CHAPTER 5

Sources of innovation

5.1 Where do innovations come from?

Where do innovations come from? There's a good chance that asking that question will conjure images like that of Archimedes, jumping up from his bath and running down the street, so enthused by the desire to tell the world his discovery that he forgot to get dressed. Or Newton, dozing under the apple tree until a falling apple helped kick his brain into thinking about the science of gravity. Or James Watt, also asleep, until woken by the noise of a boiling kettle. Such 'Eureka' moments are certainly a part of innovation folklore – and they underline the importance of flashes of insight which make new connections. They form the basis of the cartoon model of innovation which usually involves thinking bubbles and flashing light bulbs. And from time to time they do happen, for example, Percy Shaw's observation of the reflection in a cat's eye at night led to the development of one of the most widely used road-safety innovations in the world. Or George de Mestral, returning home from a walk in the Swiss Alps noticing the way plant burrs became attached to his dog's fur, found the inspiration behind Velcro fasteners. The myths of innovation – Scott Berkun, who worked on developing Internet Explorer, discusses Eureka moments and the reality of how innovations happen. Video of a lecture to Carnegie Mellon University (http://www.youtube.com/watch?v=m6gaj6huCp0).

But of course there is much more to it than that – as we saw in Chapter 2. Innovation is a process of taking ideas forward, revising and refining them, weaving the different strands of 'knowledge spaghetti' together towards a useful product, process or service. Triggering that process is not just about occasional flashes of inspiration – innovation comes from many other directions, and if we are to manage it effectively we need to remind ourselves of this diversity. Figure 5.1 indicates the wide range of stimuli which could be relevant to kick-starting the innovation journey, and we will explore some of the important triggers in this chapter.

5.2 Knowledge push . . .

One obvious source of innovation is the possibilities which emerge as a result of scientific research. From the earliest days curious men and women have experimented and explored the world around them and various Greek philosophers, Roman engineers, Egyptian astronomers, Persian mathematicians, Chinese doctors and a host of others laid the foundations of what we loosely call 'science'. Although some of the earliest work was something of a solo act we should remember that from a very early stage this process of exploring and codifying at the frontiers of knowledge became a systematic activity – and one which involved a wide network of people sharing their ideas. We sometimes think that organized science is a child of the twentieth century but a quick look at the ways in which the medieval Guilds managed the processes of knowledge acquisition, extension and diffusion reminds us that this is

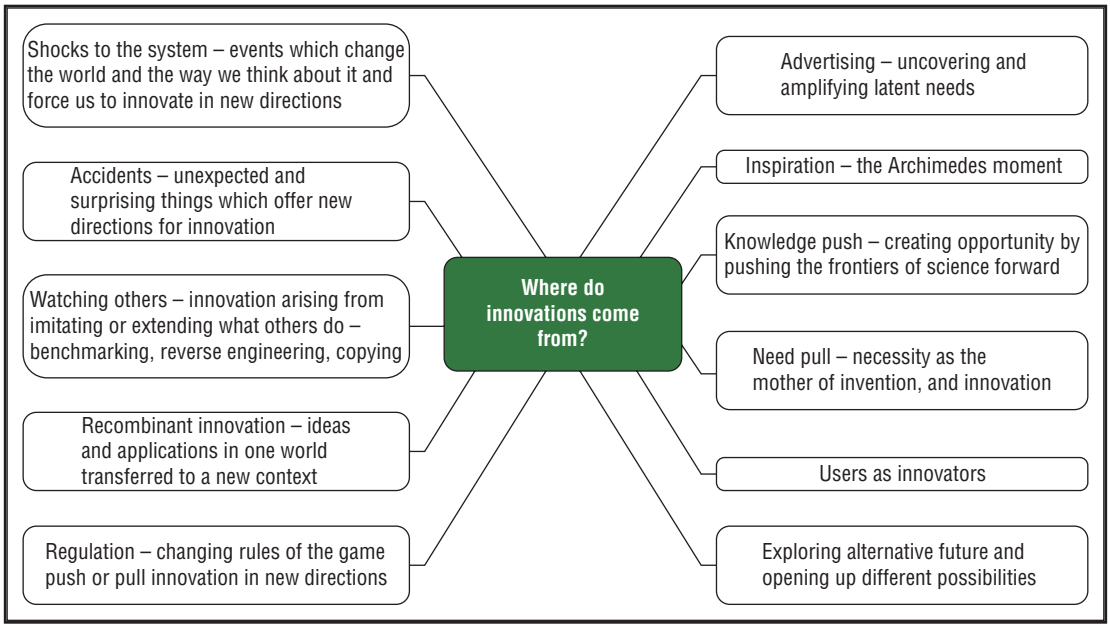

FIGURE 5.1: Where do innovations come from?

a well-established pattern. The fame of key cities like Venice or regions like Flanders owed as much to the organized scientific knowledge in fields like gun-making or textile manufacture as to the entrepreneurial activities of traders and merchants.

In the twentieth century the rise of the modern large corporation brought with it the emergence of the research laboratory as a key instrument of progress. Bell Labs, ICI, Bayer, BASF, Philips, Ford, Western Electric, Du Pont – all were founded in the 1900s as powerhouses of ideas.[1] They produced a steady stream of innovations which fed rapidly growing markets for automobiles, consumer electrical products, synthetic materials, industrial chemicals – and the vast industrial complexes needed to fight two major wars. Their output wasn't simply around product innovation – many of the key technologies underpinning process innovations, especially around the growing field of automation and information/communications technology also came from such organized R&D effort. Table 5.1 gives some examples of science-push innovations. The Corning case study provides an example of a long-term knowledge-push innovator.

TABLE 5.1 Some examples of knowledge-push innovations

Nylon	Radar	Antibiotics
Microwave	Synthetic rubber	Cellular telephony
Medical scanners	Photocopiers	Hovercraft
Fibre optic cable	Digital imaging	Transistor/integrated circuits

It's important to see the pattern which such activity established in terms of innovation. Organized R&D became a systematic commitment of specialist staff, equipment, facilities and resources targeted at key technological problems or challenges. The aim was to explore, but much of that exploration was elaborating and stretching trajectories that were established as a result of occasional breakthroughs. So the leap in technology, which the invention of synthetic materials like nylon or polyethylene represented, was followed by innumerable small-scale developments around and along that path. The rise of 'big Pharma' – the huge global pharmaceutical industry – was essentially about large R&D expenditure, but much of it spent on development and elaboration punctuated by the occasional breakthrough into 'blockbuster' drug territory. The computer and other industries that depend on semiconductors have become linked to a long-term trajectory, which followed from the early 'breakthrough' years of the industry. Moore's law (named after one of the founders of Intel) essentially sets up a trajectory which shapes and guides innovation based on the idea that the size will shrink and the power will increase by a factor of two every two years.[2] This affects memory, processor speed, display drivers and various other components, which in turn drives the rate of innovation in computers, digital cameras, mobile phones and thousands of other applications.

This can apply to products or processes: in both cases the key characteristics become stabilized and experimentation moves to getting the bugs out and refining the dominant design. For example, the nineteenth-century chemical industry moved from producing soda ash (an essential ingredient in making soap, glass and a host of other products) from the earliest days where it was produced by burning vegetable matter through to a sophisticated chemical reaction which was carried out in a batch process (the Leblanc process), which was one of the drivers of the Industrial Revolution. This process dominated for nearly a century but was in turn replaced by a new generation of continuous processes that used electrolytic techniques and which originated in Belgium where they were developed by the Solvay brothers. Moving to the Leblanc process or the Solvay process did not happen overnight – it took decades of work to refine and improve the process, and to fully understand the chemistry and engineering required to get consistent high quality and output.

The same pattern can be seen in products. For example, the original design for a camera is something which goes back to the early nineteenth century and – as a visit to any science museum will show – involved all sorts of ingenious solutions. The dominant design gradually emerged with an architecture which we would recognize today – shutter and lens arrangement, focusing principles, back plate for film or plates, etc. But this design was then modified still further, for example, with different lenses, motorized drives, flash technology, and, in the case of George Eastman's work, to creating a simple and relatively

BOX 5.1 The ubiquitous tale of polyethylene

Like it or loathe it, polythene is one of the key material innovations to come out of the twentieth century. It is the world's 'favourite' plastic measured in terms of consumption – 60 million tonnes/year find their way into films, plastic bags, packaging, cosmetics and a host of other applications. Discovered by accident by chemists working at ICI in the UK in 1933 the original low-density polyethylene product has gone through a classic pattern of incremental and occasional breakthrough innovation giving rise to new products like high-density polyethylene and film and to process innovations such as the Phillips catalysis process which enabled better yields in production.

'idiot-proof' model camera (the Box Brownie) which opened up photography to a mass market. More recent development has seen a similar fluid phase around digital imaging devices.

This idea of occasional breakthroughs followed by extended periods of exploring and elaboration along those paths has been studied and mapped by a number of writers.[3,4] It's a common pattern and one which helps us deal with the key management question of how and where to direct our search activity for innovation – a theme we will return to shortly.

5.3 Need pull . . .

Knowledge creation provides a push, creates an 'opportunity field' which sets up possibilities for innovation. But – as we saw in Chapter 2 – we know from innumerable examples that simply having a bright idea is no guarantee of adoption. The American writer Ralph Waldo Emerson is supposed to have said '*build a better mousetrap and the world will beat a path to your door*'* – but the reality is that there are plenty of bankrupt mousetrap salesmen around! Knowledge push creates a field of possibilities – but not every idea finds successful application and one of the key lessons is that innovation requires some form of demand if it is to take root. Bright ideas are not, in themselves, enough – they may not meet a real or perceived need and people may not feel motivated to change.

We should recognize that another key driver of innovation is need – the complementary pull to the knowledge push. In its simplest form it is captured in the saying that 'necessity is the Mother of invention' – innovation is often the response to a real or perceived need for change. Basic needs – for shelter, food, clothing, security – led early innovation as societies evolved and we are now at a stage where the need pull operates on more sophisticated higher level needs but via the same process. In innovation management the emphasis moves to ensuring we develop a clear understanding of needs and finding

VIEWS FROM THE FRONT LINE

Two hundred years ago Churchill Potteries began life in the UK making a range of crockery and tableware. That they are still able to do so today, despite a turbulent and highly competitive global market, says much for the approach that they have taken to ensure a steady stream of innovation. Chief Executive Andrew Roper highlights the way in which listening to users and understanding their needs has changed the business. '*We have taken on a lot of service disciplines, so you could think of us as less of a pure manufacturer and more as a service company with a manufacturing arm*'. Staff spend a significant proportion of their time talking to chefs, hoteliers and others. '. . . *sales, marketing and technical people spend far more of their time than I could ever have imagined checking out what happens to the product in use and asking the customer, professional or otherwise, what they really want next*'.

Source: Peter Marsh (2008) Ingredients for success on a plate. *Financial Times*, 26 March, p. 16.

* Ralph Waldo Emerson, '*If a man has good corn, or wood, or boards, or pigs to sell, or can make better chairs or knives, crucibles or church organs than anybody else, you will find a broad-beaten road to his home, though it be in the woods.*'

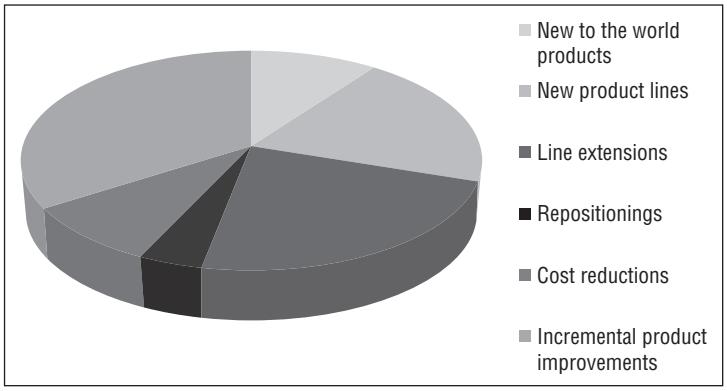

FIGURE 5.2: Types of new product
Source: Based on **Griffin, A.** (1997) PDMA research on new product development practices. *Journal of Product Innovation Management,* **14,** 429

ways to meet those needs. For example, Henry Ford was able to turn the luxury plaything that was the early automobile into something which became 'a car for Everyman', whilst Procter & Gamble began a business meeting needs for domestic lighting (via candles) and moved across into an ever-widening range of household requirements from soap to nappies to cleaners, toothpaste and beyond.

Just as the knowledge-push model involves a mixture of occasional breakthrough followed by extensive elaboration on the basic theme, searching around the core trajectory, so the same is true of need. Occasionally it involves a new-to-the-world idea which offers an innovative way of meeting a need – but mostly it is elaboration and differentiation. Various attempts have been made to classify product innovations in terms of their degree of novelty, and whilst the numbers and percentages vary slightly, the underlying picture is clear – there are very few 'new-to-the-world' products and very many extensions, variations and adaptations around those core ideas.[5,6] Figure 5.2 indicates a typical breakdown – and we could construct a similar picture for process innovations.

Understanding buyer/adopter behaviour has become a key theme in marketing studies since it provides us with frameworks and tools for identifying and understanding user needs[7] (we return to this theme in Chapter 9). Advertising and branding play a key role in this process – essentially using psychology to tune into – or even stimulate and create – basic human needs.[8,9] Much recent research has focused on detailed ethnographic studies of what people actually do and how they really use products and services – using the same approaches which anthropologists use to study strange new tribes to uncover hidden and latent needs[10] (see Case study 5.1 for an example). An example of using ethnographic methods to help get closer to user needs can be found in the case study of Tesco's Fresh & Easy store design in the USA.

Need-pull innovation is particularly important at mature stages in industry or product life cycles when there is more than one offering to choose from – competing depends on differentiating on the basis of needs and attributes, and/or segmenting the offering to suit different adopter types. There are differences between business-to-business markets (where emphasis is on needs amongst a shared group, e.g. along a supply chain) and consumer markets (where the underlying need may be much more basic, e.g. food, shelter, mobility, and appeals to a much greater number of people). Importantly there is also a 'bandwagon' effect – as more people adopt so the innovation becomes modified to take on board their needs – and the process accelerates.[11]

CASE STUDY 5.1

Understanding user needs in Hyundai

One of the problems facing global manufacturers is how to tailor their products to suit the needs of local markets. For Hyundai this has meant paying considerable attention to getting deep insights into customer needs and aspirations – an approach which they used to good effect in developing the 'Santa Fe', reintroduced to the US market in 2007. The headline for their development programme was 'touch the market' and they deployed a number of tools and techniques to enable it. For example, they visited an ice rink and watched an Olympic medallist skate around to help them gain an insight into the ideas of grace and speed which they wanted to embed in the car. This provided a metaphor – 'assertive grace' – which the development teams in Korea and the US were able to use.

Analysis of existing vehicles suggested some aspects of design were not being covered, for example, many sport/utility vehicles (SUVs) were rather 'boxy' so there was scope to enhance the image of the car. Market research suggested a target segment of 'glamour mums' who would find this attractive and the teams then began an intensive study of how this group lived their lives. Ethnographic methods looked at their homes, their activities and their lifestyles – for example, team members spent a day shopping with some target women to gain an understanding of their purchases and what motivated them. The list of key motivators that emerged from this shopping study included durability, versatility, uniqueness, child-friendly and good customer service from knowledgeable staff. Another approach was to make all members of the team experience driving routes around southern California, making journeys similar to those popular with the target segment and in the process getting first-hand experience of comfort, features and fixtures inside the car.

Source: Kluter, H. and D. Mottram (2007) Hyundai uses 'Touch the market' to create clarity in product concepts. *PDMA Visions*, **31**, 16–19.

Of course needs aren't just about external markets for products and services – we can see the same phenomenon of need pull working inside the business, as a driver of process innovation. 'Squeaking wheels' and other sources of frustration provide rich signals for change – and this kind of innovation is often something that can engage a high proportion of the workforce who experience these needs first hand. (The successful model of '*kaizen*' which underpins the success of firms like Toyota is fundamentally about sustained, high-involvement incremental process innovation along these lines.[12]). *Kaizen* provided the basic philosophy behind the 'total quality management' movement in the 1980s, the 'business process re-engineering' ideas of the 1990s and the current widespread application of concepts based on the idea of 'lean thinking' – essentially taking waste out of existing processes.[13–15]

Once again we can see the pattern – most of the time such innovation is about 'doing what we do better' but occasionally it involves a major leap. The example of glassmaking (Case study 5.2) provides a good illustration – for decades the need to produce smooth flat glass for windows had been met by a steady stream of innovations around the basic trajectory of grinding and polishing. There is plenty of scope for innovation in machinery, equipment, working practices, etc. – but such innovation tends to meet with diminishing returns as some of the fundamental bottlenecks emerge – the limits of how much you can improve an existing process. Eventually the stage is set for a breakthrough – like the emergence

CASE STUDY 5.2

Innovation in the glass industry

It's particularly important to understand that change doesn't come in standard sized jumps. For much of the time it is essentially incremental, a process of gradual improvement over time on dimensions like price, quality, choice, etc. For long periods of time nothing much shifts in either product offering or the way in which this is delivered (product and process innovation is incremental). But sooner or later someone somewhere will come up with a radical change which upsets the apple cart.

For example, the glass window business has been around for at least 600 years and is – since most houses, offices, hotels and shops have plenty of windows – a very profitable business to be in. But for most of those 600 years the basic process for making window glass hasn't changed. Glass is made in approximately flat sheets which are then ground down to a state where they are flat enough for people to see through them. The ways in which the grinding takes place have improved – what used to be a labour-intensive process became increasingly mechanized and even automated, and the tools and abrasives became progressively more sophisticated and effective. But underneath the same core process of grinding down to flatness was going on.

Then in 1952 Alastair Pilkington working in the UK firm of the same name began working on a process which revolutionized glass making for the next 50 years. He got the idea whilst washing up when he noticed that the fat and grease from the plates floated on the top of the water – and he began thinking about producing glass in such a way that it could be cast to float on the surface of some other liquid and then allowed to set. If this could be accomplished it might be possible to create a perfectly flat surface without the need for grinding and polishing.

Five years, millions of pounds and over 100 000 tonnes of scrapped glass later the company achieved a working pilot plant and a further two years on began selling glass made by the float glass process. The process advantages included around 80% labour and 50% energy savings plus those which came about because of the lack of need for abrasives, grinding equipment, etc. Factories could be made smaller and the overall time to produce glass dramatically cut. So successful was the process that it became – and still is – the dominant method for making flat glass around the world.

of float glass – which then creates new space within which incremental innovation along a new trajectory can take place.

Sometimes the increase in the urgency of a need or the extent of demand can have a forcing effect on innovation – the example of wartime and other crises supports this view. For example, the demand for iron and iron products increased hugely in the Industrial Revolution and exposed the limitations of the old methods of smelting with charcoal – it created the pull which led to developments like the Bessemer converter. In similar fashion the emerging energy crisis with oil prices reaching unprecedented levels has created a significant pull for innovation around alternative energy sources – and an investment boom for such work.

It's also important to recognize that innovation is not always about commercial markets or consumer needs. There is also a strong tradition of social need providing the pull for new products, processes and

CASE STUDY 5.3

The emergence of microfinance

One of the biggest problems facing people living below the poverty line is the difficulty of getting access to banking and financial services. As a result they are often dependent on moneylenders and other unofficial sources – and are often charged at exorbitant rates if they do borrow. This makes it hard to save and invest – and puts a major barrier in the way of breaking out of this spiral. Awareness of this problem led Muhammad Yunus, Head of the Rural Economics Program at the University of Chittagong, to launch a project to examine the possibility of designing a credit delivery system to provide banking services targeted at the rural poor. In 1976 the Grameen Bank Project (Grameen means 'rural' or 'village' in Bangla language) was established, aiming to

- extend banking facilities to the poor;
- eliminate the exploitation of the poor by money lenders;
- create opportunities for self-employment for unemployed people in rural Bangladesh;
- offer the disadvantaged an organizational format which they can understand and manage by themselves;
- reverse the age-old vicious circle of 'low income, low saving and low investment', into virtuous circle of 'low income, injection of credit, investment, more income, more savings, more investment, more income'.

The original project was set up in Jobra (a village adjacent to Chittagong University) and some neighbouring villages and ran during 1976–79. The core concept was of 'micro-finance' – enabling people (and a major success was with women) to take tiny loans to start and grow tiny businesses. With the sponsorship of the central bank of the country and support of the nationalized commercial banks, the project was extended to Tangail district (a district north of Dhaka, the capital city of Bangladesh) in 1979. Its further success there led to the model being extended to several other districts in the country and in 1983 it became an independent bank as a result of government legislation. Today Grameen Bank is owned by the rural poor whom it serves. Borrowers of the bank own 90% of its shares, while the remaining 10% is owned by the government. It now serves over 5 million clients, and has enabled 10 000 families to escape the poverty trap every month. Younis received the Nobel Peace Prize for this innovation in 2006.

services. A recent example was the development of innovations around the concept of 'micro-finance' – see Case study 5.3.

5.4 Whose needs?

When considering need pull as a source of innovation we should remember that one size doesn't fit all. Differences amongst potential users can also provide rich triggers for innovation in new directions. Disruptive innovation – a theme to which we will return later – is often associated with entrepreneurs

working at the fringes of a mainstream market and finding groups whose needs are not being met. It poses a problem for existing incumbents because the needs of such fringe groups are not seen as relevant to their 'mainstream' activities – and so they tend to ignore them or to dismiss them as not being important. But working with these users and their different needs creates different innovation options – and sometimes what has relevance for the fringe begins to be of interest to the mainstream. Clayton Christensen, in his many studies of such 'disruptive innovation', shows this has been the pattern across industries as diverse as computer disk drives, earth-moving equipment, steel making and low-cost air travel.[16]

For much of the time there is stability around markets where innovation of the 'do better' variety takes place and is well managed. Close relationships with existing customers are fostered and the system is configured to deliver a steady stream of what the market wants – and often a great deal more! (What he terms 'technology overshoot' is often a characteristic of this, where markets are offered more and more features which they may not ever use or place much value on but which come as part of the package.)

But somewhere else there is another group of potential users who have very different needs – usually for something much simpler and cheaper – which will help them get something done. For example the emergent home computer industry began amongst a small group of hobbyists who wanted simple computing capabilities at a much lower price than was available from the mini-computer suppliers. In turn the builders of those early PCs wanted disk drives which were much simpler technologically but – importantly – much cheaper and so were not really interested in what the existing disk drive industry had to offer. It was too high tech, massively overengineered for their needs and, most important, much too expensive.

Although they approached the existing drive makers none of them was interested in making such a device – not surprisingly since they were doing very comfortably supplying expensive high-performance equipment to an established mini-computer industry. Why should they worry about a fringe group of hobbyists as a market? Steve Jobs described in an interview their attempts to engage interest, '*. . . So we went to Atari and said, "Hey, we've got this amazing thing, even built with some of your parts, and what do you think about funding us? Or we'll give it to you. We just want to do it. Pay our salary, we'll come work for you." And they said, "No." So then we went to Hewlett-Packard, and they said, "Hey, we don't need you. You haven't got through college yet."*'

Consequently the early PC makers had to look elsewhere – and found entrepreneurs willing to take the risks, and experiment with trying to come up with a product which met their needs. It didn't happen overnight and there were plenty of failures on the way – and certainly the early drives were very poor performers in comparison with what was on offer in the mainstream industry. But gradually the PC market grew, moving from hobbyists to widespread home use and from there – helped by the emergence and standardization of the IBM PC – to the office and business environment. And as it grew and matured so it learned and the performance of the machines became much more impressive and reliable – but coming from a much lower cost base than mini-computers. The same thing happened to the disk drives within them – the small entrepreneurial firms who began in the game grew and learned and became large suppliers of reliable products which did the job – but at a massively lower price.

Eventually the fringe market, which the original disk drive makers had ignored because it didn't seem relevant or important enough to worry about, grew to dominate – and by the time they realized this it was too late for many of them. The best they could hope for would be to be late entrant imitators, coming from behind and hoping to catch up.

This pattern is essentially one of disruption – the rules of the game changed dramatically in the marketplace with some new winners and losers. Figure 5.3 shows the transition where the new market and

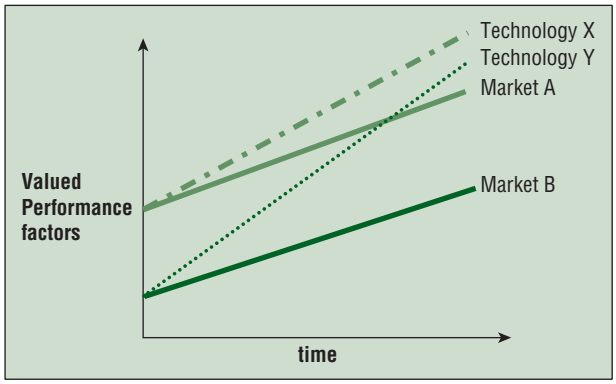

FIGURE 5.3: The pattern of disruptive innovation

suppliers gradually take over from the existing players. It can be seen in many industries – think about the low-cost airlines, for example. Here the original low-cost players didn't go head to head with the national flag carriers who offered the best routes, high levels of service and prime airport slots – all for a high price. Instead they sought new markets at the fringe – users who would accept a much lower level of service (no food, no seat allocation, no lounges, no frills at all), but for a basic safe flight would pay a much lower price. As these new users began to use the service and talk about it, so the industry grew and came to the attention of existing private and business travellers who were interested in lower cost flights at least for short-haul, because it met their needs for a 'good enough' solution to their travel problem. Eventually the challenge hit the major airlines who found it difficult to respond because of their inherently much higher cost structure – even those like BA and KLM, which set up low-cost subsidiaries, found they were unable to manage with the very different business model that low-cost flying involved.

Low-end market disruption of this kind is a potent threat – think what a producer in China might do to an industry like pump manufacturing if it began to offer a simple, low-cost 'good enough' household pump for $10 instead of the high-tech high-performance variants available from today's industry at prices 10 to 50 times as high. Or how manufacturers of medical devices like asthma inhalers will need to respond once they have come off patent – a challenge already being posed in markets such as generic pharmaceuticals.

But it is also important to recognize that similar challenges to existing market structures can happen through 'high-end' disruption – as Utterback points out.[17] Where a group of users requires something at a higher level than the current performance this can create new products or services which then migrate to mainstream expectations – for example, in the domestic broadband or mobile telephone markets.

Disruptive innovation examples of this kind focus attention on the requirement to look for needs which are not being met, or poorly met or sometimes where there is an overshoot.[18] Each of these can provide a trigger for innovation – and often involve disruption because existing players don't see the different patterns of needs. This thinking is behind, for example, the concept of 'Blue Ocean strategy'[19] which argues for firms to define and explore uncontested market space by spotting latent needs that are not well served. See Case study 5.4.

Over-served markets might include those for office software or computer operating systems where the continuing trend towards adding more and more features and functionality has possibly outstripped

CASE STUDY 5.4

Gaining competitive edge through meeting unserved needs

An example of the 'Blue Ocean' approach is the Nintendo Wii which has carved a major foothold in the lucrative computer games market – a business which is in fact bigger than Hollywood in terms of overall market value. The Wii console is not a particularly sophisticated piece of technology – compared to rivals Sony PS3 or Microsoft Xbox it has less computing power, storage or other features and the games graphics are much lower resolution than major sellers like *Grand Theft Auto*. But the key to the phenomenal success of the Wii has been its appeal to an under-served market. Where computer games were traditionally targeted at boys the Wii extends – by means of a simple interface wand – interest to all members of the family. Add-ons to the platform like the Wii board for keep fit and other applications mean that market reach extends further, for example to include the elderly or patients suffering the after-effects of stroke.

Nintendo has performed a similar act of opening up the marketplace with its DS handheld device – again by targeting unmet needs across a different segment of the population. Many DS users are middle-aged or retired and the best-selling games are for brain training and puzzles.

user needs for or ability to use them all. Linux and open office applications such as 'Star Office' represent simpler, 'good enough' solutions to the basic needs of users – and are potential disruptive innovations for players like Microsoft.

The role of 'emerging markets'

On a global scale there is growing interesting in what have been termed the 'bottom of the pyramid' (BoP) markets.[20] This term comes from a book by C.K. Prahalad who argued that 80% of the world's population lived on incomes below the poverty line – around $2 a day – and therefore did not represent markets in the traditional sense. But seeing them as a vast reservoir of under-served needs opens up a significant challenge and opportunity for innovation (see Table 5.2 for some examples of the challenge and opportunities).

Solutions to meeting these needs will have to be highly innovative but the prize is equally high – access to a high-volume low-margin marketplace. For example realized the potential of selling its shampoos and other cosmetic products not in 250ml bottles (which were beyond the price range of most BoP customers) but in single sachets. As G. Gilbert Cloyd, Chief Technology Officer, Procter & Gamble commented in a *Business Week* interview, '*. . . We've put more emphasis on serving an even broader base of consumers. We have the goal of serving the majority of the world's consumers someday. Today, we probably serve about 2 billion-plus consumers around the globe, but there are 6 billion consumers out there. That has led us to put increased emphasis on low-end markets and in mid- and low-level pricing tiers in developed geographies. That has caused us to put a lot more attention on the cost aspects of our products . . .*'

Prahalad's original book contains a wide range of case examples where this is beginning to happen in fields as diverse as healthcare, agriculture, consumer white goods and home improvements.[19] Subsequently there has been significant expansion of innovative activity in these emerging market areas – driven in part by a realization that the major growth in global markets will come from regions with a

TABLE 5.2

Challenging assumptions about the bottom of the pyramid

Assumption	Reality – and innovation opportunity
The poor have no purchasing power and do not represent a viable market	Although low income, the sheer scale of this market makes it interesting. Additionally the poor often pay a premium for access to many goods and services, e.g. borrowing money, clean water, telecommunications and basic medicines, because they cannot address 'mainstream' channels like shops and banks. The innovation challenge is to offer low-cost, low-margin but high-quality goods and services across a potential market of 4 billion people
The poor are not brand-conscious	Evidence suggests a high degree of brand and value consciousness – so if an entrepreneur can come up with a high-quality low cost solution it will be subject to hard testing in this market. Learning to deal with this can help migrate to other markets – essentially the classic pattern of 'disruptive innovation'
The poor are hard to reach	By 2015 there are likely to be nearly 400 cities in the developing world with populations over 1 million and 23 with over 10 million. 30–40% of these will be poor – so the potential market access is considerable. Innovative thinking around distribution – via new networks or agents (such as the women village entrepreneurs used by Hindustan Lever in India or the 'Avon ladies' in rural Brazil) – can open up untapped markets
The poor are unable to use and not interested in advanced technology	Experience with PC kiosks, low-cost mobile phone sharing and access to the Internet suggests that rates of take-up and sophistication of use are extremely fast amongst this group. In India the e-choupal (e-meeting place) set up by software company ITC enabled farmers to check prices for their products at the local markets and auction houses. Very shortly after that the same farmers were using the web to access prices of their soybeans at the Chicago Board of Trade and strengthen their negotiating hand!

Source: Prahalad, C.K. (2006) *The Fortune at the Bottom of the Pyramid*, Wharton School Publishing, New Jersey.

high BoP profile. There are several video clips accompanying the book *The Fortune at the Bottom of the Pyramid,* available from Wharton School Publishing. In addition there is a YouTube clip of an interview with C.K. Prahalad at http://www.youtube.com/watch?v=ew2zQnUh_uw.

Importantly many companies are actively using 'bottom of pyramid' markets as places to search for weak signals of potentially interesting new developments. For example, Nokia has been sending scouts to study how people in rural Africa and India are using mobile phones and the potential for new services which this might offer, whilst the pharmaceutical firm Novo Nordisk has been learning about low-cost provision of diabetes care in Tanzania as an input to a better understanding of how such models might be developed for different regions.[21,22]. We'll return to this theme when we look at the idea of 'extreme users' as sources of innovation.

CASE STUDY 5.5

Learning from extreme conditions

The Aravind Eye Care System has become the largest eye care facility in the world with its headquarters in Madurai, India. Its doctors perform over 200 000 cataract operations – and with such experience have developed state-of-the art techniques to match their excellent facilities. Yet the cost of these operations runs from $50 to $300, with over 60% of patients being treated free. Despite only 40% paying customers the company is highly profitable and the average cost per operation (across free and paying patients) at $25 is the envy of most hospitals around the world.

Aravind was founded by Dr G. Venkataswamy in 1976 on his retirement from the Government Medical College and represents the result of a passionate concern to eradicate needless blindness in the population. Within India there are an estimated 9 million (and worldwide 45 million) people who suffer from blindness which could be cured via corrective glasses and simple cataract or other surgery. Building on his experience in organizing rural eye camps to deal with diagnosis and treatment he set about developing a low-cost high-quality solution to the problem, originally aiming its treatment in his home state of Tamil Nadu.

One of the key building blocks in developing the Aravind system has been transferring the ideas of another industry concerned with low-cost, high and consistent quality provision – the hamburger business pioneered by the Croc brothers and underpinning McDonald's. By applying the same process innovation approaches to standardization, workflow and tailoring tasks to skills he created a system which not only delivered high quality but was also reproducible. The model has now diffused widely – there are now five hospitals within Tamil Nadu offering nearly 4000 beds, the majority of which are free. It has moved beyond cataract surgery to education, lens manufacturing, research and development and other linked activities around the theme of improving sight and access to treatment.

In making this vision come alive Dr Venkataswamy has not only demonstrated considerable entrepreneurial flair – he has also created a template which others, including health providers in the advanced industrial economies, are now looking at very closely. It has provided both the trigger and some of the trajectory for innovative approaches in health care – not just in eye surgery but across a growing range of operations.

5.5 Towards mass customization

Arguably Henry Ford's plant, based on principles of mass production, represented the most efficient response to the market environment of its time. But that environment changed rapidly during the 1920s, so that what had begun as a winning formula for manufacturing began gradually to represent a major obstacle to change. Production of the Model T began in 1909 and for 15 years or so it was the market leader. Despite falling margins the company managed to exploit its blueprint for factory technology and organization to ensure continuing profits. But growing competition (particularly from General Motors with its strategy of product differentiation) was shifting away from trying to offer the customer low-cost personal transportation and towards other design features – such as the closed body – and Ford was increasingly forced to add features to the Model T. Eventually it was clear that a new model was needed and production of the Model T stopped in 1927. See detailed case study of Model T on web.

The trouble is that markets are not made up of people wanting the same thing – and there is an underlying challenge to meet their demands for variety and increasing customization. This represents a powerful driver for innovation – as we move from conditions where products are in short supply to one of mass production so the demand for differentiation increases. There has always been a market for personalized custom-made goods – and similarly custom-configured services, for example, personal shoppers, personal travel agents, personal physicians. But until recently there was an acceptance that this customization carried a high price tag and that mass markets could only be served with relatively standard product and service offerings.[23]

However a combination of enabling technologies and rising expectations has begun to shift this balance and resolve the trade-off between price and customization. 'Mass customization' is a widely used term which captures some elements of this.[24] Mass customization is the ability to offer highly configured bundles of non-price factors configured to suit different market segments (with the ideal target of total customization, i.e. a market size of one), but to do this without incurring cost penalties and the setting up of a trade-off of agility versus prices.

Of course there are different levels of customizing – from simply putting a label 'specially made for . . . (insert your name here)' on a standard product right through to sitting down with a designer and co-creating something truly unique. Table 5.3 gives some examples of this range of options.

This trend has important implications for services, in part because of the difficulty of sustaining an entry barrier for long. Service innovations are often much easier to imitate and the competitive advantages which they offer can quickly be competed away because there are fewer barriers to entry or options for protecting intellectual property. The pattern of airline innovation on the transatlantic route provides a good example of this – there is a fast pace of innovation but as soon as one airline introduces something like a flat bed, others will quickly emulate it. Arguably the drive to personalization of the service experience will be strong because it is only through such customized experiences that a degree of customer 'lock on' takes place.[25] Certainly the experience of Internet banking and insurance suggests that, despite attempts to customize the experience via sophisticated web technologies, there is little customer loyalty and a high rate of churn. However, the lower capital cost of creating and delivering services and their relative simplicity make co-creation more of an option. Where manufacturing may require sophisticated tools like computer-aided design and rapid prototyping, services lend themselves to shared experimentation at relatively lower cost. There is growing interest in such models involving active users in design of services, for example in the open source movement around software or in the digital entertainment and communication fields where community and social networking sites like

TABLE 5.3 **Options in customization**

Type of customization	Characteristics	Examples
Distribution customization	Customers may customize product/service packaging, delivery schedule and delivery location but the actual product/service is standardized	Sending a book to a friend from Amazon.com. They will receive an individually wrapped gift with a personalized message from you – but it's actually all been done online and in their distribution warehouses. iTunes appears to offer personalization of a music experience but in fact it does so right at the end of the production and distribution chain
Assembly customization	Customers are offered a number of predefined options. Products/services are made to order using standardized components	Buying a computer from Dell or another online retailer. Customers choose and configure to suit their exact requirements from a rich menu of options – but Dell only start to assemble this (from standard modules and components) when their order is finalized. Banks offering tailor-made insurance and financial products are actually configuring these from a relatively standard set of options
Fabrication customization	Customers are offered a number of predefined designs. Products/services are manufactured to order	Buying a luxury car like a BMW, where the customers are involved in choosing ('designing') the configuration which best meets their needs and wishes, e.g. engine size, trim levels, colour, fixtures and extras. Only when they are satisfied with their virtual model does the manufacturing process begin – and customers can even visit the factory to watch their car being built Services allow a much higher level of such customization since there is less of an asset base needed to set up for 'manufacturing' the service – examples here would include made to measure tailoring, personal planning for holidays and pensions

(*continued*)

TABLE 5.3 **(Continued)**

Type of customization	Characteristics	Examples
Design customization	Customer input stretches to the start of the production process. Products do not exist until initiated by a customer order	Co-creation, where end users may not even be sure what it is they want but where – sitting down with a designer – they co-create the concept and elaborate it. It's a little like having some clothes made but rather than choosing from a pattern book they actually have a designer with them and create the concept together. Only when it exists as a firm design idea does it then get made. Co-creation of services can be found in fields like entertainment (where user-led models like YouTube are posing significant challenges to mainstream providers) and in healthcare where experiments towards radical alternatives for healthcare delivery are being explored – see for example, the Design Council RED project

Source: After Lampel, J. and H. Mintzberg (1996) Customizing, customization. *Sloan Management Review*, **38** (1), 21–30.

MySpace, Flickr and YouTube have had a major impact. See video links of Stan Davies discussing the future of mass customization and an interview with Frank Piller talking about mass customization and configurators.

5.6 Users as innovators

Although need pull represents a powerful trigger for innovation it is easy to fall into the trap of thinking about the process as a serial one in which user needs are identified and then something is created to meet those needs. The assumption underpinning this is that users are passive recipients – but this is often not the case. Indeed history suggests that users are sometimes ahead of the game – their ideas plus their frustrations with existing solutions lead to experiment and prototyping and create early versions of what eventually become mainstream innovations. Eric von Hippel of Massachusetts Institute of Technology has made a lifelong study of this phenomenon and gives the example of the pickup truck – a long-time staple of the world automobile industry. This major category did not begin life on the

drawing boards of Detroit but rather on the farms and homesteads of a wide range of users who wanted more than a family saloon. They adapted their cars by removing seats, welding new pieces on and cutting off the roof – in the process prototyping and developing the early model of the pickup. Only later did Detroit pick up on the idea and then begin the incremental innovation process to refine and mass produce the vehicle.[26] A host of other examples support the view that user-led innovation matters, for example petroleum refining, medical devices, semiconductor equipment, scientific instruments, the Polaroid camera and a wide range of sports goods.

Importantly active and interested users – 'lead users' – are often well ahead of the market in terms of innovation needs. In Mansfield's detailed studies of diffusion of a range of capital goods into major firms in the bituminous coal, iron and steel, brewing and railroad industries, he found that in 75% of the cases it took over 20 years for complete diffusion of these innovations to major firms.[27] As von Hippel points out some users of these innovations could be found far in advance of the general market.[28]

One of the fields where this has played a major role is in medical devices where active users amongst medical professionals have provided a rich source of innovations for decades. Central to their role in the innovation process is that they are very early on the adoption curve for new ideas – they are concerned with getting solutions to particular needs and prepared to experiment and tolerate failure in their search for a better solution. One strategy – which we will explore later – around managing innovation is thus to identify and engage with such 'lead users' to co-create innovative solutions. Tim Craft, a practising anaesthetist, developed a range of connectors and other equipment as a response to frustrations and concerns about the safety aspects of the equipment he was using in operating theatres. He describes the birth of the company, Anaesthetic Medical Systems, and the underlying philosophy in the podcast interview on the website.

CASE STUDY 5.6

User involvement in innovation – the Coloplast example

One of the key lessons about successful innovation is the need to get close to the customer. At the limit (and as Eric Von Hippel and other innovation scholars have noted), the user can become a key part of the innovation process, feeding in ideas and improvements to help define and shape the innovation. The Danish medical devices company, Coloplast, was founded in 1954 on these principles when nurse Elise Sorensen developed the first self-adhering ostomy bag as a way of helping her sister, a stomach cancer patient. She took her idea to a various plastics manufacturers, but none showed interest at first. Eventually Aage Louis-Hansen discussed the concept with his wife, also a nurse, who saw the potential of such a device and persuaded her husband to give the product a chance. Hansen's company, Dansk Plastic Emballage, produced the world's first disposable ostomy bag in 1955. Sales exceeded expectations and in 1957, after having taken out a patent for the bag in several countries, the Coloplast company was established. Today the company has subsidiaries in 20 countries and factories in five countries around the world, with specialist divisions dealing with incontinence care, wound care, skin care, mastectomy care, consumer products (specialist clothing etc.) as well as the original ostomy care division.

Keeping close to users in a field like this is crucial and Coloplast have developed novel ways of building in such insights by making use of panels of users, specialist nurses and other healthcare

professionals located in different countries. This has the advantage of getting an informed perspective from those involved in post-operative care and treatment and who can articulate needs which might for the individual patient be difficult or embarrassing to express. By setting up panels in different countries the varying cultural attitudes and concerns could also be built into product design and development.

An example is the Coloplast Ostomy Forum (COF) board approach. The core objective within the COF Boards is to try and create a sense of partnership with key players, either as key customers or key influencers. Selection is based on an assessment of their technical experience and competence but also on the degree to which they will act as opinion leaders and gatekeepers, for example by influencing colleagues, authorities, hospitals and patients. They are also a key link in the clinical trials process. Over the years Coloplast has become quite skilled in identifying relevant people who would be good COF board members, for example by tracking people who author clinical articles or who have a wide range of experience across different operation types. Their specific role is particularly to help with two elements in innovation:

- to identify, discuss and prioritize user needs
- to evaluate product development projects from idea generation right through to international marketing.

Importantly COF Boards are seen as integrated with the company's product development system and they provide valuable market and technical information into the stage-gate decision process. This input is mainly associated with early stages around concept formulation (where the input is helpful in testing and refining perceptions about real user needs and fit with new concepts). There is also significant involvement around project development where Board members are concerned with evaluating and responding to prototypes, suggesting detailed design improvements, design for usability, etc.

Sometimes user-led innovation involves a community which creates and uses innovative solutions on a continuing basis. Good examples of this include the Linux community around computer operating systems or the Apache server community around web server development applications, where communities have grown up and the resulting range of applications is constantly growing – a state which has been called 'perpetual beta' referring to the old idea of testing new software modules across a community to get feedback and development ideas.[29] A growing range of Internet-based applications make use of communities – for example Mozilla and its Firefox and other products, Propellerhead and other music software communities and the emergent group around Apple's i-platform devices like the iPhone.[30]

Increasing interest is being shown in such 'crowd-sourcing' approaches to co-creating innovations – and to finding new ways of creating and working with such communities. The principle extends beyond software and virtual applications – for example, LEGO makes extensive use of communities of developers in its LEGO factory and other online activities linked to its manufactured products.[31] Adidas has taken the model and developed its 'mi Adidas' concept where users are encouraged to co-create their own shoes using a combination of website (where designs can be explored and uploaded) and in-store mini-factories where user-created and customized ideas can then be produced. See LEGO and Threadless case studies on the web.

5.7 Extreme users

An important variant that picks up on both the lead user and the fringe needs concepts lies in the idea of extreme environments as a source of innovation. The argument here is that the users in the toughest environments may have needs which by definition are at the edge – so any innovative solution which meets those needs has possible applications back into the mainstream. An example would be antilock braking systems (ABS) which are now a commonplace feature of cars but which began life as a special add-on for premium high-performance cars. The origins of this innovation came from a more extreme case, though – the need to stop aircraft safely under difficult conditions where traditional braking might lead to skidding or other loss of control. ABS was developed for this extreme environment and then migrated across to the (comparatively) easier world of automobiles.[29] A set of videos outlining the experience of 3M working with Eric von Hippel as it tries to make use of lead user methods in its innovation development work can be found via links on the website.

Looking for extreme environments or users can be a powerful source of stretch in terms of innovation – meeting challenges which can then provide new opportunity space. As Roy Rothwell put it in the title of a famous paper, 'tough customers mean good designs'.[32] For example, stealth technology arose out of a very specific and extreme need for creating an invisible aeroplane – essentially something which did not have a radar signature. It provided a powerful pull for some radical innovation which challenged fundamental assumptions about aircraft design, materials, power sources etc. and opened up a wide frontier for changes in aerospace and related fields.[33] The 'bottom of the pyramid' concept mentioned earlier also offers some powerful extreme environments in which very different patterns of innovation are emerging.

For example in the Philippines there is little in the way of a formal banking system for the majority of people – and this has led to users creating very different applications for their mobile phones where pay as you go credits become a unit of currency to be transferred between people and used as currency for various goods and services. In Kenya the mobile phone is used to increase security – if a traveller wishes to move between cities he or she will not take money but instead forward it via mobile phone in the form of credits, which can then be collected from the phone recipient at the other end. This is only one of hundreds of new applications being developed in extreme conditions and by under-served users – and represents a powerful laboratory for new concepts which companies like Nokia and Vodafone are working closely to explore.[20] The potential exists to use this kind of extreme environment as a laboratory to test and develop concepts for wider application – for example, Citicorp has been experimenting with a design of ATM based on biometrics for use with the illiterate population in rural India. The pilot involves some 50 000 people but as a spokesman for the company explained, '*we see this as having the potential for global application*'.

Such experiments can open up significant new innovation space by bringing new rules to the game. For example, India's giant Tata Corporation has been developing the '1-lakh car' – essentially a car for the Indian market which would retail for around $2000. Despite considerable cynicism from the industry the Nano has been launched at close to this price and represents the first response to a classic extreme environment challenge. Producing something at this target cost, which also meets emission controls and provides a level of features to satisfy the growing Indian middle class, is already a significant innovation achievement given that the closest competitor cars retail for nearly twice that price. Creating the wider system for service and support, for insurance, for financing purchase, for driver training and so on implies a very different approach to bringing driving within the reach of a

large population. As low-cost airlines and other disruptive innovators found, the learning effects across large volumes of rapidly growing markets mean that many innovative solutions are developed and create a business model which has significant challenges for established incumbents. Arguably this is not simply a local innovation but an experiment towards the kind of industry-changing system that Henry Ford pioneered a century ago.

5.8 Watching others

Innovation is essentially a competitive search for new or different solutions – whether in the sense of commercial enterprises competing with each other for market share or in the wider sense of public service, where the competition is for doing more with limited resources, or between law and order and crime, or education and illiteracy. In such a contest one important strategy involves learning from others – imitation is not only the sincerest form of flattery but also a viable and successful strategy for sourcing innovation. For example, reverse engineering of products and processes and development of imitations – even around impregnable patents – is a well-known route to find ideas. Much of the rapid progress of Asian economies in the post-war years was based on a strategy of 'copy and develop', taking Western ideas and improving on them.[34] For example much of the early growth in Korean manufacturing industries in fields like machine tools came from adopting a strategy of 'copy and develop' – essentially learning (often as a result of taking licenses or becoming service agents) by working with established products and understanding how they might be adapted or developed for the local market. Subsequently this learning could be used to develop new generations of products or services.[35]

A wide range of tools for competitor product and process profiling has been developed which provide structured ways of learning from what others do or offer.[36] See web for examples of competitiveness profiling.

One powerful variation on this theme is the concept of benchmarking.[37] In this process enterprises make structured comparisons with others to try and identify new ways of carrying out particular processes or to explore new product or service concepts. The learning triggered by benchmarking may arise from comparing between similar organizations (same firm, same sector, etc.), or it may come from looking outside the sector but at similar products or processes. For example, Southwest Airlines became the most successful carrier in the USA by dramatically reducing the turnaround times at airports – an innovation which it learned from studying pit-stop techniques in the Formula 1 Grand Prix events. Similarly the Karolinska Hospital in Stockholm made significant improvements to its cost and time performance through studying inventory management techniques in advanced factories.[38]

Benchmarking of this kind is increasingly being used to drive change across the public sector, both via 'league tables' linked to performance metrics which aim to encourage fast transfer of good practice between schools or hospitals and also via secondment, visits and other mechanisms designed to facilitate learning from other sectors managing similar process issues such as logistics and distribution. One of the most successful applications of benchmarking has been in the development of the concept of 'lean thinking', now widely applied to a many public- and private-sector organizations.[39] The origins were in a detailed benchmarking study of car manufacturing plants during the 1980s, which identified significant performance differences and triggered a search for the underlying process innovations that were driving the differences.[40]

5.9 Recombinant innovation

Another easy assumption to make about innovation is that it always has to involve something new to world. The reality is that there is plenty of scope for crossover – ideas and applications which are commonplace in one world may be perceived as new and exciting in another. This is an important principle in sourcing innovation where transferring or combining old ideas in new contexts – a process called 'recombinant innovation' by Andrew Hargadon – can be a powerful resource.[41] The Reebok pump running shoe, for example, was a significant product innovation in the highly competitive world of sports equipment – yet although this represented a breakthrough in that field it drew on core ideas which were widely used in a different world. Design Works – the agency which came up with the design – brought together a team that included people with prior experience in fields like paramedic equipment (from which they took the idea of an inflatable splint providing support and minimizing shock to bones) and operating theatre equipment (from which they took the micro-bladder valve at the heart of the pump mechanisms). Many businesses – as Hargadon points out – are able to offer rich innovation possibilities primarily because they have deliberately recruited teams with diverse industrial and professional backgrounds and thus bring very different perspectives to the problem in hand. His studies of the design company, IDEO, show the potential for such recombinant innovation work.[42]

Nor is this a new idea. Thomas Edison's famous 'Invention Factory' in New Jersey was founded in 1876 with the grand promise of 'a minor invention every ten days and a big thing every six months or so'. They were able to deliver on that promise not because of the lone genius of Edison himself but rather from taking on board the recombinant lesson – Edison hired scientists and engineers (he called them 'muckers') from all the emerging new industries of early twentieth-century USA. In doing so he brought experience in technologies and applications like mass production and precision machining (gun industry), telegraphy and telecommunications, food processing and canning and automobile manufacture. Some of the early innovations that built the reputation of the business – for example the teleprinter for the NYSE – were really simple cross-over applications of well-known innovations in other sectors.[41]

In many ways recombinant innovation involves a core principle understood by researchers on human creativity. Very often original – breakthrough – ideas come about through a process of what Arthur Koestler called 'bisociation' – the bringing together of apparently unrelated things which can somehow be connected and yield an interesting insight.[43] The key message here for managing innovation is to look to diversity to provide the raw material which might be combined in interesting ways – and realizing this makes the search for unlikely bedfellows a useful strategy.

5.10 Regulation

Photographs of the pottery towns around Stoke on Trent in the Midlands of the UK taken in the early part of the twentieth century would not be much use in tracing landmarks or spotting key geographical features. The images in fact would reveal very little at all – not because of a limitation in the photographic equipment or processing but because the subject matter itself – the urban landscape – was rendered largely invisible by the thick smog which regularly enveloped the area. Yet 60 years later the same images would show up crystal clear – not because the factories had closed (although there are fewer of them) but because of the continuing effects of the Clean Air Act and other legislation. They provide a

clear reminder of another important source of innovation – the stimulus given by changes in the rules and regulations which define the various 'games' for business and society. The Clean Air Act didn't specify how but only what had to change – achieving the reduction in pollutants emitted to the atmosphere involved extensive innovation in materials, processes and even in product design made by the factories.

Regulation in this way provides a two-edged sword – it both restricts certain things (and closes off avenues along which innovation had been taking place) and opens up new ones along which change is mandated to happen.[44] And it works the other way – deregulation – the slackening off of controls – may open up new innovation space. The liberalization and then privatization of telecommunications in many countries led to rapid growth in competition and high rates of innovation, for example.

Given the pervasiveness of legal frameworks in our lives we shouldn't be surprised to see this source of innovation. From the moment we get up and turn the radio on (regulation of broadcasting shaping the range and availability of the programmes we listen to), to eating our breakfast (food and drink is highly regulated in terms of what can and can't be included in ingredients, how foods are tested before being allowed for sale, etc.), to climbing into our cars and buckling on our safety belt whilst switching on our hands-free phone devices (both the result of safety legislation), the role of regulation in shaping innovation can be seen.[45]

Regulation can also trigger counter innovation – solutions designed to get round existing rules or at least bend them to advantage. The rapid growth in speed cameras as a means of enforcing safety legislation on roads throughout Europe has led to the healthy growth of an industry providing products or services for detecting and avoiding cameras. And at the limit changes in the regulatory environment can create radical new space and opportunity. Although Enron ended its days as a corporation in disgrace due to financial impropriety it is worth asking how a small gas pipeline services company rose to become such a powerful beast in the first place. The answer was its rapid and entrepreneurial take up of the opportunities opened up by deregulation of markets for utilities like gas and electricity.[46]

5.11 Futures and forecasting

Another source of stimuli for innovation comes through imagining and exploring alternative trajectories to the dominant version in everyday use. Various tools and techniques for forecasting and imagining alternative futures are used to help strategy making – but can also be used to stimulate imagination around new possibilities in innovation. For example, Shell has a long history of exploring future options and driving innovations, most recently through its GameChanger programme.[47] Sometimes various 'transitional objects' are used, like concept models and prototypes in the context of product development, to explore reactions and provide a focus for various different kinds of input which might shape and co-create future products and services.[48,49]

Chapter 8 explores this theme and the related toolkits in detail.

5.12 Accidents

Accidents and unexpected events happen – and in the course of a carefully planned R&D project they could be seen as annoying disruptions. But on occasions accidents can also trigger innovation, opening up surprisingly new lines of attack. The famous example of Fleming's discovery of penicillin is but

CASE STUDY 5.7

Cleaning up by accident

Audley Williamson is not a household name of the Thomas Edison variety but he was a successful innovator whose UK business sold for £135 million in 2004. The core product which he invented was called 'Swarfega' and offered a widely used and dermatologically safe cleaner for skin. It is a greenish gel which has achieved widespread use in households as a simple and robust aid with the advertising slogan 'clean hands in a flash!' But the original product was not designed for this market at all – it was developed in 1941 as a mild detergent to wash silk stockings. Unfortunately the invention of nylon and its rapid application in stockings meant that the market quickly disappeared and he was forced to find an alternative. Watching workers in a factory trying to clean their hands with an abrasive mixture of petrol, paraffin and sand which left their hands cracked and sore led him to rethink the use of his gel as a safer alternative.

Source: *The Independent*, 28 February 2006, p.7.

one of many stories in which mistakes and accidents turned out to trigger important innovation directions. For example, the famous story of 3M's 'Post-it' notes began when a polymer chemist mixed an experimental batch of what should have been a good adhesive but which turned out to have rather weak properties – sticky but not very sticky. This failure in terms of the original project provided the impetus for what has become a billion dollar product platform for the company. Henry Chesbrough calls this process 'managing the false negatives' and draws attention to a number of cases.[50] For example, in the late 1980s, scientists working for Pfizer began testing what was then known as compound UK-92,480 for the treatment of angina. Although promising in the lab and in animal tests, the compound showed little benefit in clinical trials in humans. Despite these initial negative results the team pursued what was an interesting side effect which eventually led to UK-92,480 becoming the blockbuster drug Viagra.

The secret is not so much recognizing that such stimuli are available but rather in creating the conditions under which they can be noticed and acted upon. As Pasteur is reputed to have said, '*chance favours the prepared mind!*' Using mistakes as a source of ideas only happens if the conditions exist to help it emerge. For example Xerox developed many technologies in its laboratories in Palo Alto which did not easily fit their image of being 'the document company'. These included Ethernet (later successfully commercialized by 3Com and others) and PostScript language (taken forward by Adobe Systems). Chesbrough reports that 11 of 35 rejected projects from Xerox's labs were later commercialized with the resulting businesses having a market capitalization of twice that of Xerox itself.[50]

In similar fashion shocks to the system which fundamentally change the rules provide not only a threat to the existing status quo but a powerful stimulus to find and develop something new. The tragedy of the 9/11 bombing of the Twin Towers served to change fundamentally the public sense of security – but it has also provided a huge stimulus to innovate in areas like security, alternative transportation, fire safety and evacuation.[45]

RESEARCH NOTE

In a major research project around 'ideation' – where do innovation ideas come from? – Robert Cooper and Scott Edgett looked at 18 possible sources in the field of product innovation. Their sample covered 160 firms in the business-to-business and business-to-consumer markets, split approximately 70%/30% and covering a wide size range. They looked at how extensively each method was used but also asked managers to report on how effective they felt each technique to be. Their results are summarized below:

Approach	How extensively used (% of sample using)	Rank	How effective (scale of 1–10)	Rank
Ethnography	12.9	13	6.8	1
Customer visit teams	30.6	4	6.6	2
Customer focus groups for problem detection	25.5	5	6.4	3
Lead user methods	24	6	6.4	4
User design	17.4	11	6.0	5
Customer brainstorming	17.4	11	5.9	6
Peripheral vision tools	33.1	2	5.9	7
Customer advisory board	17.6	10	5.8	8
Community of enthusiasts	8	15	5.7	9
Disruptive technologies	22	8	5.7	10
Internal idea capture	38	1	5.5	11
Partners and vendors	22.1	7	5.5	12
Patent mining	33	3	5.5	13
Accessing external technical community	19.5	9	4.9	14
Scanning small businesses and start-ups	13	13	4.9	15
External product design/ crowdsourcing	2	18	4.8	16
External submitted ideas	7.9	16	4.5	17
External idea contest	4.1	17	4.3	18

Source: Cooper, R. and S. Edgett (2008) Ideation for product innovation: What are the best methods? *PDMA Visions*, Product Development Management Association, March, 12–16.

5.13 A framework for looking at innovation sources

It's clear that opportunities for innovation are not in short supply – and they arise from many different directions. The key challenge for innovation management is how to make sense of the potential input – and to do so with often limited resources. No organization can hope to cover all the bases so there needs to be some underlying strategy to how the search process is undertaken. One way is to impose some dimensions on the search space to help us frame where and why we might search for innovation triggers.

One important question is the relative importance of the push or pull forces outlined above. This has been the subject of many innovation studies over the years, using a variety of different methods to try and establish which is more important (and therefore where organizations might best place their resources). The reality is that innovation is never a simple matter of push or pull but rather their interaction; as Chris Freeman said '*necessity may be the mother of invention but procreation needs a partner*'! Innovations tend to resolve into vectors – combinations of the two core principles. And these direct our attention in two complementary directions – creating possibilities (or at least keeping track of what others are doing along the R&D frontier) and identifying and working with needs. Importantly the role of needs in innovation is often to translate or select from the range of knowledge-push possibilities the variant which becomes the dominant strain. Out of all the possible bicycle ideas we eventually get to the dominant design – which is with us today.[51] The iPod wasn't the first MP3 player but it somehow clicked as the one which resonated best with user needs.

In fact most of the sources of innovation we mentioned above involve both push and pull components – for example, 'applied R&D' involves directing the push search in areas of particular need. Regulation both pushes in key directions and pulls innovations through in response to changed conditions. User-led innovation may be triggered by user needs but it often involves creating new solutions to old problems – essentially pushing the frontier of possibility in new directions.

There is a risk in focusing on either of the 'pure' forms of push or pull sources. If we put all our eggs in one basket we risk being excellent at invention but without turning our ideas into successful innovations – a fate shared by too many would-be entrepreneurs. But equally too close an ear to the market may limit us in our search – as Henry Ford is reputed to have said, '*if I had asked the market they would have said they wanted faster horses!*' The limits of even the best market research lie in the fact that they represent sophisticated ways of asking people's reactions to something which is already there – rather than allowing for something completely outside their experience so far.

Another key dimension is around incremental or radical innovation. We've seen that there is a pattern of what could be termed 'punctuated equilibrium' with innovation – most of the time innovation is about exploiting and elaborating, creating variations on a theme within an established technical, market or regulatory trajectory. But occasionally there is a breakthrough which creates a new trajectory – and the cycle repeats itself. This suggests that much of our attention in searching for innovation triggers will be around incremental improvement innovation – the different versions of a piece of software, the mark 2, 3, 4 of a product or the continuing improvement of a business process to make it closer to lean. But we will need to have some element of our portfolio focused on the longer range, higher risk, which might lead to the breakthrough and set up a new trajectory.

A third issue is around timing – at different stages in the product or industry life cycle the emphasis may be more or less on push or pull. For example, mature industries will tend to focus on pull, responding to different market needs and differentiating by incremental innovation in key directions of user need. By contrast a new industry – for example the emergent industries based on genetics or nano materials

RESEARCH NOTE **Where do innovations come from? Transformations in the US National Innovation System, 1970–2006**

Using an innovative research method, UC Davis scholars Fred Block and Mathew Keller analysed a sample of innovations recognized by *R&D Magazine* as being among the top 100 innovations of the year over the last four decades. They found that while in the 1970s almost all winners came from corporations acting on their own, more recently over two-thirds of the winners have come from partnerships involving business and government, including federal labs and federally funded university research. Moreover, in 2006 77 of the 88 US entities that produced award-winning innovations were beneficiaries of federal funding.

Source: http://www.itif.org.

technology – is often about solutions looking for a problem. So we would expect a different balance of resources committed to push or pull within these different stages.

This kind of thinking is reflected in the Abernathy/Utterback model of innovation life cycle which we covered in Chapter 1.[52] This sees innovation at the early fluid stage being characterized by extensive experimentation and with emphasis on product – creating a radical new offering. As the dominant design emerges attention shifts towards more incremental variation around the core trajectory – and as the industry matures so emphasis shifts to process innovation aimed at improving parameters like cost and quality. Once again this helps allocate scarce search resources in particular ways.

A fourth and related issue is around diffusion – the adoption and elaboration of innovation over time. Innovation adoption is not a binary process but rather one which takes place gradually over time, following some version of an S-curve.[53] At the early stages innovative users with high tolerance for failure will explore, to be followed by early adopters. This gives way to the majority following their lead until finally the remnant of a potential adopting population – the laggards in Roger's terms – adopt or remain stubbornly resistant. Understanding diffusion processes and the influential factors (which we will explore in more detail in Chapter 8) is important because it helps us understand where and when different kinds of triggers are picked up. Lead users and early adopters are likely to be important sources of ideas and variations, which can help shape an innovation in its early life, whereas the early and late majority will be more a source of incremental improvement ideas.[54]

5.14 How to search

Of course the challenge in managing innovation is not one of classifying different sources but rather how to seek out and find the relevant triggers early and well enough to do something about them. In developing search strategies we can make use of some of the broad dimensions highlighted above – for example by ensuring we have a balance between push and pull, and between incremental and radical. A good place to start understanding broad strategies is to look at what firms actually do in searching for innovation triggers. There are many large-scale innovation surveys which ask around this theme, for example, the European Community Innovation Survey (`www.cordis.europa.eu/cip/index.html`) which looks at the innovative behaviour of firms across 27 EU states (Table 5.4).

TABLE 5.4

Innovation activity and cooperation during 2002–2004

	Enterprises with innovation activity, % of all enterprises	All types of co-operation with other enterprises or institutions	Co-operation partners:			
			Suppliers	Clients or customers	Universities or other higher education institutes	Government or public research institutes
		% of all innovative enterprises				
EU27	42	42	17	14	9	6
Belgium	51	36	26	21	13	9
Bulgaria	16	22	16	13	6	4
Czech Republic*	38	38	31	26	13	7
Denmark	52	43	28	28	14	7
Germany	65	16	7	8	8	4
Estonia	49	35	23	23	9	6
Ireland	52	32	23	25	10	6
Greece	36	24	11	8	6	2
Spain	35	18	9	4	5	5
France	33	40	26	20	10	7
Italy	36	13	7	5	5	1
Cyprus	46	37	24	4	2	2
Latvia	18	39	33	29	14	12
Lithuania	29	56	45	35	12	10
Luxembourg	52	30	24	22	10	8
Hungary	21	37	26	20	14	5
Malta	21	32	22	17	4	4
Netherlands	34	39	30	22	12	9
Austria	53	17	7	8	10	5
Poland	25	42	28	16	6	9
Portugal	41	19	14	12	8	5
Romania	20	17	14	10	4	4
Slovenia	27	47	38	33	19	13
Slovekia	23	38	32	30	15	11
Finland	43	44	41	41	33	26
Sweden	50	43	32	28	17	6
United Kingdom	43	31	23	22	10	8
Iceland	52	29	20	20	5	13
Norway	37	33	23	22	15	16

*Data for Czech Republic correspond to the reference period 2003–2005

Source: fourth Community Innovation Survey

Source: Fourth European Community Innovation Survey. (c) European Communities 2007. Reproduced with permission.

Data from studies like the Community Innovation Survey gives us one picture – and it reinforces the view that successful innovation is about spreading the net as widely as possible, mobilizing multiple channels. Although surveys of this kind tell us a lot they also miss important elements in the sources of innovation picture. A lot of incremental innovation and how it is triggered lies beneath the radar screen, and there is a bias towards product innovation where we know that a great deal of incremental process improvement goes on. And surveys don't capture position or business model innovation so well, again

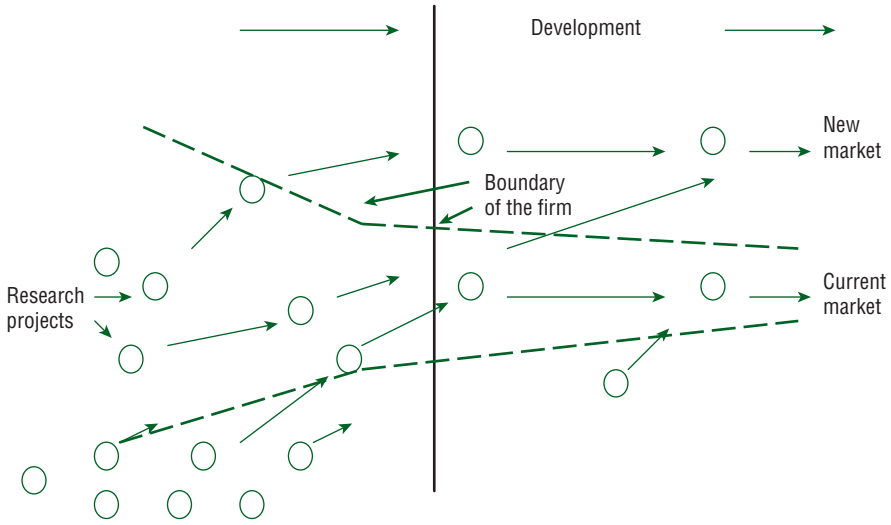

FIGURE 5.4: The open innovation model
Source: Chesbrough, H. (2003) *Open Innovation: The New Imperative for Creating and Profiting from Technology,* Harvard Business School Press, Boston, MA.

especially at the incremental end. It tends to focus on the 'obvious' search agents like R&D or market research departments – but others are involved, e.g. purchasing, and within the business the idea of suggestion schemes and high-involvement innovation. But surveys give us a broad picture – and underline the need for an extensive net.

Building rich and extensive linkages with potential sources of innovation has always been important – for example studies by Carter and Williams in the UK in the 1950s identified one key differentiator between successful and less successful innovating firms as the degree to which they were 'cosmopolitan' as opposed to 'parochial' in their approach towards sources of innovation.[55] There are, of course, arguments for keeping a relatively closed approach, for example there is a value in doing your own R&D and market research because the information collected is then available to be exploited in ways that the business can control. It can choose to push certain lines, hold back on others, keeping things essentially within a closed system. But as we've seen the reality is that innovation is triggered in all sorts of ways and a sensible strategy is to cast the net as widely as possible. In what is termed 'open innovation' organizations move to a more permeable view of knowledge in which they recognize the importance of external sources and also make their own knowledge more widely available.[56] Figure 5.4 illustrates this principle.

This is not without its difficulties – on the one hand it makes sense to recognize that in a knowledge-rich world 'not all the smart guys work for us'. Even large R&D spenders like Procter & Gamble (annual R&D budget around $3 billion and about 7000 scientists and engineers working globally in R&D) are fundamentally rethinking their models – in its case switching from 'Research and Develop' to 'Connect and Develop' as the dominant slogan, with the strategic aim of moving from closed innovation to sourcing 50% of its innovations from outside the business.[57] But on the other we should recognize the tensions that arise around intellectual property (how do we protect and hold on to knowledge when it is now much more mobile – and how do we access other people's knowledge?), around appropriability (how do we ensure a return on our investment in creating knowledge?) and around the mechanisms to make sure we can find and use relevant knowledge (when we are now effectively sourcing it from across

the globe and in all sorts of unlikely locations). In this context innovation management emphasis shifts from knowledge creation to knowledge trading and managing knowledge flows.[58]

We will return to this theme of 'open innovation' and how to enable it, shortly.

5.15 Balancing exploitation and exploration

A core theme in discussion of innovation relates to the tensions in search behaviour between 'exploitation' and 'exploration' activities.[59,60] On the one hand firms need to deploy knowledge resources and other assets to secure returns and a 'safe' way of doing so is to harvest a steady flow of benefits derived from 'doing what we do better'. This has been termed 'exploitation' by innovation researchers, and it essentially involves '*the use and development of things already known*'.[61] It builds strongly through '*knowledge leveraging activities*'[62] on what is already well established – but in the process leads to a high degree of path dependency – '*firms' accumulated exploitation experience reinforces established routines within domains*'.[63]

The trouble is that in an uncertain environment the potential to secure and defend a competitive position depends on 'doing something different', i.e. radical product or process innovation rather than imitations and variants of what others are also offering.[64] This kind of search had been term 'exploration' and is the kind which involves '*long jumps*' or '*re-orientations that enable a firm to adopt new attributes and attain new knowledge outside its domain*'[65,66]

The above-mentioned tension comes because the organizational routines needed to support these activities differ. Incremental exploitation innovation is about highly structured processes and often high-frequency small-scale innovation carried out within operating units. Radical innovation, by contrast, is occasional and high risk, often requiring a specific and cross-functional combination of resources and a looser approach to organization and management.[67]

There is no easy prescription for doing these two activities but most organizations manage a degree of 'ambidexterity' through the use of a combination of approaches across a portfolio.[68,69] So, for example, technological search activity is managed by investment in a range of R&D projects with a few 'blue-sky'/high-risk outside bets and a concentration of projects around core technological trajectories.[70] Market research is similarly structured to develop deep and responsive understanding of key market segments but also allowing some search around peripheral and emergent constituencies.[71]

5.16 Absorptive capacity

One more broad strategic point concerns the question of where, when and how organizations make use of external knowledge to grow. It's easy to make the assumption that because there is a rich environment full of potential sources of innovation that every organization will find and make use of these. The reality is, of course, that they differ widely in their ability to make use of such trigger signals – and the measure of this ability to find and use new knowledge has been termed 'absorptive capacity'.

The concept was first introduced by Cohen and Levinthal who described it as '*the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends*' and saw it as '*largely a function of the firm's level of prior related knowledge*'.[72] It is an important construct because it shifts our attention to how well firms are equipped to search out, select and implement knowledge.

The underlying construct of absorptive capacity is not new – discussion of firm learning forms the basis of a number of studies going back to the work of Arrow,[73] Simon and March[74] and others. In the

area of innovation studies the ideas behind 'technological learning' – the processes whereby firms acquire and use new technological knowledge and the underlying organizational and managerial processes which are involved – were extensively discussed by, inter alia, Freeman,[1] Bell and Pavitt[75] and Lall.[76] Cohen and Levinthal's original work was based on exploring (via mathematical modelling) the premise that firms might incur substantial long-run costs for learning a new 'stock' of information and that R&D needed to be viewed as an investment in today's and tomorrow's technology.[72] In later work they broadened and refined the model and definition of absorptive capacity to include more than just the R&D function and also explored the role of technological opportunity and appropriability in determining the firm's incentive to build absorptive capacity.

Absorptive capacity is clearly not evenly distributed across a population. For various reasons firms may find difficulties in growing through acquiring and using new knowledge. Some may simply be unaware of the need to change never mind having the capability to manage such change. Such firms – a classic problem of SME growth for example – differ from those which recognize in some strategic way the need to change, to acquire and use new knowledge but lack the capability to target their search or to assimilate and make effective use of new knowledge once identified. Others may be clear what they need but lack capability in finding and acquiring it. And others may have well-developed routines for dealing with all of these issues and represent resources on which less experienced firms might draw – as is the case with some major supply chains focused around a core central player.[77]

Reviewing the literature on why and when firms take in external knowledge suggests that this is not – as is sometimes assumed – a function of firm size or age. It appears instead that the process is more one of transitions via crisis-turning points. Some firms do not make the transition, others learn up to a

RESEARCH NOTE Absorptive capacity

Research by Zahra and George (2002) noted that carrying out studies of absorptive capacity (AC) has become fraught with difficulty owing to the diversity and ambiguity surrounding its definition and components. Zahra and George decided to review and extend the absorptive capacity construct and suggested that several different processes were involved – rather than a simple absorption of new knowledge there were discrete activities linked to search, acquisition, assimilation and exploitation. Potential AC relates to Cohen and Levinthal's (1990) research on how a firm may value and acquire knowledge, although not necessarily exploit it. The firm's ability to transform and exploit the knowledge is captured by Realized AC. In short, absorptive capacity is a set of organizational routines and processes which are used to create a dynamic organizational capability. The authors state that firms need to build both types of absorptive capacity in order to maintain a competitive advantage.

Zahra and George discuss how Potential and Realized AC are separate but complementary, and why the distinction is useful. By distinguishing between Potential and Realized absorptive capacity we are able to ascertain which firms are unable to leverage and exploit external information. This can provide useful implications for managerial competences in developing both aspects of AC. They use the Potential and Realized absorptive capacity constructs to build a model of the antecedents, moderators and outcomes of the construct. For instance, they propose that a firm's experience and exposure to external knowledge will influence the development of Potential AC. Activation triggers, such as a change in dominant design may also

play a moderating influence in determining the locus of search for external sources of knowledge. Finally they introduce the role of the social integration mechanism in reducing the gap between Potential and Realized AC. These mechanisms can help distribute information throughout the firm and provide an environment whereby information can be exploited.

Their work spawned extensive discussion and application – but the resulting proliferation of use of the term led to problems highlighted by Lane *et al.* (2006), who tried to evaluate how much divergence there has been in the field. These authors analysed 289 absorptive capacity papers from 14 journals to understand how the construct had been used and to identify the contributions to the broader literature of absorptive capacity. From their analysis, the authors concluded that the construct had become reified. '*Reification is the outcome of the process by which we forget the authorship of ideas and theories, objectify them (turn them into things), and then forget that we have done so*' (p. 835). They identified only six papers which extended the understanding of absorptive capacity in any meaningful way.

Todorova and Durisin (2007) also focus on the dynamic characteristics of the absorptive capacity construct, by examining the relationship between identification and acquisition of relevant knowledge, and the ability to apply that knowledge to commercial ends. In particular they claim that 'transformation' should be regarded not as a consequence but as an alternative process to 'assimilation' suggesting a more complex relationship between the components of absorptive capacity. In addition, they highlight the role of power relationships and socialization mechanisms within the dynamic model of absorptive capacity.

Sources: Zahra, S.A. and G. George (2002) Absorptive capacity: a review, reconceptualization and extension. *Academy of Management Review*, **27**, 185–94; Cohen, W. and D. Levinthal (1990) Absorptive capacity: a new perspective on learning and innovation. *Administrative Science Quarterly*, **35** (1), 128–52; Lane, P., B. Koka and S. Pathar (2006) The reification of absorptive capacity: a critical review and rejuvenation of the construct. *Academy of Management Review*, **31** (4), 833–63; Todorova, G. and B. Durisin (2007) Absorptive capacity: valuing a reconceptualization. *Academy of Management Review*, **32** (3), 774–96.

limited level. Equally the ability to move forwards depends on the past – a point made forcibly by Cohen and Levinthal in their original studies.

The key message from research on AC is that this complex construct – acquiring and using new knowledge – involves multiple and different activities around search, acquisition, assimilation and implementation. Connectivity between these is important – the ability to search and acquire (Potential AC in Zahra and George's model) may not lead to innovation. To complete the process further capabilities around assimilation and exploitation (Realized AC) are also needed. Importantly AC is associated with various kinds of search and subsequent activities, not just large firm formal R&D; mechanisms whereby SMEs explore and develop their process innovation, for example are also relevant.

AC is essentially about accumulated learning and embedding of capabilities – search, acquire, assimilate, etc. – in the form of routines (structures, processes, policies and procedures) which allow organizations to repeat the trick. Firms differ in their levels of AC and this places emphasis on how they develop, establish and reinforce these routines. In other words their ability to learn. Developing AC involves two complementary kinds of learning. Type 1 – adaptive learning – is about reinforcing and establishing relevant routines for dealing with a particular level of environmental complexity; and type 2 – generative learning – for taking on new levels of complexity.[78,79]

5.17 Tools and mechanisms to enable search

Within this broad framework firms deploy a range of approaches to organizing and managing the search process. For example, much experience has been gained in how R&D units can be structured to enable a balance between applied research (supporting the 'exploit' type of search) and more wide-ranging 'blue-sky' activities (which facilitate the 'explore' side of the equation.[70] These approaches have been refined further along 'open innovation' lines where the R&D work of others is brought into play, and by ways of dealing with the increasingly global production of knowledge – for example the pharmaceutical giant GSK deliberately pursues a policy of R&D competition across several major facilities distributed around the world. In similar fashion market research has evolved to produce a rich portfolio of tools for building a deep understanding of user needs – and which continues to develop new and further refined techniques – for example, empathic design, lead-user methods and increasing use of ethnography.

Choice of techniques and structures depends on a variety of strategic factors like those explored above – balancing their costs and risks against the quality and quantity of knowledge they bring in. Throughout the book we have stressed the idea that managing innovation is a dynamic capability – something which needs to be updated and extended on a continuing basis to deal with the 'moving frontier' problem. As markets, technologies, competitors, regulations and all sorts of other elements in a complex environment shift so we need to learn new tricks and sometimes let go of older ones which are no longer appropriate. In the following section we'll look at some examples of tools and mechanisms for innovation search, which are emerging in response to a context that sees very high levels of knowledge production, global distribution of such production and of the marketplaces providing the demand signals, increasing virtualization of those markets, growing involvement of users in shaping and 'co-creating' innovation, etc.

Managing internal knowledge connections

One area which has seen growing activity addresses a fundamental knowledge management issue which is well expressed in the statement – '*if only xxx (insert the name of any large organization) knew what it knows*!' In other words how can organizations tap into the rich knowledge (and potential innovation triggers) within its existing structures and amongst its workforce?

This has led to renewed efforts to deal with what is an old problem, for example, Procter & Gamble's successes with 'connect and develop' owe much to their mobilizing rich linkages between people who know things within their giant global operations and increasingly outside it. They use 'communities of practice'[80] – Internet-enabled 'clubs' where people with different knowledge sets can converge around core themes – and they deploy a small army of innovation 'scouts' who are licensed to act as prospectors, brokers and gatekeepers for knowledge to flow across the organization's boundaries (we discuss this in more detail in Chapter 6). Intranet technology links around 10 000 people in an internal 'ideas market' – and some of their significant successes have come from making better internal connections.

3M – another firm with a strong innovation pedigree dating back over a century – similarly put much of its success down to making and managing connections. Larry Wendling, Vice President for Corporate Research, talks of 3M's 'secret weapon' – the rich formal and informal networking which links the thousands of R&D and market-facing people across the organization. Their long-history of breakthrough innovations – from masking tape, through Scotchgard, Scotch tape, magnetic recording tape to Post-its and their myriad derivatives – arise primarily out of people making connections.

It's important to recognize that much of the knowledge lies in the experience and ideas of 'ordinary' employees rather than solely with specialists in formal innovation departments like R&D or market research. Increasingly organizations are trying to tap into such knowledge as a source of innovation via various forms of what can be termed 'high-involvement innovation' systems such as suggestion schemes, problem-solving groups and innovation 'jams'.

VIEWS FROM THE FRONT LINE

Sources of innovation

We look in the usual places for our industry. We look at our customers. We look at our suppliers. We go to trade bodies. We go to trade fairs. We present technical papers. We have an input coming from our customers. What we also try to do is develop inputs from other areas. We've done that in a number of ways. Where we're recruiting, we try to bring in people who can bring a different perspective. We don't necessarily want people who've worked in the type of instruments we have in the same industry . . . certainly in the past we've brought in people who bring a completely different perspective, almost like introducing greensand into the oyster. We deliberately look outside. We will look in other areas. We will look in areas that are perhaps different technology. We will look in areas that are adjacent to what we do, where we haven't normally looked. And we also do encourage the employees themselves to come forward with ideas.

Some of our product ideas have come from an individual who was sitting as a peripheral part of a little project team that was looking at different project ideas, different products for the future of the business. He had an idea. He created something in his garage. He brought it into me and says, what about this? And we looked at it. We had a quick discussion about it, talked to the management team and initiated a development that we did for one of our suppliers. That came right from outside the area we normally operate in. It came through one of our employees, a long-service employee, so not someone who was recent to the business. But it was triggered by him thinking in a different way. An idea came that he has married up to a potential market need because of the job he worked in when he was working in the service and repair area. He said, right, there's an opportunity for this product. He created a prototype out of a piece of drainpipe and some pieces he had taken from the repair area and made a functional model. And from that, we actually created a product that has spawned a product range of small manual instruments, which traditionally the business hasn't been involved with for probably 20 years. So, that's an idea that came from within the business. It came from an existing employee, but it's not something that we would have thought of as part of our normal pipeline.

We didn't immediately see, oh, there's a demand for this, let's do that. This came from him having some local knowledge and talking to customers at lower levels and saying, there's actually a demand for this small product. It's small, it's relatively niche, it's not going to set the world alight, but it enhances our product range and it puts us into an area where we've never been before. So, we're very receptive to those ideas coming forward. We create an environment where we encourage people to question and challenge. We've actually got an appraisal system where we look at people's competencies rather than performance, and one of the competencies we want is, is that person going to question and challenge? Are they willing to say, how can we do this better, how can we do this more effectively? So, continuous improvement is something we look for. But

we also want people to hold up hands and say, hang on a minute, why are you doing it that way? What about this? I've seen this because of something I've done, one of my hobbies or in some of the social activities, and we encourage people to bring those ideas in and work with us to develop that into a product idea. We've actually set up a mechanism where we run a project team where we take people from all areas of the business . . . this is no longer just a product development area. We then put them in a room with all the resources they need for three or four days and say, what we want out of this is a number of product ideas that are different to what we do. Where can we go in the future? Where can you take this little business? Working within the limits of what we're capable of they will come up with product ideas, and the last one that we ran, we had seven or eight product ideas came out.

A full video version and transcript of the interview with Patrick is on the website.

Source: Patrick McLaughlin, Managing Director, Cerulean

One rich source of internal innovation lies in the entrepreneurial ideas of employees – projects which are not formally sanctioned by the business but which build on the energy, enthusiasm and inspiration of people passionate enough to want to try out new ideas. Encouraging internal entrepreneurship – 'intrapreneurship' as it has been termed[81] – is increasingly popular and organizations like 3M and Google make attempts to manage it in a semi-formal fashion, allocating a certain amount of time/space to employees to explore their own ideas.[82] Managing this is a delicate balancing act – on the one hand there is a need to give both permission and resources to enable employee-led ideas to flourish, but on the other there is the risk of these resources being dissipated with nothing to show for them. In many cases there is an attempt to create a culture of what can be termed 'bootlegging' in which there is tacit support for projects which go against the grain.[83] An example in BMW – where these are called 'U-boat projects' –was the Series 3 Estate version which the mainstream company thought was not wanted and would conflict with the image of BMW as a high-quality, high-performance and somewhat 'sporty' car. A small group of staff worked on a U-boat project, even using parts cannibalized from an old VW Rabbit to make a prototype – and the model has gone on to be a great success and opened up new market space.[84]

Extending external connections

The principle of spreading the net widely is well established in innovation studies as a success factor – and places emphasis on building strong relationships with key stakeholders. In a recent IBM survey of 750 CEOs around the world 76% ranked business partner and customer collaboration as top sources for new ideas whilst internal R&D ranked only eighth. The study also indicated that 'outperformers' – in terms of revenue growth – used external sources 30% more than underperformers. It's not hard to see why – the managers interviewed listed the clear benefits from collaboration with partners as things like reduced costs, higher quality and customer satisfaction, access to skills and products, increased revenue, and access to new markets and customers. As one CEO put it, '*We have at our disposal today a lot more capability and innovation in the marketplace of competitive dynamic suppliers than if we were to try to create on our own*' while another stated simply, '*If you think you have all of the answers internally, you are wrong.*'

This emphasizes the need both for better use of existing mainstream innovation agents – for example sales or purchasing as channels to monitor and bring back potential sources of innovation – and for

establishing new roles and structures. In the former case there is already strong evidence of the importance of customers and suppliers as sources of innovation and the key role which relevant staff have in managing these knowledge sources. In the field of process innovation, for example, where the 'lean' agenda of improving on cost, quality and delivery is a key theme, there is strong evidence that diffusion can be accelerated through supply-chain learning initiatives like the UK Industry Forum in the auto components, aerospace, textiles and other sectors.[85,86]

But the 'open innovation' challenge also points us to where further experimentation is needed to make new connections. Table 5.5 identifies these and the following section explores some approaches which represent this 'frontier' in terms of search behaviour.[84]

Table 5.5 Extending search strategies for innovation

Search strategy	Mode of operation
Sending out scouts	Dispatch idea hunters to track down new innovation triggers
Exploring multiple futures	Use futures techniques to explore alternative possible futures; and then develop innovation options
Using the web	Harness the power of the web, through online communities, and virtual worlds, for example, to detect new trends
Working with active users	Team up with product and service users to see the ways in which they change and develop existing offerings
Deep diving	Study what people actually do, rather than what they say they do
Probe and learn	Use prototyping as a mechanism to explore emergent phenomena and act as boundary object to bring key stakeholders into the innovation process
Mobilize the mainstream	Bring mainstream actors into the product and service development process
Corporate venturing	Create and deploy venture units
Corporate entrepreneurship and intrapreneuring	Stimulate and nurture the entrepreneurial talent inside the organization
Use brokers and bridges	Cast the ideas net far and wide and connect with other industries
Deliberate diversity	Create diverse teams and a diverse workforce
Idea generators	Use creativity tools

Sending out scouts

This is a widely used strategy which involves sending out people (full or part time) to search actively for new ideas to trigger the innovation process. (In German they are called *Ideen-Jäger* – idea-hunters – a term which captures the concept well.) They could be searching for technological triggers, emerging markets or trends, competitor behaviour, etc., but what they have in common is a remit to seek things out, often in unexpected places. Search is not restricted to the organization's particular industry; on the contrary, the fringes of an industry or even currently entirely unrelated fields can be of interest.

For example, the mobile phone company O2 has a trend-scouting group of about 10 people who interpret externally identified trends into their specific business context whilst BT has a scouting unit in Silicon Valley which assesses some 3000 technology opportunities a year in California. The four-person operation was established in 1999 to make venture investments in promising telecom start-ups, but after the dotcom bubble burst it shifted its mission towards identifying partners and technologies that BT was interested in. The small team looks at more than 1000 companies per year and then, based on their deep knowledge of the issues facing the R&D operations back in England, they target the small number of cases where there is a direct match between BT's needs and the Silicon Valley company's technology. While the number of successful partnerships that result from this activity is small – typically four or five per year – the unit serves an invaluable role in keeping BT abreast of the latest developments in its technology domain.[84]

Exploring multiple futures

Futures studies of various kinds can provide a powerful source of ideas about possible innovation triggers, especially those which do not necessarily follow the current trajectory. Shell's 'GameChanger' programme is a typical example which makes extensive use of alternative futures as a way of identifying domains of interest for future business which may lie outside the 'mainstream' of their current activities. Increasingly these rich 'science fiction' views of how the world might develop (and the threats and opportunities which it might pose in terms of discontinuous innovations) are being constructed by using a wide and deliberately diverse set of inputs rather than using the relatively narrow frame of reference that company staff might bring. One consequence has been the growth of specialist service companies, which offer help in building and exploring models of alternative futures. See interview with Helen King from Bord Bia about the Irish food industry futures project.

For example, Novo Nordisk, a major Danish pharmaceuticals business makes use of a company-wide scenario-based programme to explore radical futures around their core business. Its 'Diabetes 2020' process involved exploring radical alternative scenarios for chronic disease treatment and the roles which a player like Novo Nordisk could play. As part of the follow-up from this initiative, in 2003 the company helped set up the Oxford Health Alliance, a non-profit collaborative entity which brought together key stakeholders – medical scientists, doctors, patients and government officials – with views and perspectives which were sometimes quite widely separated. To make it happen, Novo Nordisk made clear that its goal was nothing less than the prevention or cure of diabetes – a goal which if it were achieved would potentially kill off the company's main line of business. As Lars Rebien Sørensen, the CEO of Novo Nordisk, explained:

> In moving from intervention to prevention – that's challenging the business model where the pharmaceuticals industry is deriving its revenues! . . .We believe that we can focus on some major global health issue – mainly diabetes – and at the same time create business opportunities for our company.

Another related approach is to build 'concept' models and prototypes to explore reactions and provide a focus for various different kinds of input which might shape/co-create future products and services. Concept cars are commonly used in the automotive industry not as production models but as stepping stones to help understand and shape the products of the future. Similarly Airbus and other aerospace firms have concept aircraft whilst Toyota is working on concept projects around housing, transportation and energy systems.

More recently companies have started to see value in developing such scenarios jointly with other organizations and discover exciting opportunities for cross-industry collaboration (which often means the creation of an entirely new market).

Using the web

At one level the Internet offers a vast library – and the mechanisms to make new connections to and amongst the information it contains. This is, naturally, a widely used approach but it is interesting to look a little more deeply at how particular forms are developing and shaping this powerful tool.

In its simplest form the web is a passive information resource to be searched – an additional space into which the firm might send its scouts. Increasingly there are professional organizations who offer focused search capabilities to help with this hunting, for example, in trying to pick up on emerging 'cool' trends among particular market segments. High-velocity environments like mobile telecommunications, gaming and entertainment depend on picking up early warning signals and often make extensive use of these search approaches across the web.

Developments in communications technology also make it possible to provide links across extranets and intranets to speed up the process of bringing signals into where they are needed. Firms like Zara and Benetton have sophisticated IT systems giving them early warning of emergent fashion trends, which can be used to drive a high-speed flexible response on a global basis.

This rich information source aspect can quickly be amplified in its potential if it is seen as a two-way or multi-way information marketplace. One of the first companies to take advantage of this was Eli Lilly who set up InnoCentive.com as a match-making tool, connecting those with scientific problems to those being able to offer solutions. As InnoCentive CEO Darrel Carroll says, '*Lilly hires a large number of extremely talented scientists from around the world, but like every company in its position, it can never hire all the scientists it needs. No company can.*' There are now multiple sites offering a brokering service, linking needs and means and essentially creating a global marketplace for ideas – in the process providing a rich source of early warning signals.

A further extension of this is to use websites in a more open-ended fashion, as laboratories in which experiments can be conducted or prototypes tested. For example, a site which is growing in popularity is www.secondlife.com – essentially a role-playing game with over six million users. In this alternative world people can create different characters for themselves and interact with each other – in the process creating a powerful laboratory for testing out ideas. Since, by definition, Second Life is the result of people projecting their aspirations and interests in a different space, it offers significant scope for early warning about or even creating new trends. The potential of 'advergaming' is being explored, for example, by US clothing retailer American Apparel which opened a virtual store in Second Life in 2006. In similar fashion social networking sites such as MySpace (with 120 million members) have become a powerful channel for finding and developing music and other entertainment ideas, challenging 'traditional' marketing approaches.

The largest network of web-based communities for innovation is organized by CommuniSpace, a Boston-based company that organizes and hosts communities around products and brands for major

manufacturers around the world. At the beginning of 2007, CommuniSpace operated more than 300 parallel communities. In each of these communities, members discuss either concrete product concepts posted by companies, or develop in a more open discussion new ideas and trends. Each community contains between 50 and 200 members, who are screened, selected and invited by CommuniSpace to participate.

Beyond these uses come those which bring users into the equation as 'co-creators' – a theme we discussed earlier. For example, BMW makes use of the web to enable a 'Virtual Innovation Agency' – a forum where suppliers from outside the normal range of BMW players can offer ideas that BMW may be able to use. These can be both product related and also process related, for example a recent suggestion was for carbon recycling out of factory waste. Although this carries the risk that many 'cranks' will offer ideas, suggestions may also provide stepping stones to new domains of interest.

Working with active users

As we saw earlier, an increasingly significant strategy involves seeing users not as passive consumers of innovations created elsewhere but rather as active players in the process. Their ideas and insights can provide the starting point for very new directions and create new markets, products and services. The challenge now is to find ways of identifying and working with such lead users.

One of the clues is that active users are often at the fringes of the mainstream – in diffusion theory they are not even early adopters but rather active innovators. They are tolerant of failure, prepared to accept that things go wrong but through mistakes they can get to something better – hence the growing interest in participating in 'perpetual beta testing' and development of software and other online products. More often than not active users love to get involved because they feel strongly about the product or service in question; they really want to help and improve things. LEGO found that the prime motivator amongst its communities of user-developers was the recognition which came with having their products actually made and distributed. Microsoft maintains a group of so-called 'Microsoft buddies' – about 1500 power users of their products such as web masters, programmers, software vendors, etc. Strong ties to these customers support Microsoft. They participate in beta testing, help to improve existing products, and submit ideas for new functionalities. The users get no monetary rewards, but receive free software and are invited to bi-annual meetings. To prevent a 'not-invented-here' problem within Microsoft's internal development teams, special liaison officers act as bridges between the 'buddies' and the development teams of the company.

The German firm Webasto makes a wide range of roofing systems for cars including the sophisticated cabriolet features on luxury cars like the Porsche, Volvo, Saab and Ferrari. They went through a systematic approach to understand what lead users are and how to identify them. Building on existing literature they identified four aspects that really drive people's propensity to innovate (cognitive complexity, team expertise, general knowledge, willingness to help). Based on those aspects they developed a questionnaire that they sent out, depending on the project in question, to up to 5000 people from their database. About 20% returned the questionnaires, there were several selection steps (e.g. age bracket, innovation potential) before they arrived at a lead-user group of between 10 and 30. The lead users committed to come for an entire weekend, and without pay.

'Deep diving'

Most market research has become adept at hearing the 'voice of the customer' via interviews, focus groups, panels, etc. But sometimes what people say and what they actually do is different. In recent years there has been an upsurge in the use of anthropological-style techniques to get closer to what

people need/want in the context in which they operate. 'Deep diving' is one of many terms used to describe the approach – 'empathic design' and 'ethnographic methods' are others.

Much of the research toolkit here originates from the field of anthropology where the researcher aims to gain insights primarily through observation and immersing herself in the day-to-day life of the object of study – rather than through questioning only. For example, to ensure their new terminal at Heathrow would address user needs well into the future, BAA commissioned some research into what users in 2020 might look like, and what their needs might be. Of course the ageing population came up as an issue; focusing on the behaviour of older people at the airport they noticed that they tend to go to the toilet rather frequently. So, the conclusion was to plan for more toilets at Terminal 5. However, when someone really followed people around they noted that many people going to the restrooms did not actually go to the toilet – but went there because it was quiet, and they could actually hear the announcements!

Probe and learn

One of the problems about a radically different future is that it is hard to imagine it and to predict how things will play out. Sometimes a powerful approach is to try something out – probe – and learn from the results, even if they represent a 'failure'. In this way emergent trends, potential designs, etc. can be explored and refined in a continuing learning process.

There are two complementary dimensions here – the concept of 'prototyping' as a means of learning and refining an idea; and the concept of pilot-scale testing before moving across to a mainstream market. In both cases the underlying theme is essentially one of 'learning as you go', trying things out, making mistakes but using the experience to get closer to what is needed and will work. As Geoff Penney, Chief Information Officer of the US-based investment house Charles Schwab, once said, '*To avoid running too much risk we run pilots, and everyone knows it is "just" a pilot and is not afraid of making suggestions for improvement – or killing it.*'

Not surprisingly prototyping is particularly relevant in product-based firms. For example, Bang & Olufsen has revitalized its prototyping department and made it refer directly to the innovation hub of the company. The prototyping department is engaged in new ideas as early as possible and the experiences are that this strongly supports the process. And, after a period with disappointing results in applying electronics in toys, LEGO made a change in their development approach towards more intensive use of prototypes. Prototypes were created within days – often within hours – after the ideas matured. The result was a much more precise dialogue both within the organization and with the main customers. Eventually, this led to more simple technology – and more success in terms of sales.

But the principles also apply in services – for example the UK National Health Service and the Design Council have been prototyping new options for dealing with chronic diseases like diabetes, heart conditions and Alzheimer's disease. The aim is to learn by doing and also by engaging with the multiple stakeholders who will be part of whatever new system co-evolves. See case study of NHS/RED and podcast interview with Lynn Maher.

Corporate venturing

One widely used approach involves setting up of special units with the remit – and more importantly the budget – to explore new diversification options. Loosely termed 'corporate venture' (CV) units they actually cover a spectrum ranging from simple venture capital funds (for internal and externally generated ideas) through to active search and implementation teams, acquisition and spin-out specialists. For example, Nokia has a very interesting corporate venturing approach for finding innovation. It has moved beyond 'not invented here' and is embracing 'let's find the best ideas wherever they are'. Nokia

Venturing Organization is focused on corporate venturing activities that include identifying and developing new businesses, or as they put it 'the renewal of Nokia'. Nokia Venture Partners invests exclusively in mobile and Internet Protocol (I/P) related start-up businesses. They have a very interesting third group called Innovent that directly supports and nurtures nascent innovators with the hope of growing future opportunities for Nokia.

SAP has set up a venture unit called SAP Inspire to fund start-ups with interesting technologies. The mission of the group is to 'be a world-class corporate venturing group that will contribute, through business and technical innovation, to SAP's long-term growth and leadership'. It does so by:

- seeking entrepreneurial talent within SAP and providing an environment where ideas are evaluated on an open and objective basis
- actively soliciting and cultivating ideas from the SAP community as well as effectively managing the innovation process from idea generation to commercialization
- looking for growth opportunities that are beyond the existing portfolio but within SAP's overall vision and strategy.

The purpose of corporate venturing is to provide some ring-fenced funds to invest in new directions for the business. Such models vary from being tightly controlled (by the parent organization) to being fully autonomous. (Chapter 10 discusses this approach in detail.)

Use brokers and bridges

As we saw earlier, innovation can often take a 'recombinant' form – and the famous saying of William Gibson is relevant here – '*the future is already here, it's just unevenly distributed*'. Much recent research work on networks and broking suggests that a powerful search strategy involves making or facilitating connections – 'bridging small worlds'. Increasingly organizations are looking outside their 'normal' knowledge zones as they begin to pursue 'open innovation' strategies. But sending out scouts or mobilizing the Internet can result simply in a vast increase in the amount of information coming at the firm – without necessarily making new or helpful connections. There is a clear message that networking – whether internally across different knowledge groups – or externally – is one of the big management challenges in the twenty-first century. Increasingly organizations are making use of social networking tools and techniques to map their networks and spot where and how bridges might be built – and this is a source of a growing professional service sector activity. Firms like IDEO specialize in being experts in nothing except the innovation process itself – their key skill lies in making and facilitating connections.

A number of new brokers today use the Internet to facilitate innovation. We have already mentioned InnoCentive and CommuniSpace above. Other web-based brokers are companies like YET2.com, who provide bridging capabilities for (external) inventors with ideas or concepts to corporate development units.

Learning to search at the frontier

As we saw earlier there is a long-standing discussion in innovation literature around 'exploration' and 'exploitation' – both are search behaviours but one is essentially incremental, doing what we do better, adaptive learning; whilst the second is radical, do different, generative learning. A key issue is how organizations can operationalize these different behaviours – what 'routines' (structures, processes, behaviours) can they embed to enable effective exploration and exploitation? Whilst the literature is fairly clear about routines for exploitation – essentially innovation approaches to enable continuous incremental extension and adaptation – there is less about exploration.

Striking a suitable balance is tricky enough under what might be called 'steady-state' innovation conditions, but the work of Christensen and others on disruptive innovation suggests that under certain conditions (for example the emergence of completely new markets) established incumbents get into difficulties. They are too focused in their search routines (both explore and exploit) for dealing with what they perceive as a relevant part of the environment (their market 'value network') and they fail to respond to a new emerging challenge until it is often too late. This is partly because their search behaviour is so routinized, embedded in reward structures and other reinforcement mechanisms, that it blinds the organization to other signals.[87–89]

Importantly this is not a failure in innovation management per se – the firms described are in fact very successful innovators under the 'steady-state' conditions of their traditional marketplace, deploying textbook routines and developing close and productive networks with customers and suppliers. The problem arises at the edge of their 'normal' search space and under the discontinuous conditions of new market emergence.

In similar fashion incumbent organizations often suffer when technologies shift in discontinuous fashion. Again their established repertoire of search routines tends towards exploitation and bounds their search space – with the risk that developments outside can achieve considerable momentum and by the time they are visible the organization has little reaction time.[90] This is further complicated by the issue of sunk costs which commit the incumbent to the earlier generation of technology, and the 'sailing ship' effect whereby their exploitation routines continue to bring a stream of improvements to the old technology and sustain that pathway while the new technology matures.[91] (The 'sailing ship' effect refers to the fact that when steamships were first invented it gave a spur to an intensive sequence of innovation in sailing ship technology which meant the two could compete for an extended period before the underlying superiority of steamship technology worked through.)

It is also clear that another key issue is how to integrate these different approaches within the same organization – how (or even if it is possible) to develop what Tushman and O'Reilly call 'ambidextrous' capability around innovation management.[92] Much recent literature on disruptive, radical, discontinuous innovation highlights the tensions which are set up and the fundamental conflicts between certain sets of routines – for example, Christensen's theory suggests that by being too good at 'exploit' routines to listen to and work with the market, incumbent firms fail to pick up or respond to other signals from new fringe markets until it is too late.

5.18 Two dimensions of innovation search

The problem is not just that such firms fail to get the balance between exploit and explore right but also because there are choices to be made about the overall direction of search. Characteristic of many of these businesses is that they continue to commit to 'explore' search behaviour – but in directions which reinforce the boundaries between them and emergent new innovation space. For example, in many of the industries that Christensen studied high rates of R&D investment were going on to push technological frontiers even further – resulting in many cases in 'technology overshoot'. This is not a lack of search activity but rather a problem of direction.

The issue is that the search space is not one-dimensional. As Henderson and Clark point out it is not just a question of searching near or far from core knowledge concepts but also across configurations – the 'component/architecture challenge'. They argue that innovation rarely involves dealing with a single technology or market but rather a bundle of knowledge, which is brought together into a configuration.

Successful innovation management requires that we can get hold of and use knowledge about components but also about how those components can be put together – what they termed the architecture of an innovation.[93]

One way of looking at the search problem is in terms of the ways in which 'innovation space' is framed by the organization. Just as human beings need to develop cognitive schemas to simplify the 'blooming, buzzing confusion' which the myriad stimuli in their environment offer them, so organizations make use of simplifying frames. They 'look' at the environment and take note of elements which they consider relevant – threats to watch out for, opportunities to take advantage of, competitors and collaborators, etc. The construction of such frames helps give the organization some stability and – amongst other things – defines the space within which it will search for innovation possibility. Whilst there is scope for organizations to develop their own individual ways of seeing the world – their business models – in practice there is often commonality within a sector. So most firms in a particular field will adopt similar ways of framing – assuming certain 'rules of the game', following certain trajectories in common.

These frames correspond to accepted 'architectures' – the ways in which players see the configuration within which they innovate. The dominant architecture emerges over time but once established becomes the 'box' within which further innovation takes place. We are reminded of the difficulties in thinking and working outside this box because it is reinforced by the structures, processes and toolkit – the core routines – which the organization (and its key reference points in a wider network of competitors, customers and suppliers) has learned and embedded.

This perspective highlights the challenge of moving between knowledge sets. Firms can be radical innovators but still be 'upstaged' by developments outside their search trajectory. The problem is that search behaviour is essentially bounded exploration and raises a number of challenges:

- When there is a shift to a new mindset – cognitive frame – established players may have problems because of the reorganization of their thinking which is required. It is not simply adding new information but changing the structure of the frame through which they see and interpret that information. They need to 'think outside the box' within which their *bounded* exploration takes place – and this is difficult because it is highly structured and reinforced.[94]
- This is not simply a change of personal or even group mindset – the consequence of following a particular mindset is that artefacts and routines come into place which block further change and reinforce the status quo. Christensen points out, for example, the difficulty of seeing and accepting the relevance of different signals about emerging markets because the reward systems around sales and marketing are biased towards reinforcing the established market.[87] Henderson and Clark highlight the problems of social and knowledge networks which need to be abandoned and new ones set up in the move to new architectures in photolithography equipment.[93] Day and Shoemaker show how organizations develop particular ways of seeing and not seeing.[95] These are all part of the bounding process – essentially they create the box we need to get out of.
- Architectural – as opposed to component innovation – requires letting go of existing networks and building new ones.[96] This is easier for new players to do, hard for established players, because the inertial tendency is to revert to established pathways for knowledge and other exchange – the finding, forming and performing problem.
- The new frame may not necessarily involve radical change in technology or markets but rather a rearrangement of the existing elements. Low-cost airlines did not, for example, involve major technological shifts in aircraft or airport technology but rather problem solving to make flying available to

an under-served market segment. Similarly the 'bottom of the pyramid' development is not about radical new technologies but about applying existing concepts to under-served markets with different characteristics and challenges.[20] There may be incremental innovation to make the new configuration work but this is not usually new to the world but rather problem solving.

5.19 A map of innovation search space

In summarizing the different sources of innovation and how we might organize and manage the process of searching for them we can use a simple map – see Figure 5.5. The vertical axis refers to the familiar 'incremental/radical' dimension in innovation whilst the second relates to environmental complexity – the number of elements and their potential interactions. Rising complexity means that it becomes increasingly difficult to predict a particular state because of the increasing number of potential configurations of these elements. In this way we capture the 'component/architecture' challenge outlined above. Firms can innovate at component level – the left-hand side – in both incremental and radical fashion but such changes take place within an assumed core configuration of technological and market elements – the dominant architecture. Moving to the right introduces the problem of new and emergent architectures arising out of alternative ways of framing amongst complex elements.

Organizations simplify their perceptions of complex environments, choosing to pay attention to certain key features which they interpret via a shared mental model. They learn to manage innovation within this space and construct routines – embedding structures and processes and building networks to support and enable work within it. In mature sectors a characteristic is the dominance of a particular logic which gives rise to business models of high similarity, for example, industries like pharmaceuticals or integrated circuit design and manufacture are characterized by a small number of actors playing to a similar set of rules involving R&D spend, sales and marketing, etc.

But whilst such models represent a 'dominant logic' or trajectory for a sector they are not the only possible way of framing things. In high-complexity environments with multiple sources of variety it becomes possible to configure alternative models – to 'reframe' the game and arrive at an alternative architecture. Whilst many attempts at reframing may fail, from time to time alternatives do emerge which better deal with the environmental complexity and become the new dominant model.

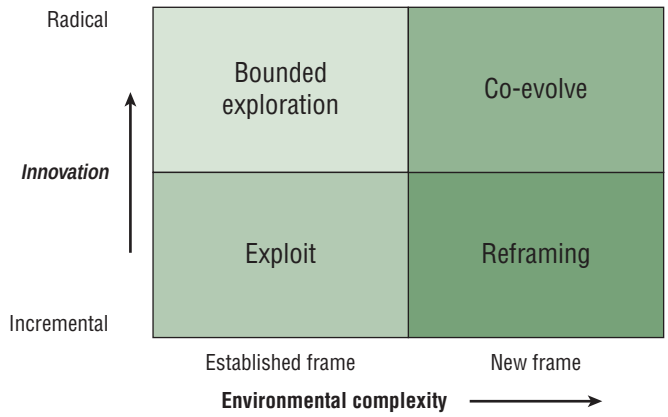

FIGURE 5.5: Innovation search space

Using this idea of different 'frames' we can explore four zones in Figure 5.5 which have different implications for the ways in which innovation is managed. Whilst those approaches for dealing with the left-hand side – zones 1 and 2 – are well developed we argue that there is still much to learn about the right-hand side challenges and how to approach them in practical terms – via methods and tools.

Zone 1 corresponds to the 'exploit' field discussed earlier and assumes a stable and shared frame within which adaptive and incremental development takes place. Search routines here are associated with refining tools and methods for technological and market research, deepening relationships with established key players. Examples would be working with key suppliers, getting closer to customers and building key strategic alliances to help deliver established innovations more efficiently.

The structures for carrying out this kind of search behaviour are clearly defined with relevant actors – department or functions responsible for market research, product (service) development, etc. They involve strong ties in external networks with customers, suppliers and other relevant actors in their wider environment. The work of core groups like R&D is augmented by high levels of participation across the organization – because the search questions are clearly defined and widely understood high involvement of nonspecialists is possible. So procurement and purchasing can provide a valuable channel as can sales and marketing – since these involve contact with external players.[97] Process innovation can be enabled by inviting suggestions for incremental improvement across the organization – a high-involvement *kaizen* model.[15]

Zone 2 involves search into new territory, pushing the frontiers of what is known and deploying different search techniques for doing so. But this still takes place within an established framework – a shared mental model which we could term 'business model as usual'. R&D investments here are on big bets with high strategic potential, patenting and IP strategies aimed at marking out and defending territory, riding key technological trajectories (such as Moore's law in semiconductors). Market research similarly aims to get close to customers but to push the frontiers via empathic design, latent needs analysis, etc. Although the activity is risky and exploratory it is still governed strongly by the frame for the sector – as Pavitt observed there are certain sectoral patterns which shape the behaviour of all the players in terms of their innovation strategies.[98]

The structures involved in such exploration are, of necessity, highly specialized. Formal R&D and within that sophisticated specialization is the pattern on the science/technology frontier, often involving separate facilities. Here too there is mobilization of a network of external but similarly specialized researchers – in university, public and commercial laboratories – and the formation of specific strategic alliances and joint ventures around a particular area of deep technology exploration. The highly specialized nature of the work makes it difficult for others in the organization to participate – and indeed this gap between worlds can often lead to tensions between the 'operating' and the 'exploring' units and the boardroom battles between these two camps for resources are often tense. In similar fashion market research is highly specialized and may include external professional agencies in its network with the task of providing sophisticated business intelligence around a focused frontier.

These two zones represent familiar territory in discussion of exploit/explore in innovation search. But arguably they take place within an accepted frame, a way of seeing the world which essentially filters and shapes perceptions of what is relevant and important. This corresponds to Henderson and Clark's architecture and, as we have argued, defines the 'box' within which innovative activity is expected to occur. Such framing is, however, a construct and open to alternatives – and Zone 3 is essentially associated with reframing. It involves searching a space where alternative architectures are generated, exploring different permutations and combinations of elements in the environment. Importantly this often happens by working with elements in the environment not embraced by established business

models – for example, Christensen's work on fringe markets,[87] Prahalad's bottom of the pyramid[20] or von Hippel's extreme users.[26]

For example, the low-cost airline industry was not a development of new product or process – it still involves airports, aircraft, etc. Instead the innovation was in position and paradigm, reframing the business model by identifying new elements in the markets – students, pensioners, etc. – who did not yet fly but might if the costs could be brought down. Rethinking the business model required extensive product and process innovation to realize it – for example in online booking, fast turnaround times at airports, multi-skilling of staff, etc. – but the end result was a reframing and creation of new innovation space.

Zone 4 represents the 'edge of chaos' complex environment where innovation emerges as a product of a process of co-evolution. This is not the product of a predefined trajectory so much as the result of complex interactions between many independent elements.[99,100] Processes of amplification and feedback reinforce what begin as small shifts in direction and gradually define a trajectory. This is the pattern – the 'fluid state' – before a dominant design emerges and sets the standard.[52] As a result it is characterized by very high levels of experimentation.

Search strategies here are difficult since it is impossible to predict what is going to be important or where the initial emergence will start and around which feedback and amplification will happen. The best an organization can do is to try and place itself within that part of its environment where something might emerge and then develop fast reactions to weak signals. 'Strategy' here can be distilled down to three elements – be in there, be in there early and be in there actively (i.e. in a position to be part of the feedback and amplification mechanisms).

With these four zones we have a simple map on which to explore innovation routines. Our concern in this chapter is with search routines – how do organizations manage the process of recognizing and acquiring key new knowledge to enable the innovation process? There are also implications for how they assimilate and transform (select) and how they exploit and implement but we will not focus on those at this stage. As we have suggested each zone represents a different kind of challenge and leads to the use of different methods and tools. And whilst the toolbox is well stocked for zones 1 and 2 there is value in experimentation and experience sharing around zones 3 and 4.

Table 5.6 summarizes the challenge.

Table 5.6

Zone	Search challenges	Tools and methods	Enabling structures
1 'Business as usual' – innovation but under 'steady-state' conditions, little disturbance around core business model	Exploit – extend in incremental fashion boundaries of technology and market. Refine and improve. Close links/strong ties with key players	'Good practice' new product/service development Close to customer Technology platforms and systematic exploitation tools	Formal and mainstream structures High involvement across organization Established roles and functions (including production, purchasing, etc.)

(*continued*)

Table 5.6 **(Continued)**

Zone	Search challenges	Tools and methods	Enabling structures
2 'Business model as usual' – bounded exploration within this frame	Exploration – pushing frontiers of technology and market via advanced techniques. Close links with key strategic knowledge sources	Advanced tools in R&D, market research. Increasing 'open innovation' approaches to amplify strategic knowledge search resources	Formal investment in specialized search functions – R&D, market research, etc.
3 Alternative frame – taking in new/different elements in environment Variety match ing, alternative architectures	Reframe – explore alternative options, introduce new elements Experimentation and open-ended search Breadth and periphery important	Alternative futures Weak signal detection User-led innovation Extreme and fringe users Prototyping – probe and learn Creativity techniques Bootlegging, etc.	Peripheral/ad hoc Challenging – 'licensed fools' CV units Internal entrepreneurs Scouts Futures groups, brokers, boundary spanning and consulting agencies
4 Radical – new to the world – possibilities. New architecture around as yet unknown and established elements	Emergence – need to co-evolve with stakeholders Be in there Be in there early Be in there actively	Complexity theory – feedback and amplification, probe and learn, prototyping and use of boundary objects	Far from mainstream 'Licensed dreamers' Outside agents and facilitators

Summary and further reading

In this chapter we've looked at the many ways in which the innovation process can be triggered – and the need for multiple approaches to the problem of searching for them. The management challenge lies in recognizing the rich variety of sources and configuring search mechanisms which balance the 'exploit' and 'explore' domains, providing a steady stream of both incremental (do what we do better) ideas and more radical (do different) stimuli – and doing so with limited resources.

The long-running debate about which sources – demand pull or knowledge push – are most important is well covered in Freeman and Soete's work (*The Economics of Industrial Innovation*, MIT Press, 1997),