Models of innovation

Traditional arguments about innovation have centred on two schools of thought. On the one hand, the social deterministic school argued that innovations were the result of a combination of external social factors and influences, such as demographic changes, economic influences and cultural changes. The argument was that *when* the conditions were right, innovations would occur. On the other hand, the individualistic school argued that innovations were the result of unique individual talents and such innovators are born. Closely linked to the individualistic theory is the important role played by serendipity; more on this later.

Over the past 10 years, the literature on what drives innovation has tended to divide into two schools of thought: the market-based view and the resource-based view. The market-based view argues that market conditions provide the context that facilitates or constrains the extent of firm innovation activity (Porter, 1980, 1985; Slater and Narver, 1994). The key issue here, of course, is the ability of firms to recognise opportunities in the marketplace. Cohen and Levinthal (1990) and Trott (1998) would argue that few firms have the ability to scan and search their environments effectively.

The resource-based view of innovation considers that a market-driven orientation does not provide a secure foundation for formulating innovation strategies for markets that are dynamic and volatile; rather a firm's own resources provide a much more stable context in which to develop its innovation activity and shape its markets in accordance with its own view (Conner and Prahalad, 1996; Eisenhardt and Martin, 2000; Grant, 1996; Penrose, 1959; Prahalad and Hamel, 1990; Wernerfelt, 1984, 1995). The resource-based view of innovation focuses on the firm and its resources, capabilities and skills. It argues that when firms have resources that are valuable, rare and not easily copied they can achieve a sustainable competitive advantage – frequently in the form of innovative new products. Chapter 6 offers a more detailed overview of the **resource-based theory of the firm**.

Serendipity

Many studies of historical cases of innovation have highlighted the importance of the unexpected discovery. The role of serendipity or luck is offered as an explanation. As we have seen, this view is also reinforced in the popular media. It is, after all, everyone's dream that they will accidentally uncover a major new invention leading to fame and fortune.

On closer inspection of these historical cases, serendipity is rare indeed. After all, in order to recognise the significance of an advance, one would need to have some

prior knowledge in that area. Most discoveries are the result of people who have had a fascination with a particular area of science or technology and it is following extended efforts on their part that advances are made. Discoveries may not be expected, but in the words of Louis Pasteur, 'chance favours the prepared mind'.

Linear models

It was US economists after the Second World War who championed the linear model of science and innovation. Since then, largely because of its simplicity, this model has taken a firm grip on people's views on how innovation occurs. Indeed, it dominated science and industrial policy for 40 years. It was only in the 1980s that management schools around the world began seriously to challenge the sequential linear process. The recognition that innovation occurs through the interaction of the science base (dominated by universities and industry), technological development (dominated by industry) and the needs of the market was a significant step forward (see Figure 1.4). The explanation of the interaction of these activities forms the basis of models of innovation today. Students may also wish to note that there is even a British Standard (BS7000), which sets out a design-centred model of the process (BSI, 2008).

There is, of course, a great deal of debate and disagreement about precisely what activities influence innovation and, more importantly, the internal processes that affect a company's ability to innovate. Nonetheless, there is broad agreement that it is the linkages between these key components that will produce successful innovation. Importantly, the devil is in the detail. From a European perspective, an area that requires particular attention is the linkage between the science base and technological development. The European Union (EU) believes that European universities have not established effective links with industry, whereas in the United States universities have been working closely with industry for many years.

As explained above, the innovation process has traditionally been viewed as a sequence of separable stages or activities. There are two basic variations of this model for product innovation. First, and most crudely, there is the technology-driven model (often referred to as technology push) where it is assumed that scientists make unexpected discoveries, technologists apply them to develop product ideas and engineers and designers turn them into prototypes for testing. It is left to manufacturing to devise ways of producing the products efficiently. Finally, marketing and sales will promote the product to the potential consumer. In this model, the marketplace was a passive recipient for the fruits of R&D. This technology-push

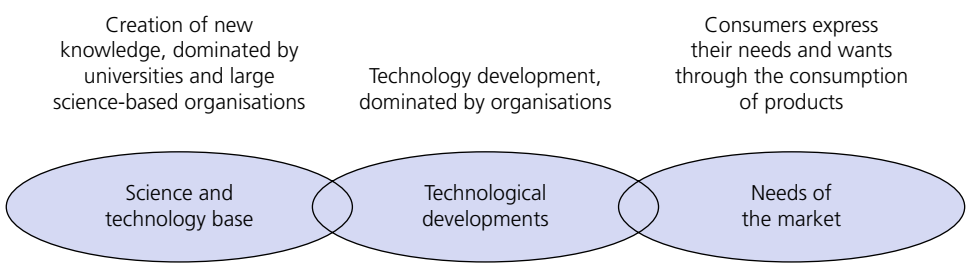

Figure 1.4 Conceptual framework of innovation

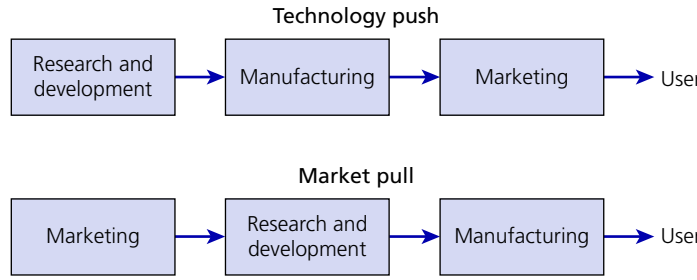

Figure 1.5 **Linear models of innovation**

model dominated industrial policy after the Second World War (see Figure 1.5). Whilst this model of innovation can be applied to a few cases, most notably the pharmaceutical industry, it is not applicable in many other instances; in particular where the innovation process follows a different route.

It was not until the 1970s that new studies of actual innovations suggested that the role of the marketplace was influential in the innovation process (von Hippel, 1978). This led to the second linear model, the market-pull model of innovation. The customer need-driven model emphasises the role of marketing as an initiator of new ideas resulting from close interactions with customers. These, in turn, are conveyed to R&D for design and engineering and then to manufacturing for production. In fast-moving consumer goods industries the role of the market and the customer remains powerful and very influential. The managing director of McCain Foods argues that knowing your customer is crucial to turning innovation into profits:

> *It's only by understanding what the customer wants that we can identify the innovative opportunities. Then we see if there's technology that we can bring to bear on the opportunities that exist. Being innovative is relatively easy – the hard part is ensuring your ideas become commercially viable.*
>
> (Murray, 2003)

Simultaneous coupling model

Whether innovations are stimulated by technology, customer need, manufacturing or a host of other factors, including competition, misses the point. The models above concentrate on what is driving the downstream efforts rather than on *how* innovations occur (Galbraith, 1982). The linear model is able to offer only an explanation of *where* the initial stimulus for innovation was born, that is, where the trigger for the idea or need was initiated. The simultaneous coupling model shown in Figure 1.6

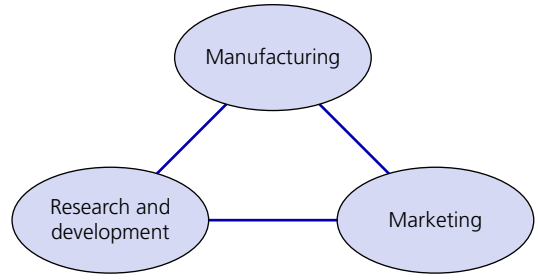

Figure 1.6 **The simultaneous coupling model**

suggests that it is the result of the simultaneous coupling of the knowledge within all three functions that will foster innovation. Furthermore, the point of commencement for innovation is not known in advance.

Architectural innovation

Henderson and Clark (1990) divide technological knowledge along two new dimensions: *knowledge of the components* and knowledge of the linkage between them, which they called *architectural knowledge*. The result is four possible types of innovation: incremental, modular, radical and architectural innovation. Essentially, they distinguish between the components of a product and the ways they are integrated into the system, that is, the product architecture, which they define as innovations that change the architecture of a product without changing its components. Prior to the Henderson and Clark model, the radical/incremental dimension suggests that incumbents will be in a better position if the innovation is incremental, since they can use existing knowledge and resources to leverage the whole process. New entrants, on the other hand, will have a large advantage if the innovation is radical because they will not need to change their knowledge background. Furthermore, incumbents struggle to deal with radical innovation both because they operate under a managerial mindset constraint and because, strategically, they have less of an incentive to invest in the innovation if it will cannibalise their existing products.

Kodak illustrates this well. The company dominated the photography market over many years and, throughout this extended period, all the incremental innovations solidified its leadership. As soon as the market experienced a radical innovation – the entrance of digital technology – Kodak struggled to defend its position against the new entrants. The new technology required different knowledge, resources and mindsets. This pattern of innovation is typical in mature industries. This concept is explored further in Chapter 7.

Interactive model

The interactive model develops this idea further (see Figure 1.7) and links together the technology-push and market-pull models. It emphasises that innovations occur as the result of the interaction of the marketplace, the science base and the organisation's capabilities. Like the coupling model, there is no explicit starting point. The use of information flows is used to explain how innovations transpire and that they can arise from a wide variety of points.

Whilst still oversimplified, this is a more comprehensive representation of the innovation process. It can be regarded as a logically sequential, though not necessarily continuous, process that can be divided into a series of functionally distinct but interacting and interdependent stages (Rothwell and Zegveld, 1985). The overall innovation process can be thought of as a complex set of communication paths over which knowledge is transferred. These paths include internal and external linkages. The innovation process outlined in Figure 1.7 represents the organisation's capabilities and its linkages with both the marketplace and the science base. Organisations that are able to manage this process effectively will be successful at innovation.

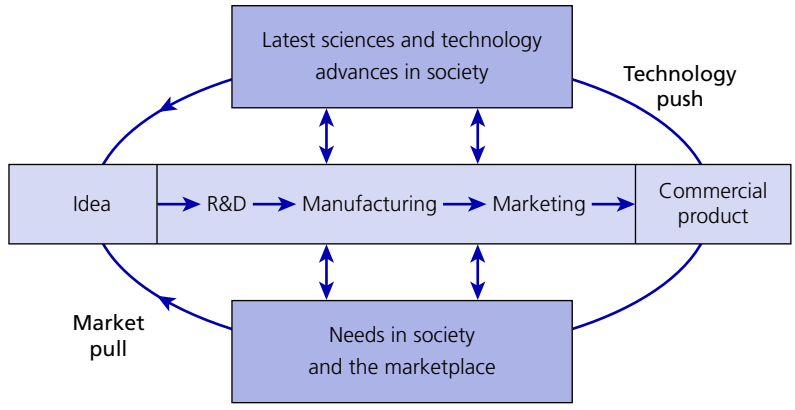

Figure 1.7 **Interactive model of innovation**

At the centre of the model are the organisational functions of R&D, engineering and design, manufacturing and marketing and sales. Whilst, at first, this may appear to be a linear model, the flow of communication is not necessarily linear. There is provision for feedback. Also, linkages with the science base and the marketplace occur between all functions, not just with R&D or marketing. For example, as often happens, it may be the manufacturing function that initiates a design improvement that leads to the introduction of either a different material or the eventual development by R&D of a new material. Finally, the generation of ideas is shown to be dependent on inputs from three basic components (as outlined in Figure 1.4): technological developments; the needs of the marketplace; the science and technology base. Recent research confirms the validity of this concept today. Research by Stefano et al., (2012) updates the debate on the sources of innovation. They show and confirm that:

- the market is a major source of innovation;
- firm competences enable firms to match technology with demand; and
- external and internal sources of innovations are important.

All of which are necessary for value creation and capture.