynamic capabilities requires high levels of time and energy from committed managers. This means that dynamic capabilities are closely linked to strategic decision making of top management.

Source: Ellonen, H-K., A. Jantunen, and O. Kuivalainen, The role of dynamic capabilities in developing innovation-related capabilities, *International Journal of Innovation Management*, 2011. **15**(3), 459–78.

A study of radical technological innovations found how visions can influence the development or acquisition of competencies and identified three related mechanisms through which firms link emerging technologies to markets that do not yet exist: motivation, insight and elaboration [83]. Motivation serves to focus attention and to direct energy and encourages the concentration of resources. It requires the senior management to communicate the importance of radical innovation and to establish and enforce challenging goals to influence the *direction* of innovative efforts. Insight represents the critical connection between technology and potential application. For radical technological innovations, such insight is rarely from the marketing function, customers or competitors, but is driven by those with extensive technical knowledge and expertise with a sense of both market needs and opportunities. Elaboration involves the demonstration of technical feasibility, validating the idea within the organization, prototyping and the building and testing of different business models.

At this point, the concept is sufficiently well elaborated to work with the marketing function and potential customers. Market visioning for radical technologies is necessarily the result of individual or technological leadership. '*There were multiple ways for a vision to take hold of an organization . . . our expectation was that a single individual would create a vision of the future and drive it across the organization. But just as we discovered that breakthrough innovations don't necessarily arise simply because of a critical scientific discovery, neither do we find that visions are necessarily born of singular prophetic individuals*' (pp. 239–244) [83]. **Case Study 4.10** illustrates how Corning developed its ceramic technologies and deep process competencies to develop products for the emerging demand for catalytic converters in the car industry and for glass fibre

CASE STUDY 4.10 Market Visions and Technological Innovation at Corning

Corning has a long tradition of developing radical technologies to help create emerging markets. It was one of the first companies in the United States to establish a corporate research laboratory in 1908. The facility was originally setup to help solve some fundamental process problems in the manufacture of glass and resulted in improved glass for railroad lanterns. This led to the development of Pyrex in 1912, which was Corning's version of the German-invented borosilicate glass. In turn, this led to new markets in medical supplies and consumer products.

In the 1940s, the company began to develop television tubes for the emerging market for colour television sets, drawing upon its technology competencies developed for radar during the war. Corning did not have a strong position in black-and-white television tubes, but the tubes for colour television followed a different and more challenging technological trajectory, demanding a deep understanding of the fundamental phenomena to achieve the alignment of millions of photofluorescent dots to a similar pattern of holes.

In 1966, in response from a joint enquiry from the British Post Office and British Ministry of Defence, Corning supplied a sample of high-quality glass rods to determine the performance in transmitting light. Based on the current performance of copper wire, a maximum loss of 20 db/km was the goal. However, at that time the loss of the optical fibre (waveguide) was 10 times this: 200 db/km. The target was theoretically possible given the properties of silica, and Corning began research on optical fibre. Corning pursued a different approach to others, using pure silica, which demanded very high temperatures, making it difficult to work with. The company had developed this tacit knowledge in earlier projects, and this would take time for others to acquire. In 1970, the research group developed a composition and fibre design that exceeded the target performance. Excluded from the US market by an agreement with AT&T, Corning formed a five-year joint development agreement with five companies from the United Kingdom, Germany, France, Italy and Japan. Subsequently, Corning developed key technologies for waveguides, filed the 12 key patents in the field, and after a number of high-profile but successful patent infringement actions against European, Japanese and Canadian firms, it came to dominate what would become $10 million annual sales by 1982.

Corning had also close relationships with the main automobile manufacturers as a supplier of headlights, but it had failed to convince these companies to adopt its safety glass for windscreens (windshields) due to the high cost and low importance of safety at that time. Corning had also developed a ceramic heat exchanger for petrol (gasoline) turbine engines, but the automobile manufacturers were not willing to reverse their huge investments for the production of internal combustion engines. However, discussion with GM, Ford and Chrysler indicated that future legislation would demand reduced vehicle emissions, and therefore some form of catalytic converter would become standard for all cars in the United States. However, no one knew how to make these at that time. The passing of the Clean Air Act in 1970 required reductions in emissions by 1975, and accelerated development. Competitors included 3M and GM. However, Corning had the advantage of having already developed the new ceramic for its (failed) heat exchanger project, and its competencies in R&D organization and production processes. Unlike its competitors, which organized development along divisional lines, Corning was able to apply as many researchers as it had to tackle the project, what became known as 'flexible critical mass'. In 1974, it filed a patent for its new extrusion production technology, and in 1975 for a new development of its ceramic material. The competitors' technologies proved unable to match the increasing reduction in emissions needed, and by 1994 catalytic converters generated annual sales of $1 billion for Corning.

Source: Based on Graham, M. and A. Shuldiner, *Corning and the Craft of Innovation*. 2001, Oxford: Oxford University Press.

for telecommunications. **Case Study 4.11** shows the limited role of technology in the Internet search engine business and the central role of an integrated approach to process, product and business innovation.

CASE STUDY 4.11 Innovation in Internet Search Engines

Internet search engines demonstrate the need for an integrated approach to innovation, which includes process, product and business innovation. Perhaps surprisingly, the leading companies such as Google and Yahoo! have not based their innovation strategies on technological research and development, but rather on the novel combinations of technological, process, product and business innovations.

For example, of the 126 search engine patents granted in the United States between 1999 and 2001, the market leaders Yahoo! and Google each only had a single patent, whereas IBM led the technology race with 16 patents, but no significant search business. However, over the same period Yahoo! published more than 1000 new feature releases and Google over 300. These new releases included new configurations of search engine, new components for existing search engines, new functions and improved usability.

Moreover, this strategy of a broad range of type of innovations, rather than a narrow focus on technological innovations, did not follow the classic product–process life cycle. A strong consistent emphasis on process innovation throughout the company histories was punctuated with multiple episodes of significant product and business innovation, in particular, new offerings which integrated core search functions and other services. This pattern confirms that even in so-called high-tech sectors, other competencies are equally or even more important for continued success in business.

Source: Lan, P., G.A. Hutcheson, Y. Markov, and N.W. Runyan, An examination of the integration of technological and business innovation: Cases of Yahoo! and Google. *International Journal of Technology Marketing*, 2007. **2**(4), 295–316.

4.7 GLOBALIZATION OF INNOVATION

Many analysts and practitioners have argued that, following the 'globalization' of product markets, financial transactions and direct investment, large firms' R&D activities should also be globalized – not only in their traditional role of supporting local production but also in order to create interfaces with specialized skills and innovative opportunities at a world level [84]. This is consistent with more recent notions of 'open innovation', rather than 'closed innovation' which relies on internal development. However, although striking examples of the internationalization of R&D can be found (e.g., the large Dutch firms, particularly Philips [85]), more comprehensive evidence casts doubt on the strength of such a trend (**Table 4.12**).

This evidence is based on the countries of origin of the inventors cited on the front page of patents granted in the United States, to nearly 359 of the world's largest, technologically active firms (and which account for about half of all patenting in the United States). This information turns out to be an accurate guide to the international spread of large firms' R&D activities.

Taken together, the evidence shows that [86]:

- Twenty years ago, the world's large firms performed about 12% of their innovative activities outside their home country. The equivalent share of production is now about 25%.
- The most important factor explaining each firm's share of foreign innovative activities is its share of foreign production. In general, firms from smaller countries have higher shares of foreign innovative activities. On average, the foreign production is less innovation intensive than the home production.

Table 4.12 Indicators of the Geographic Location of the Innovative Activities of Firms

Nationality of Large Firms (no.)	% Share Origin of US Patents 1992–1996		% Share of Foreign-performed R&D Expenditure (year)	% Share of Foreign Origin of US Patents in 1992–1996				% Change in Foreign Origin of US Patents, Since 1980–1984
	Home	Foreign		US	Europe	Japan	Other	
Japan (95)	97.4	2.6	2.1 (1993)	1.9	0.6	0.0	0.1	–0.7
USA (128)	92.0	8.0	11.9 (1994)	0.0	5.3	1.1	1.6	2.2
Europe (136)	77.3	22.7		21.1	0.0	0.6	0.9	3.3
Belgium	33.2	66.8		14.0	52.6	0.0	0.2	4.9
Finland	71.2	28.8	24.0 (1992)	5.2	23.5	0.0	0.2	6.0
France	65.4	34.6		18.9	14.2	0.4	1.2	12.9
Germany	78.2	21.8	18.0 (1995)	14.1	6.5	0.7	0.5	6.4
Italy	77.9	22.1		12.0	9.5	0.0	0.6	7.4
Netherlands	40.1	59.9		30.9	27.4	0.9	0.6	6.6
Sweden	64.0	36.0	21.8 (1995)	19.4	14.2	0.2	2.2	–5.7
Switzerland	42.0	58.0		31.2	25.0	0.9	0.8	8.2
UK	47.6	52.4		38.1	12.0	0.5	1.9	7.6
All firms (359)	87.4	12.6	11.0 (1997)	5.5	5.5	0.6	0.9	2.4

Sources: Based on Patel, P. and K. Pavitt, National systems of innovation under strain: The internationalization of corporate R&D. In R. Barrell, G. Mason and M. O'Mahoney, eds, *Productivity, Innovation and Economic Performance*. 2000, Cambridge: Cambridge University Press; and Patel, P. and M. Vega, *Technology Strategies of Large European Firms*, In: Strategic Analysis for European S&T Policy Intelligence. TSER Project 1093; Paris: OST, 1998, pp. 195–250.

- Most of the foreign innovative activities are performed in the United States and Europe (in fact, Germany). They are *not* 'globalized'.
- European firms – and especially those from France, Germany and Switzerland – have been performing an increasing share of their innovative activities in the United States, in large part in order to tap into local skills and knowledge in such fields as biotechnology and IT.

Controversy remains both in the interpretation of this general picture and in the identification of implications for the future. The development of major innovations remains complex, costly and depends crucially on the integration of tacit knowledge. This remains difficult to achieve across national boundaries; firms therefore still tend to concentrate major product or process developments in one country. They will sometimes choose a foreign country only when it offers identifiable advantages in the skills and resources required for such developments and/or access to a lead market [87].

Advances in IT have enabled spectacular increases in the international flow of codified knowledge in the form of operating instructions, manuals and software. They are also having some positive impact on international exchanges of tacit knowledge through teleconferencing, but not anywhere near to the same extent. The main impact will therefore be at the second stage of the 'product cycle' [88], when product design has stabilized, and production methods are standardized and documented, thereby facilitating the internationalization of production. Product development and the first stage of the product cycle will still require frequent and intense personal exchanges, facilitated by physical proximity. Advances in IT are therefore more likely to favour the internationalization of production than that of the process of innovation.

The two polar extremes of organizing innovation globally are the specialization-based and integration-based, or network structure [89]. In the specialization-based structure the firm develops global centres of excellence in different fields, which are responsible globally for the development of a specific technology or product or process capability. The advantage of such global specialization is that it helps to achieve a critical mass of resources and makes coordination easier. As one R&D director notes:

> *'. . . the centre of excellence structure is the most preferable. Competencies related to a certain field are concentrated, coordination is easier, and economies of scale can be achieved. Any R&D director has the dream to structure R&D in such a way. However, the appropriate conditions seldom occur [90].'*

Research Note 4.11 contrasts two conflicting strategies for the globalization of innovation.

RESEARCH NOTE 4.11 Globalization Strategies for Innovation

It is possible to distinguish between two conflicting strategies for the globalization of innovation: augmenting, in which firms locate innovation activities overseas primarily in order to learn from foreign systems of innovation, public and private; and exploiting, the exact opposite, where the main motive is to gain competitive advantage from existing corporate-specific capabilities in an environment overseas. In practice firms will adopt a combination of these two different approaches, and need to manage the trade-offs on a technology and market-specific basis.

Christian Le Bas and Pari Patel analysed the patenting behaviour of 297 multinational firms over a period of eight years. They found that overall the augmenting strategy was the most common, but this varied by nationality of the firm and technical field. Consistent with other studies, they confirm that the strategy of augmenting was strongest for European firms and weakest for Japanese firms. The Japanese firms were more likely to adopt a strategy of exploiting home technology overseas. By technological field, the ranking for the importance of augmenting was (augmenting strategy most common in the first): instrumentation, consumer goods, civil engineering, industrial processes, engineering and machinery, chemicals and pharmaceuticals and electronics. Moreover, they argue that these different strategies are persistent over time, and are not the result of changes in the internationalization of innovation.

Source: Le Bas C. and P. Patel, The determinants of homebase-augmenting and homebase-exploiting technological activities: Some new results on multinationals' locational strategies. *SPRU Electronic Working Paper Series (SEWPS)*, 2007, **www.sussex.ac.uk/spru/publications**.

In practice, hybrids of these two extreme structures are common, often as a result of practical compromises and trade-offs necessary to accommodate history, acquisitions and politics. For example, specialization by centre of excellence may include contributions from other units, and integrated structures may include the contribution of specialized units. The main factors influencing the decision where to locate R&D globally are in the order of importance [90]:

1. The availability of critical competencies for the project.
2. The international credibility (within the organization) of the R&D manager responsible for the project.
3. The importance of external sources of technical and market knowledge, for example, sources of technology, suppliers and customers.
4. The importance and costs of internal transactions, for example, between engineering and production.
5. Cost and disruption of relocating key personnel to the chosen site.

Case Study 4.12 charts the development of innovation strategies and capabilities in China.

CASE STUDY 4.12 Building Innovation Capabilities in China

China's policy has followed the East Asian model in which success has depended on technological and commercial investment and by collaboration with foreign firms. Typically companies in the East Asian tiger economies such as South Korea and Taiwan developed technological capabilities on a foundation of manufacturing competence based on low-tech production and developed higher levels of capability such as design and new product development, for example, through OEM (Own Equipment Manufacturer) production for international firms. However, the flow of technology and development of capabilities are not automatic. Economists refer to 'spillovers' of know-how from foreign investment and collaboration, but this demands a significant effort by domestic firms.

Most significantly, China has encouraged foreign multinationals to invest in China, and these are now also beginning to conduct some R&D in China. In 1992, Motorola opened the first foreign R&D lab, and estimates indicate that in 2005, there were more than 700 R&D centres in China, although care needs to be taken in the definitions used. The transfer of technology to China, especially in the manufacturing sector, is considered to be a major contributor to its recent economic growth. Around 80% of China's inward foreign direct investment (FDI) is 'technology' (hardware and software), and FDI inflows have continued to grow. However, we must distinguish between technology transferred by foreign companies into their wholly or majority-owned subsidiaries in China, versus the technology acquired by indigenous enterprises. It is only through the successful acquisition of technological capability by indigenous enterprises, many of which still remain state-owned, that China can become a really innovative and competitive economic power.

The import of foreign technology can have a positive impact on innovation; and for large enterprises, the more foreign technology is imported, the more conducive it is to its own patenting. However, for the small- and medium-sized enterprises this is not the case. This probably implies that larger enterprises possess certain absorptive capacity to take advantage of foreign technology, which in turn leads to an enhancement of innovation capacity, whereas the small- and medium-sized enterprises are more likely to rely on foreign technology due to the lack of appropriate absorptive capacity and the possibly huge gap between imported and its own technology. Buying bundles of technology has been encouraged. These included embodied and codified technology: hardware and licenses. If innovation expenditure is broken down by a class of innovative activity, the costs of acquisition for embodied technology, such as machines and production equipments, account for about 58% of the total innovation expenditures, compared with 17% internal R&D, 5% external R&D, 3% marketing of new product, 2% training cost and 15% engineering and manufacturing start-up.

It is clear that the large foreign MNCs are most active in patenting in China. Foreign patenting began around 1995, and since 2000 patent applications have increased annually by around 50%. MNCs' patenting activities are highly correlated with 'the total revenue', or the overall Chinese market size. This strongly supports the standpoint that foreign patents in China are largely driven by demand factors. China's specialization in patenting does not correspond to its export specialization. Automobiles, household durables, software, communication equipment, computer peripherals, semiconductors and telecommunication services are the primary areas. For example, in 2005, the semiconductor industry was granted as many as fourfold inventions of the previous year. Patents by foreign MNCs account for almost 90% of all patents in China, the most active being firms from Japan, the United States and South Korea. Thirty MNCs have been granted more than 1000 patents, and each of the eight firms has more than 5000 patents: Samsung, Matsushita, Sony, LG, Mitsubishi, Hitachi, Toshiba and Siemens. Almost half of these patents are for the application of an existing technology, a fifth for inventions and the rest for industrial designs. Among the 18,000 patents for inventions with no prior-overseas rights, only 924 originate from Chinese subsidiaries of these MNCs, accounting for only 0.75% of the total. The average lag between patenting in the home country and in China is more than three years, which is an indicator of the technology lag between China and MNCs.

In China, innovation inputs and outcomes continue to grow significantly, for example, as measured by R&D expenditures and number of patents filed. However, the rates of innovation growth have slowed in recent years, with some industries out-performing others, and growth in innovation inputs and outcomes is increasingly uneven across sectors and firm-size. The reasons are complex, but certain patterns have emerged.

Zhu et al. (2019) adopt a resource-based view (RBV) to study the differential effects of internal resources (R&D personnel, R&D expenditure),external resources (government subsides) and firm characteristics (firm size, export ratio) on firm technological innovation performance in different high-tech industries. They find that the effects of these resources vary by sector in China. In the pharmaceutical and IT industries, R&D personnel and government subsidies have a positive and almost linear effect on technological innovation. In electronics and telecommunications industry, firm size has a positive effect, but the diversity of technology is main contribution to technological innovation, whereas the relationship between technological innovation and export performance is an inverted U curve.

Li et al. (2017) examined the effects of foreign direct investment (FDI) in China on the innovation capabilities of local firms, so-called spillover effects, based on 1610 companies over a decade. They found that FDI was positively associated with both the number and diversity of patents filed by local firms, suggesting that they were acquiring and absorbing knowledge from FDI. However, the degree of local firm specialization has a moderating effect on the benefits of FDI. Local firms can more easily capture FDI spillovers in diverse industrial environments, but in contrast, specialized industrial structures retard the capacity of local firms to capture innovation spillovers.

Chinese enterprises have invested in more than 210 countries, making China the second largest outward foreign direct investment (OFDI) in the world, with OFDI in leading developed countries such as United States, Australia, Singapore, United Kingdom, France, Canada, Germany, the Netherlands, Sweden, Korea and Japan (in order of level of investment). Zhou et al. (2019) explore the influence reverse technology spillovers through OFDI, that is, how domestic firms in China may improve their technological innovation and productivity as a result of overseas investment, a so-called knowledge-seeking strategy. They find that domestic innovation performance (DIP) is positively related to OFDI in developed countries, but negatively related to OFDI in transitional and emerging countries such as China. However, these relationships between OFDI and DIP are moderated by the degree of financial development and human capital. The authors argue that in China most of the large-scale banks are state-owned, and favour domestic investments, making it more difficult for enterprises to raise the funds needed to invest overseas and to assimilate advanced technology from developed countries. In general, improvements in human capital, that is education, training and experience, would be expected to increase local absorptive capacity, but this study finds the opposite effect. It appears that improvements in domestic human capital have a more direct effect, via R&D personnel, than more indirect absorption of technological knowhow via OFDI.

However, there remain significant regulatory and institutional challenges with complex ownership structures, poor corporate governance and ambiguous intellectual property rights issues, especially with public research, former state enterprises and university spin-offs and academic-run enterprises.

Sources: Based on Jinwei Zhu, Yangyang Wang, and Changyu Wang (2019), A comparative study of the effects of different factors on firm technological innovation performance in different high-tech industries, *Chinese Management Studies*, **13**(1), 2–25; Chongyang Zhou, Jin Hong, Yanrui Wu, and Dora Marinova (2019), Outward foreign direct investment and domestic innovation performance: Evidence from China, *Technology Analysis & Strategic Management*, **31**(1), 81–95; Jian Li, Dylan Sutherland, and Lutao Ning (2017), Inward FDI spillovers and innovation capabilities in Chinese business: Exploring the moderating role of local industrial externalities, *Technology Analysis & Strategic Management*, **29**(8), 932–945; Yip, G.S. and B. McKern, China's next strategic advantage; From imitation to innovation. 2016, MIT Press; Woo, J., *Technological upgrading in China and India: What do we know?* OECD Development Centre Working Paper no. 308, 2012; Wang Q., S. Collinson, and X. Wu (eds.), *International Journal of Innovation Management* (2010) Special Issue on Innovation in China, **14**(1); East meets West: 15th International Conference on Management of Technology, Beijing, May 2006.

View 4.1 discusses the various motivations for locating global innovation activities.

VIEW 4.1 LOCATION OF GLOBAL INNOVATION

Large companies swing between 'distributed R&D', where researchers are based in small business units (SBUs), and centralized R&D. The reason for this is that there are merits in both approaches. The centralized R&D improves recruitment and development of world-class specialists, whereas the distributed R&D improves researchers' understanding of business strategy. Anyone working in centralized R&D must make the most of the advantages and work to overcome the disadvantages. The biggest challenge for centralized R&D is the connectivity with the SBU.

In Sharp Laboratories of Europe, we have found that the probability of success of our projects is the probability of technical success multiplied by the probability of commercial success. Technical success is fundamentally easier to manage because so many of the parameters are within our control. It is easy for us to increase the effort, bring in outside expertise or try different routes. Commercial success is much harder for us to manage, and we have learnt that the quality of relationships is fundamental to success. There are well-understood motivational and cultural differences between R&D and other company functions such as manufacturing or marketing. Manufacturing is measured by quality, yield, availability, low inventory and low cost, and the parameters are all disrupted by the introduction of new products. Marketing is seeking to provide customers with exactly what they want, but those goals may not be technically achievable. Researchers are measured by the strength of the technology and are always looking for a better solution.

Inability to bridge these different motivations and cultures is a major barrier to delivering innovation in products. Engaging in short-term R&D projects is the most useful way to build a bridge between a centralized R&D centre and SBU. It creates an understanding on both sides and in our experience is a vital precursor to a major technology transfer. There is a risk associated with it that vital long-term R&D resource will be diverted into fire-fighting activities and this needs to be managed. It is our experience that managing commercial risk through strong relationships is vital to the success of a project.

Source: Dr Stephen Bold FREng, Managing Director, Sharp Laboratories of Europe Ltd, **www.sle.sharp.co.uk**.

4.8 ENABLING STRATEGY MAKING

Scanning and searching the environment identifies a wide range of potential targets for innovation and effectively answers the question, 'What could we do?' But even the best-resourced organization will need to balance this with some difficult choices about *which* options it will explore – and which it will leave aside. This process should not simply be about responding to what competitors do or what customers ask for in the marketplace. Nor should it simply be a case of following the latest technological fashion. Successful innovation strategy requires understanding the key parameters of the competitive game (markets, competitors, external forces, etc.) and also the role which technological knowledge can play as a resource in this game. How can it be accumulated and shared, how can it be deployed in new products/services and processes, how can complementary knowledge be acquired or brought to bear and so on? Such questions are as much about the management of the learning process within the firm as about investments or acquisitions – and building effective routines for supporting this process is critical to success.

Although developing such a framework is complex, we can identify a number of key routines that organizations use to create and deploy such frameworks. These help provide answers to the following three key questions:

- Strategic analysis – what, realistically, could we do?
- Strategic choice – what are we going to do (and in choosing to commit our resources to that, what will we leave out)?
- Strategic monitoring – overtime reviewing to check is this still what we want to do?

ROUTINES TO HELP STRATEGIC ANALYSIS

Research has repeatedly shown that organizations that simply innovate on impulse are poor performers. For example, a number of studies cite firms that have adopted expensive and complex innovations to upgrade their processes but which have failed to obtain competitive advantage from process innovation [91]. By contrast, those which understand the overall business, including their technological competence and their desired development trajectory, are more likely to succeed [92]. In a similar fashion, studies of product/service innovation regularly point to lack of strategic underpinning as a key problem [93]. For this reason, many organizations take time – often off-site and away from the day-to-day pressures of their 'normal' operations – to reflect and develop a shared strategic framework for innovation.

Many structured methodologies exist to help organizations work through these questions and these are often used to help smaller and less experienced players build management capability [94]. An increasing emphasis is being placed on the role of intermediaries – innovation consultants and advisors – who can provide a degree of assistance in thinking through innovation strategy – and a number of regional and national government support programs include this element. Examples include the IRAP program (developed in Canada but widely used by other countries such as Thailand), the European Union's MINT program, the TEKES counselling scheme in Finland, the Manufacturing Advisory Service in the UK (modelled in part on the US Manufacturing Extension Service in the United States) and the AMT program in Ireland [95].

In carrying out such a systematic analysis, it is important to build on multiple perspectives. Reviews can take an 'outside-in' approach, using tools for competitor and market analysis, or they can adopt an 'inside-out' model, looking for ways of deploying competencies. They can build on explorations of the future such as the scenarios described earlier in this chapter, and they can make use of techniques such as 'technology road-mapping' to help identify courses of action which will deliver broad strategic objectives [96]. But in the process of carrying out such reviews, it is critical to remember that strategy is not an exact science so much as a process of building shared perspectives and developing a framework within which risky decisions can be located.

It is also important not to neglect the need to communicate and share this strategic analysis. Unless people within the organization understand and commit to the analysis, it will be hard for them to use it to frame their actions. The issue of strategy *deployment* – communicating and enabling people to use the framework – is essential if the organization is to avoid the risk of having 'know-how' but not 'know-why' in its innovation process. Policy deployment of this kind requires suitable tools and techniques and examples include *hoshin* (participative) planning, how–why charts, 'bowling charts', and briefing groups. Chapter 10 picks up this theme in more detail.

PORTFOLIO MANAGEMENT APPROACHES

There are a variety of approaches that have developed to deal with the question of what is broadly termed 'portfolio management'. These range from simple judgements about risk and reward to complex quantitative tools based on probability theory [97]. But the underlying purpose is the same – to provide a coherent basis on which to judge which projects should be undertaken and to ensure a good balance across the portfolio of risk and potential reward. Failure to make such judgements can lead to a number of issues, as **Table 4.13** indicates.

In general, we can identify three approaches to this problem of building a strategic portfolio – benefit measurement techniques, economic models and portfolio models. Benefit measurement approaches are usually based on relatively simple subjective judgements – for example, checklists that ask whether certain criteria are met or not. More advanced versions attempt some kind of scoring or weighting so that projects can be compared in terms of their overall attractiveness. The main weakness here is that they consider each project in relative isolation [98].

Economic models attempt to put some financial or other quantitative data into the equation – for example, by calculating a payback time or discounted cash flow arising from the project. Once again these suffer from only treating single projects rather than reviewing a bundle, and they are also heavily dependent on the availability of good financial data – not always the case at the outset of a risky project. The third group – portfolio methods – tries to deal with the issue of reviewing across a set of projects and looks for balance. A typical example is to construct some form of matrix measuring risk versus reward – for example, on a 'costs of doing the project' versus expected returns. **Research Note 4.12** demonstrates the widespread application of portfolio methods in innovation strategy.

Rather than reviewing projects just on these two criteria, it is possible to construct multiple charts to develop an overall picture – for example, comparing the relative familiarity of the market or technology – this would highlight the balance between projects that are in unexplored territory as opposed to those in familiar technical or market areas (and thus with a lower risk).

Table 4.13 Criteria for Evaluating Different Types of Research Projects

Objective	Technical Activity	Evaluation Criteria (% of all R&D)	Decision-takers	Market Analysis	Nature of Risk	Higher Volatility	Longer Time Horizons	Nature of External Alliances
Knowledge building	Basic research, monitoring	Overhead cost allocation (2–10%)	R&D	None	Small = cost of R&D	Reflects wide potential	Increases search potential	Research grant
Strategic positioning	Focused applied research, exploratory development	'Options' evaluation (10–25%)	Chief executive R&D division	Broad	Small = cost of R&D	Reflects wide potential	Increases search potential	R&D contract Equity
Business investment	Development and production engineering	'Net present value' analysis (70–99%)	Division	Specific	Large = total cost of launching	Uncertainty reduces net present value	Reduces present value	Joint venture Majority control

RESEARCH NOTE 4.12 Strategic Innovation Portfolio Management

We examined the use and effectiveness of various innovation management practices (IMPs) within and across sectors, drawing upon a sample of 292 firms and associated and validated case studies. We found that only a very small number of innovation management practices can be considered to be universally positive, including external technology intelligence gathering, technology and portfolio management, whereas the use and effectiveness of most IMPs varies by industry and innovation context.

Significantly, innovation portfolio management, including technology, products and processes, was found to be a potential bridge between innovation strategy and development because it provides the mechanism through which innovation activities are aligned with corporate strategy, and in which opportunities for improved synergies across activities can be identified.

Portfolio management is associated with superior innovation and financial performance, as it helps to identify the relationships between multiple products and projects; identify new applications and businesses; and creates independence from established products, markets and businesses. Firms that performed benchmarking and scoring methods to inform their portfolios outperformed those that did not.

Source: Tidd, J. and B. Thuriaux-Alemán, Innovation management practices: Cross-sectorial adoption, Variation and Effectiveness, *R&D Management*. 2016. **46**(3), 1024–1043.

Other possible axes include the ease of entry versus market attractiveness (size or growth rate), the competitive position of the organization in the project area versus the attractiveness of the market or the expected time to reach the market versus the attractiveness of the market. However, it is important to recognize that even advanced and powerful screening tools will only work if the corporate is willing to implement the recommended decisions; for example, Cooper and Kleinschmidt found that the majority of firms studied (885) performed poorly at this stage, and often failed to kill off weak concepts [99]. Table 4.13 shows different criteria for assessing different types of projects. **Research Note 4.13** identifies methods that support the development of innovation strategy in practice, rather than in theory.

RESEARCH NOTE 4.13 Strategy-making in Practice

We examined how strategy develops and evolves over time, and how different tools and processes are used in practice. Unlike most studies, which rely on surveys or interviews after the event, in this study, we collected data from two case study companies by direct observation over many months, in *real* time. The data we generated included:

a. 1392 digital photographs – the photographs we had taken of activities in the two settings included pictures taken during project and client meetings, interactions with visual materials, individual working and office conversations.

b. Field notebooks – the notebooks had been used by each researcher to keep a diary of their time in the field, jotting down observations alongside the date and time, and at times relinquishing control to engineers and designers who took the notebooks and drew directly into them.

c. 34 hours of audio material – taped during the project meetings attended as part of the observational work and follow-up interviews. This was also transcribed.

d. Digital and physical files – additional documentation relating to the new product development project was archived in both digital and hard-copy formats.

The more useful practices we observed included:

- **Business strategy charts and roadmaps** These timeline charts are generated in PowerPoint and used by the general managers to disseminate corporate strategy, showing gross margin and the competitive roadmap. They were used in a meeting called by the general manager and attended by everybody in the division. Copies were then published on the server.

- **Technology development roadmap** This is a sector-level roadmap for silicon implant technology, which also shows R&D and product release schedules. It shows the lifetime of product models, with quarterly figures for spending on R&D and continuous improvement. A printed version sits on the desk of the assistant to the product manager. A PowerPoint version was published on the server.
- **Financial forecast spreadsheets** These are used to manage cost reduction and projections of revenue flow; the charts have a time dimension. For example, versions of cost reduction spreadsheets, generated by senior management, are used in a frozen way in cross-function team meetings between representatives of the engineering and procurement departments to negotiate and coordinate around delivery of targets and responsibilities for cost.
- **Strategic project timelines** These are timelines showing the goals of the project; the different streams of business and relationships with clients that relate to it. The general manager used a whiteboard to sketch the first version, which was then converted over a number of weeks into a proliferation of more formalized and detailed versions.
- **Gantt charts** These are timelines for scheduling activities. As the project progressed, versions of this timeline were widely used by the project team to keep present the understanding of the activities involved in achieving production against a tight deadline. An example is posted up on the office wall of the assistant to the product manager. Hard copies and PowerPoint versions were used in cross-function product development team meetings.
- **Progress charts** These are timelines for progress toward phase exit (and hence, revenue generation) shown in a standardized format with 'smileys' used to represent the project manager's assessment of risks. It is used by the quality manager for generic product development process, in a fortnightly cross-function meeting to review progress across the entire portfolio of new product development activity.

Source: Whyte, J., B. Ewenstein, M. Hales, and J. Tidd, How to visualize knowledge in project-based work. *Long Range Planning*, **41**(1), 74–92. © 2008 Elsevier.

SUMMARY

In formulating and executing their innovation strategies, organizations cannot ignore the national systems of innovation and international value chains in which they are embedded. Through their strong influences on demand and competitive conditions, the provision of human resources, and forms of corporate governance, national systems of innovation both open opportunities and impose constraints on what firms can do.

However, although firms' strategies are influenced by their own national systems of innovation and their position in international value chains, they are not determined by them. Learning (i.e., assimilating knowledge) from competitors and external sources of innovation is essential for developing capabilities, but does require costly investments in R&D, training and skills development in order to develop the necessary absorptive capacity. This depends in part on what management itself does, by way of investing in complementary assets in production, marketing, service and support, and its position in local and international systems of innovation. It also depends on a variety of factors that make it more or less difficult to appropriate the benefits from innovation, such as intellectual property and international trading regimes, and over which management can sometimes have very little influence. Nonetheless, capabilities are central to developing an innovation strategy:

Resources can be tangible, including assets, plant and equipment, and location, or intangible, such as employee skills and intellectual property. However, as these are generally freely available in the market they do not necessarily in isolation confer a sustainable competitive advantage.

Capabilities are more functional than resources, and by definition are rare combinations of resource that are difficult to imitate and create value for the organization.

Dynamic capabilities allow organizations to adapt, innovate and renew, and are therefore critical under conditions of uncertainty and for long-term growth.

Capabilities create value and contribute to competitiveness in a number of ways, including the ability to differentiate products and processes which are difficult to imitate.

FURTHER READING

Our companion text *Strategic Innovation Management* (Wiley, 2014) covers all these topics in greater depth. There are a number of texts that describe and compare different systems of national innovation policy, including *National Innovation Systems* (Oxford University Press, 1993), edited by Richard Nelson; *National Systems of Innovation* (Pinter, 1992), edited by B.-A. Lundvall; and *Systems of Innovation: Technologies, Institutions and Organisations* (Pinter, 1997), edited by Charles Edquist. The former is stronger on US policy, the other two on European, but all have an emphasis on public policy rather than corporate strategy. Michael Porter's *The Competitive Advantage of Nations* (Macmillan, 1990) provides a useful framework in which to examine the direct impact on corporate behaviour of innovation systems. At the other extreme, David Landes' *Wealth and Poverty of Nations* (Little Brown, 1998) takes a broad (and stimulating) historical and cultural perspective. The best overview is provided by the anthology of Chris Freeman's work in *Systems of Innovation* (Edward Elgar, 2008). More recent reviews of emerging economy systems include *Mastering Innovation in China: Insights from History on China's Journey towards Innovation,* by Joachim Jan Thraen (Springer, 2016), *China's Next Strategic Advantage: From Imitation to Innovation,* by George S. Yip and Bruce McKern (MIT Press, 2016) and *National Innovation Systems, Social Inclusion and Development: The Latin American Experience*, edited by Gabriela Dutrenit and Judith Sutz (Edward Elgar, 2016).

Comprehensive and balanced reviews of the arguments and evidence for product leadership versus follower positions is provided by G.J. Tellis and P.N. Golder: *Will and Vision: How Latecomers Grow to Dominate Markets* (McGraw-Hill, 2002) and *Fast Second: How Smart Companies Bypass Radical Innovation to Enter and Dominate New Markets* (Jossey Bass, 2004) by Costas Markides. More relevant to firms from emerging economies, and our favourite text on the subject, is Naushad Forbes and David Wield's *From Followers to Leaders: Managing Technology and Innovation* (Routledge, 2002), which includes numerous case examples.

For recent reviews of the core competence and dynamic capability perspectives see David Teece's *Dynamic Capabilities and Strategic Management: Organizing for Innovation and Growth* (Oxford University Press, 2011), Joe Tidd's (editor) *From Knowledge Management to Strategic Competence* (Imperial College Press, 3rd edition, 2012) and Connie Helfat's *Dynamic Capabilities: Understanding Strategic Change in Organizations* (Blackwell, 2006). Lockett, Thompson and Morgenstern (2009) provide a useful review in 'The development of the resource-based view of the firm: A critical appraisal', *International Journal of Management Reviews,* vol. 11, no. 1, as do Wang and Ahmed (2007). 'Dynamic capabilities: A review and research agenda', *International Journal of Management Reviews*, vol. 9, no. 1. Davenport, Leibold and Voelpel provide an edited compilation of leading strategy writers in *Strategic Management in the Innovation Economy* (2nd edition, Wiley, 2006), and the review edited by Robert Galavan, John Murray and Costas Markides, *Strategy, Innovation and Change* (Oxford University Press, 2008), is excellent. On the more specific issue of technology strategy Vittorio Chiesa's *R&D Strategy and Organization* (Imperial College Press, 2001) is a good place to start.

The renewed interest in business model innovation, that is how value is created and captured, is discussed in *Strategic Market Creation: A New Perspective on Marketing and Innovation Management*, a review of research at Copenhagen Business School and Bocconi University, edited by Karin Tollin and Antonella Carù (Wiley, 2008). There was a special issue of the journal *Long Range Planning* on innovative business models, volume 43 (2 & 3), 2011, and a compilation of articles republished in the *Harvard Business Review on Business Model Innovation* (2012). For the specific case of innovation strategies for digital technologies, see J. Tidd, *Digital Disruptive Innovation* (World Scientific, 2020).

OTHER RESOURCES

A number of additional resources including downloadable case studies, audio and video materials dealing with themes raised in the chapter can be found at locations listed below.

Resource type	Details	Access
Video/audio	Armin Rau talking about some of the challenges in developing innovation strategy within Swisscom	http://www.innovation-portal.info/resources/armin-rau-2/

Resource type	Details	Access
Case studies	• The Zara case demonstrates the contribution of dynamic capabilities to create a competitive advantage through process and product innovation. • The Fujifilm case examines how the company responded to the major changes in the photographic industry as a consequence of the emergence of digital imaging.	All at https://johnbessant.org/case-studies/
Tools	• 4Ps mapping of innovation space • Benchmarking • Blue Ocean strategy • Identifying innovative capabilities • Portfolio management There is a full description of these and other tools in the 'Strategy toolkit' section	All at https://johnbessant.org/tools-for-innovation-and-entrepreneurship/

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