CHAPTER 6 Sources of Innovation

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LEARNING OBJECTIVES

By the end of this chapter you will understand:

- That innovation comes from wide range of different sources and can be triggered in a variety of ways
- The idea of 'push' and 'pull' forces and their interaction
- Innovation as a pattern of occasional breakthrough and long periods of incremental improvement
- The importance of different sources over time
- Where and when you might search for opportunities to innovate

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, too enthused by the desire to tell the world 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 that make new connections. They form the basis of the cartoon model of innovation that 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. And George de Mestral noticed the way plant burrs became attached to his dog's fur while returning home from a walk in the Swiss Alps. This provided him with the inspiration behind Velcro fasteners.

But of course there is much more to it than that – as we saw in Chapter 3. 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. This chapter explores some of the many sources of innovation.

6.1 WHERE DO INNOVATIONS COME FROM?

A quick review of the contents of anyone's house will throw up a wide range of innovations – and the chances are that these will have been the result of many different kinds of triggers. **Figure 6.1** indicates a wide range of stimuli that could be relevant to kick-starting the innovation journey, and we will explore some of the important sources in this chapter.

It's important to remember that a wide variety of sources means that we will need similarly diverse approaches to search for key innovation signals – something which is also discussed in this chapter.

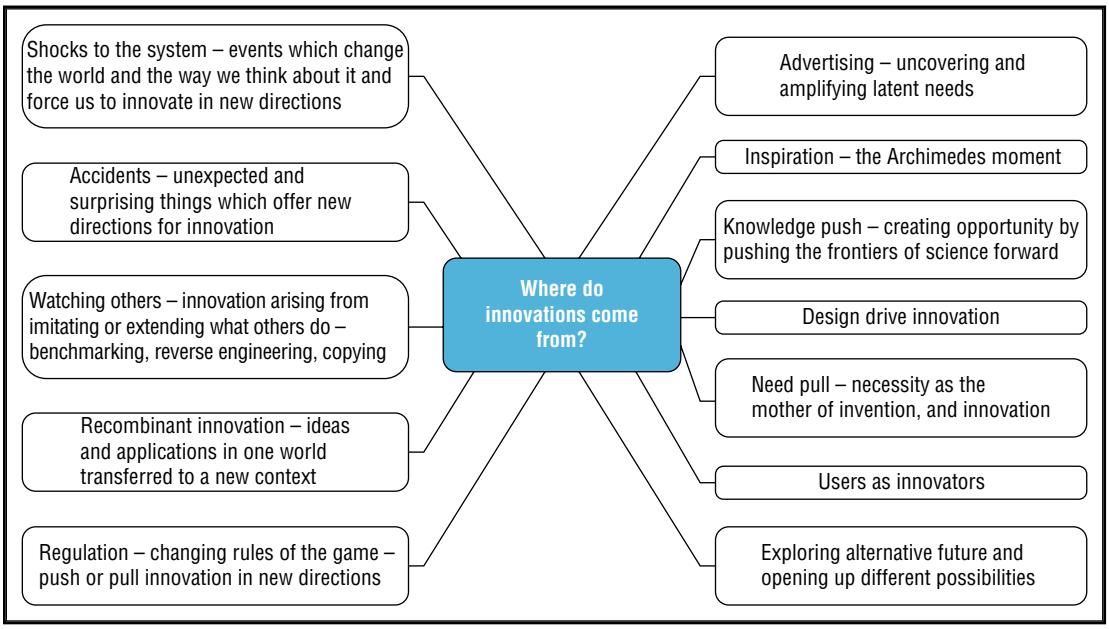

FIGURE 6.1 Where do innovations come from?

6.2 KNOWLEDGE PUSH

Around the world, approximately $1,700 billion is spent every year on research and development (R&D).[1] All this activity, taking place in laboratories and science facilities in the public and private sector, isn't for the sheer fun of discovery. It's driven by a clear understanding of the importance of R&D as a source of innovation. Although there have always been solo researchers, from a very early stage, the process of exploring and codifying at the frontiers of knowledge has been a systematic activity involving a wide network of people sharing their ideas. In the twentieth century, the rise of the large corporate research laboratory was a key instrument of progress; Bell Labs, ICI, Bayer, BASF, Philips, Ford, Western Electric and DuPont (all founded in the early 1900s) are good examples of such 'idea powerhouses' [1].

Now we are in a new era in which R&D is becoming more open and distributed and the large central laboratory is giving way to networks of collaborating groups inside and between firms. This involves some big changes; for example, the giant Philips research complex at Eindhoven in the Netherlands, established a hundred years ago, has moved away from white-coated armies of company researchers in a corporate laboratory to operating as a science campus on the site involving many different research groups. Some work directly for Philips, others are independent small firms and others are joint ventures. But the underlying idea is still the same; generate ideas and they will provide the basis for a steady stream of innovations.

This model of 'knowledge push' has a strong track record [2]. During the twentieth century it produced a steady stream of innovations that fed rapidly growing markets for automobiles, consumer electrical products, synthetic materials and industrial chemicals – and the vast industrial complexes needed to fight two major wars. The output of such R&D wasn't simply around product innovation – many of the key technologies underpinning process innovations, especially in the growing field of automation and information/communications technology, also came from such organized R&D effort. **Table 6.1** gives a few examples of knowledge-push innovations, each of which has been the source of a wave of subsequent innovative activity.

Organized R&D of this kind involves a systematic commitment of specialist staff, equipment, facilities and resources targeted at key technological problems or challenges. The aim is to explore, but much of that exploration involves elaborating and stretching trajectories, which are 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 along that path. The rise of 'Big Pharma' – the huge global pharmaceutical industry – is based on big and sustained R&D expenditure (estimated at $90 billion in 2016 in the USA and Europe alone).[2] However much of it is spent on development and elaboration punctuated by the occasional breakthrough into 'blockbuster' drug territory.[3] While there are

Table 6.1 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
Carbon fibre	CRISPR technology	Nanoparticles

[1] *Source*: http://uis.unesco.org/apps/visualisations/research-and-development-spending/
[2] *Source*: https://pharmaintelligence.informa.com/~/media/informa-shop-window/pharma/2019/files/whitepapers/top-10-best-selling-drugs-of-2018-fund-us-and-eu-pharma-rd.pdf
[3] A blockbuster drug is usually defined as one that earns in excess of $1 billion for its manufacturers over its lifetime.

spectacular success stories (the top 10 drugs in the United States in 2016 had earned nearly $66 billion), the real value from such R&D investment comes in the systematic improvement across a broad frontier of products and the processes that created them.

It's a story of occasional breakthrough punctuated by long periods of incremental innovation, consolidating around that idea. We can see it play out in the semiconductor and computer industries that have become linked to a long-term trajectory, which followed from the early 'breakthrough' years of the industry. Moore's Law (named after Gordon Moore, one of the founders of Intel) essentially sets up a trajectory that shapes and guides innovation based on the idea that the size will shrink and the power will increase by a factor of 2 every two years.[4] 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.

As we saw in Chapter 1 industries grow through innovation. For example the chemical industry moved from making 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 that was carried out on 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 output.

Another good illustration is the camera. Originally invented in the late nineteenth century, the dominant design gradually emerged with an architecture which we would recognize – shutter and lens arrangement, focusing principles, back plate for film or plates and so on. 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 'idiot-proof' model camera (the Box Brownie), which opened up photography to a mass market. This pattern stabilized for an extended period in the twentieth century; however, by the 1980s, we saw another surge in the research around new imaging technologies and the product changed dramatically with the growth of digital cameras and then a host of other imaging devices such as phones and tablets. Although the core players in the industry have shifted positions, the underlying process of innovation driven by scientific research remains the same, and there are still plenty of patents being registered around this. (The recent legal battles between Apple and Samsung are one illustration of the strategic importance of such knowledge in playing out the innovation game.)

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]. It's a common pattern and one that 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 in Chapter 7. It forms the basis of much R&D strategy in big corporations – and also opens up space for individual inventors to spot new niches and different directions.

Knowledge push has long been a source of innovative start-ups where entrepreneurs have used ideas based on their own research (or that of others) to create new ventures. This model underpins the success of many high-tech regions – for example, Silicon Valley and Route 128 in the United States, 'medical valley' around the city of Nuremburg in Germany, or the Cambridge area in the United Kingdom, where giant technology businesses such as ARM (whose chips are at the heart of most mobile phones) were founded as spin outs from the university. (We discuss this in more detail in Chapter 12.)

[4] G. Moore, 'Cramming more components onto integrated circuits', *Electronics Magazine*, 1965.

6.3 NEED PULL

Knowledge creation is a field of possibilities for innovation. But – as we saw in Chapter 3 – 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![5] 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 need to recognize that another key driver of innovation is needed – 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 to 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 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*', while Procter & Gamble began a business meeting needs for domestic lighting (via candles) and moved across into an ever-widening range of household needs from soap to nappies to cleaners, toothpaste and beyond. Their 'Pampers' brand of nappies illustrates this process well; its origins in the 1950s lay in the experience of one of their researchers, Vic Mills, who was babysitting his new-born grandson and became frustrated at the amount of time and trouble involved in washing cloth nappies. They began a development program and the product eventually came to market in 1961; it is still a major contributor to the business, with around $10 billion in global sales in 2017 and 41% of the world market share.

Case Study 6.1 gives another example drawn from the world of domestic tableware.

CASE STUDY 6.1 Continuous Innovation Through Demand Pull

Two hundred years ago, Churchill Potteries began life in the United Kingdom making a range of crockery and tableware. That it is still able to do so today, despite a turbulent and highly competitive global market says much for the approach which 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 have 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: Adapted from P. Marsh, 'Ingredients for success on a plate', *Financial Times*, March 26, p. 16, 2008.

Just as the knowledge-push model involves a mixture of occasional breakthroughs followed by extensive elaboration on the basic theme, searching around the core trajectory, so the same is true of need pull. Occasionally, it involves a 'new to the world' idea that offers a new 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, while the numbers and percentages vary slightly, the underlying picture is clear – there are very few 'new to the world' products and

[5] R.W. 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.'

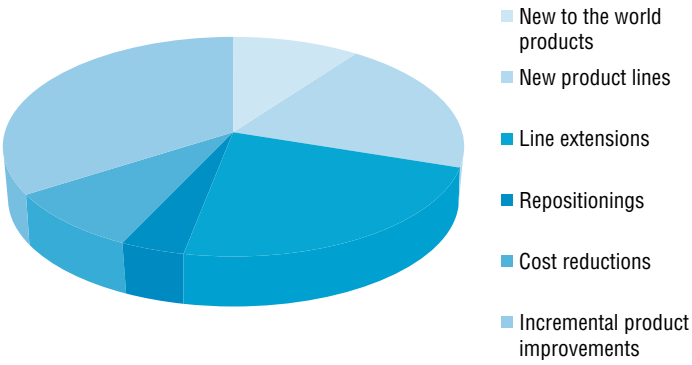

FIGURE 6.2 Types of new products [6]

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

very many extensions, variations and adaptations around those core ideas [4]. **Figure 6.2** 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 [5]. (We return to this theme in Chapter 10.) Advertising and branding play a key role in this process – essentially using psychology to tune into – or even stimulate and create – basic human needs. Much recent research has focused on detailed ethnographic studies of what people actually do and how they actually use products and services – using the same approaches which anthropologists use to study strange new tribes to uncover hidden and latent needs [6,7].

Case Study 6.2 gives an example of Hyundai's efforts to understand its customers, showing how a major corporation builds in such techniques to develop a rich understanding of latent and potential user needs.

CASE STUDY 6.2 Understanding User Needs in Hyundai Motor

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 the customer needs and aspirations – an approach that they used to good effect in developing the Santa Fe, reintroduced to the US market in 2007. The headline for their development program 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 United States were able to use.

Analysis of existing vehicles suggested that 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, and so on [8].

Source: H. Kluter and D. Mottram, 'Hyundai uses "Touch the market" to create clarity in product concepts'. Product Development Management Association, 2007.

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 among a shared group, e.g., along a supply chain) and consumer markets where the underlying need may be much more basic – food, shelter and mobility – and appeal to a much greater number of people. Importantly, there is also a 'bandwagon' effect – as more people adopt so that the innovation becomes modified to take on board their needs – and the process accelerates [9].

It is also a key source of opportunity for entrepreneurial start-ups. Identifying a need that no one has worked on before or finding novel ways to meet an existing need lie behind many new business ideas. For example, Jeff Bezos picked up on the needs (and frustrations) around conventional retail and has built the Amazon empire on the back of using new technologies to meet these in a different way. AirBnB ('*I need to find somewhere to stay*'), NextBike, Zipcar ('*I need easy short-term access to transport*') and WhatsApp ('*I need to communicate with my friends*') are other well-known examples.

A good source of opportunity for entrepreneurs is to look at the underlying need which people have for goods and services – and then to ask if there are different ways of expressing or meeting this need. For example, the huge industry around selling drills and screws and other devices to the domestic market is not about a desire for owning power tools but reflects a more basic need – *how can I put a picture or photograph on the wall?* Maybe there are other ways of meeting this need and new business opportunities behind that?

It's also important to recognize that innovation is not always about commercial markets or consumer needs; social innovation is also important. Whether it's providing health care or clean water in developing countries or more effective education or social services in established industrial economies, the need for change is clear and provides an engine for increasing innovation. Some examples of major social innovations that grew out of meeting needs are the kindergarten (providing childcare when both parents are working), the National Childbirth Trust (providing education and information to new parents about all aspects of childbirth), the Open University (providing access to higher education to those students once excluded by the barriers of wealth and work) and the Big Issue (providing employment and identity to homeless people).

6.4 MAKING PROCESSES BETTER

Of course needs aren't just about external markets for products and services – we can see the same phenomenon of need pull working inside organizations, 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 experiences these needs first hand. The successful model of 'kaizen', which underpins the success of firms such as Toyota, is fundamentally about sustained, high-involvement incremental process innovation along these lines [10], and we can see its application in 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' [11–13].

Case Study 6.3 provides an example.

This kind of process improvement is of particular relevance in the public sector, where the issue is not about creating wealth but of providing value for money in service delivery. Many applications of 'lean' and similar concepts can be found that apply this principle – for example, in reducing waiting times or improving patient safety in hospitals, in speeding up delivery of services such as car taxation and passport issuing, and even in improving the collection of taxes!

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 6.4**) provides a good illustration – for decades, the need to produce smooth flat

CASE STUDY 6.3 Pretty in Pink

Walking through the plant belonging to Ace Trucks (a major producer of forklift trucks) in Japan, the first thing that strikes you is the colour scheme. In fact, you would need to be blind not to notice it – among the usual rather dull greys and greens of machine tools and other equipment, there are flashes of pink. Not just a quiet pastel tone but a full-blooded, shocking pink, which would do credit to even the most image-conscious flamingo. Closer inspection shows that these flashes and splashes of pink are not random but associated with particular sections and parts of machines – and the eye-catching effect comes in part from the sheer number of pink-painted bits, distributed right across the factory floor and all over the different machines.

What is going on here is not a bizarre attempt to redecorate the factory or a failed piece of interior design. The effect of catching the eye is quite deliberate – the colour is there to draw attention to the machines and other equipment that have been modified. Every pink splash is the result of a *kaizen* project to improve some aspect of the equipment, much of it in support of the drive towards 'total productive maintenance' (TPM) in which every item of the plant is available and ready for use 100% of the time. This is a goal like 'zero defects' in total quality – certainly ambitious, possibly an impossibility in the statistical sense, but one which focuses the minds of everyone involved and leads to extensive and impressive problem finding and solving. TPM programs have accounted for year-on-year cost savings of 10–15% in many Japanese firms, and these savings are being ground out of a system, which is already renowned for its lean characteristics.

Painting the improvements pink plays an important role in drawing attention to the underlying activity in this factory in which systematic problem finding and solving are part of 'the way we do things around here'. The visual cues remind everyone of the continuing search for new ideas and improvements and often provide stimulus for other ideas or for places where the displayed pink idea can be transferred to. Closer inspection around the plant shows other forms of display – less visually striking but powerful nonetheless – charts and graphs of all shapes and sizes that focus attention on trends and problems as well as celebrating successful improvements. Photographs and graphics pose problems or offer suggested improvements in methods or working practices. And flipcharts and whiteboards covered with symbols and shapes of fish bones and other tools are being used to drive the improvement process forward.

CASE STUDY 6.4 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 such as price, quality, choice and so on. For a longer period 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 that 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 that 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 United Kingdom firm of the same name began working on a process, which revolutionized glassmaking for the next 50 years. He got the idea while 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 that came because of the lack of need for abrasives, grinding equipment and so on. Factories could be made smaller, and the overall time to produce glass can be dramatically cut. So successful was the process that it became – and still is – the dominant method for making flat glass around the world.

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

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 services. One example has been the development of innovations around the concept of 'micro-finance' – see **Case Study 6.5**.

CASE STUDY 6.5 The Emergence of Micro-Finance

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 through starting new entrepreneurial ventures. 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 moneylenders;
- create opportunities for self-employment for unemployed people in rural Bangladesh;
- offer the disadvantaged an organizational format that 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 setup in Jobra (a village adjacent to Chittagong University) and some neighbouring villages and ran during 1976–1979. 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. In 2006, Yunus received the Nobel Peace Prize for this innovation.

6.5 CRISIS-DRIVEN INNOVATION

Sometimes, the urgency of a need or the extent of demand can have a forcing effect on innovation. 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 that led to developments like the Bessemer converter. In a similar fashion, the emerging energy crisis with oil prices reaching unprecedented levels created a significant pull for innovation around alternative energy sources – and an investment boom for such work. The origins of 'lean thinking' – an approach that has revolutionized manufacturing and large parts of public and private sector services – lie in the experience of Japanese manufacturers like Toyota in the immediate postwar period. Faced with serious shortages of raw materials, energy and skilled

labour, it was impossible to apply the resource-intensive methods associated with mass production and instead they were forced to experiment and develop an alternative approach – which became known as 'lean' because it implied a minimum waste philosophy [14].

Case Study 6.6 gives some other examples of crisis-driven innovation.

CASE STUDY 6.6 Crisis-driven Innovation

It's easy to think that innovation is about resources – throw enough money, smart minds and clever technology at the problem and the answer will surely follow. But the history of ideas suggests that there is another pathway. Sometimes, the very absence of resources is what galvanizes innovation. Think about these examples:

- Back in 1943 at the height of the war, a small team at Lockheed's Burbank factory was given the apparently impossible task of designing and building a jet aircraft within six months. They'd never built a jet before, so there were no designs to work from, the technology was unknown, the only engine was in the United Kingdom and wouldn't be available to them to experiment with until near the end of the project – and the factory was already working flat out on producing bombers for the war effort. Kelly Johnson was the manager appointed to run this project, and one of his first tasks was to rent a circus tent because there was no space available for his team to work in! Time was of the essence – the Germans had been working on jets since 1938 and were already flying their Messerschmitt Me 262 fighters in Europe. Despite all these barriers, his 'skunk works' team achieved their target with weeks to spare, producing and safely flying the Shooting Star.
- It's not just in the world of manufacturing – back in the 1970s, Dr Govindappa Venkataswamy began his search to try and bring safe, low-cost eye care to the poor of India. The cataract operation he pioneered was simple enough to perform technically; the innovation challenge he faced was doing so in a resource-constrained context: lack of skills or facilities and more importantly lack of money – the average cost of cataract treatment was around $300, far beyond the means of poor village folk trying to subsist on incomes of less than $2/day. His Aravind Eye System borrowed ideas from the world of fast food and essentially shifted the model of surgery to one similar to manufacturing – in the process cutting the average cost to $25 and delivering it using largely unskilled labour trained in narrow focused areas. Forty years later, millions of people around the world owe their sight to his innovation; his ideas influenced Devi Shetty and others to pioneer similar approaches to operations as complex as heart by-pass surgery, again massively lowering the costs without compromising on the safety element.
- The same pattern can be seen in the world of the arts. Each season, the Royal Shakespeare Company faces the challenge of short time scales and the need to find something new in a 400-year-old repertoire limited to 37 plays – all of which have already been performed thousands of times before. Despite this, they can still push the edges of the audience experience. One of jazz pianist Keith Jarrett's most popular works (selling over 3 million copies) is the 1975 Koln Concert – yet this was nearly never recorded. The organizers had failed to provide the Bosendorfer grand piano on stage, and so he was forced to improvise with a much smaller and less well-tuned instrument!
- In the world of humanitarian relief, the extreme needs of people in disaster situations have triggered a series of radical innovations including high-energy biscuits, which can be quickly distributed, building materials, which can be deployed and assembled quickly into makeshift shelters, and robust communication platforms, which can be quickly established to improve information flow around crisis events.

6.6 WHOSE NEEDS? THE CHALLENGE OF UNDERSERVED MARKETS

When considering need pull as a source of innovation, we should remember that one size doesn't fit all. Differences among 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' showed this was the pattern across industries as diverse as computer disk drives, earth-moving equipment, steel making and low-cost air travel [15].

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 comes 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 among a small group of hobbyists who wanted simple computing capabilities at a much lower price than that 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 importantly, 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 this well in an interview exploring their attempts to engage interest from the mainstream electronics world '*. . . 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 did meet 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 that 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 6.3** shows the transition where the new market and suppliers gradually take over from the existing players. It can be seen in many industries – for example, think about the low-cost airlines. 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

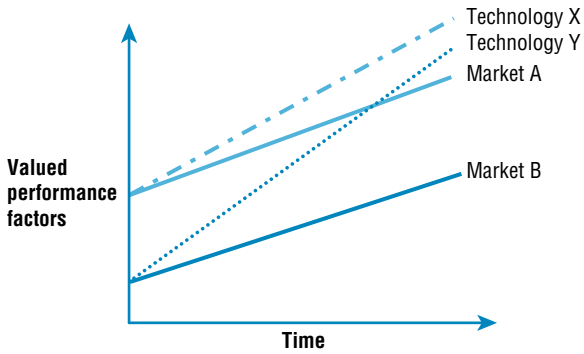

FIGURE 6.3 The pattern of disruptive innovation

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 – such as BA and KLM, which setup low-cost subsidiaries that found they were unable to manage with the very different business model, low-cost flying involved.

Low-end market disruption of this kind is a potent threat – in many sectors the emergence of simpler 'good enough' products has challenged existing incumbents. For example, the pharmaceutical industry has been shaken up by moves towards generic versions of key medicines and devices like asthma inhalers. And 'reverse innovation' is beginning to happen – for example, GE began making a simple ultrasound scanner for use in their Indian markets where the need was for something low cost, robust and portable so it could be taken out by midwives in visiting remote villages. But the basic package was also of considerable interest in many other markets, and the product has become a best seller – in the process changing the company's orientation towards product design [16]. Following the success of this scanner General Electric committed to a major expansion of at least $3 billion to develop 100 low-cost health-care innovations, targeted at emerging economies but with potential for such reverse innovation.

Case Study 6.7 gives some examples of such 'frugal innovation'.

CASE STUDY 6.7 Frugal Innovation

Say the word 'frugal' – and it conjures images of making do, eking out scarce resources, managing on a shoestring. And in the world of innovation, there are plenty of examples where this principle has triggered interesting solutions. For example, Alfredo Moser's idea of reusing Coke bottles as domestic lighting in the favelas of Rio has led to its use in around a million homes around the world.[6] And potter Mansukhbhai Prajapati's Mitticool ceramic refrigerator offers a low cost way of keeping food cold without the need for power.[7]

But frugal is not simply low-cost improvised solutions in a resource-constrained part of the world.[8] It's a mind-set with powerful implications for even the most advanced organization. Sometimes crisis conditions and resource scarcity trigger search in new directions, leading to radical and unexpected alternatives. While frugal innovation is associated with emerging market conditions where purchasing power is low, there is also potential for such ideas to transfer back to industrialized markets. GE's simple ECG machine (the MAC 400)

[6] http://www.bbc.co.uk/news/magazine-23536914
[7] http://www.thebetterindia.com/14711/mitticool-rural-innovation-nif-mansukhbhai/
[8] There's an excellent website and network on the topic here http://frugalinnovationhub.com/en/

was originally developed for use in rural India but has become widely successful in other markets because of its simplicity and low cost. It was developed in 18 months for a 60% lower product cost yet offers most of the key functions needed by healthcare professionals.

Siemens took a similar approach with its Somatom Spirit, designed in China as a low-cost computer body scanner (CAT) machine. The target was to be affordable, easy to maintain, usable by low skilled staff; the resulting product costs 10% of full-scale machine, increases throughput of patients by 30% and delivers 60% less radiation. Over half of the production is now sold in international markets. In particular, Siemens took a 'SMART' approach based on key principles – simple (concentrating on the most important and widely used functions rather than going for the full state of the art), maintainable, affordable, reliable, fast time to market.[9]

Others are imitating this approach – for example, in China, software giant Neusoft is pioneering the use of advanced telemedicine to help deal with the growing crisis in which 0.5 billion people will need health care. Instead of building more hospitals, the plan is to develop an advanced IT-supported infrastructure to offer a network of primary care – a 'virtual hospital' model at much lower cost and with much wider outreach.

Ratan Tata pioneered a frugal approach in developing the 'Nano' – essentially a safe, reliable car for the Indian mass market. The whole project, from component supply chain through to downstream repair and servicing, was designed to a target price of $2,500. Early experience has been mixed, but it has led others to move into the 'frugal' space, notably Renault-Nissan. Building on the success of a 'frugal' model (the Dacia/Logan platform in Europe) they established a design centre in Chennai to develop products for the local market. The Kwid SUV was launched in 2016 selling at $4,000 and has broken sales records with a healthy order book despite strong competition.

It's easy to dismiss these examples as relevant only to a low-income, emerging world – but there are several reasons why this would be a mistake. Frugal innovation is relevant because:

- Resources are increasingly scarce and organizations are looking for ways to do more with less. The frugal approach can be applied to intellectual and skilled resources as much as to physical ones – something of relevance in a world where R&D productivity is increasingly an issue. For example, the Indian Mangalyaan Mars orbiter spacecraft was successfully launched in 2013 at the first attempt. Despite the complexity of such a project, this was developed three times faster than international rivals and for a tenth of their costs. Its success is attributed to frugal principles – simplifying the payload, reusing proven components and technology, and so on.
- Crisis conditions can often force new thinking – something which research on creativity has highlighted. So the improvisational entrepreneurial skills of frugal innovators – nicely captured in the Hindi word 'jugaad' – could be an important tool to enable 'out-of-the-box' thinking.

So how might an organization begin to think about frugal innovation? There are some core principles that help make up the mind-set:

- Simplify – not dumbing down but distilling the key necessary functions
- Focus on value – avoid overshoot, avoid waste
- Don't reinvent the wheel – adopt, adapt, re-use, recombine ideas from elsewhere
- Think horizontally – open up the innovation process, engage more minds on the job
- Platform thinking – build a simple frugal core and then add modules
- Continuous improvement – evolve and learn, best is the enemy of better

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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 require 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 need 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, which are not well-served. **Case Study 6.8** gives some examples of Blue Ocean strategy.

[9] More details at http://www.nesta.org.uk/sites/default/files/our_frugal_future.pdf

CASE STUDY 6.8 Gaining Competitive Edge Through Meeting Unserved Needs

An example of the 'Blue Ocean' approach is the Nintendo Wii, which 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 was not a particularly sophisticated piece of technology – compared to the rivals Sony PS3 or the Microsoft Xbox it had less computing power, storage or other features, and the games graphics were much lower resolution than major sellers like *Grand Theft Auto*. But the key to the phenomenal success of the Wii was its appeal to an underserved market. Where computer games were traditionally targeted at boys the Wii extended – by means of a simple interface wand – their interest to all members of the family. Add-ons to the platform like the Wii board for keep fit and other applications extended the market reach – for example, to include the elderly or patients suffering the after-effects of stroke.

Nintendo 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 were middle-aged and the best-selling games were for brain training and puzzles.

Overserved markets might include those for office software or computer operating systems where the continuing trend towards adding more and more features and functionality can outstrip users' needs or their ability to use them all. Linux-based open office applications such as 'LibreOffice' or 'Apache Office' represent simpler, 'good enough' solutions to the basic needs of users – and are potential disruptive innovations for a player like Microsoft.

Central to this idea is the role of entrepreneurs – by definition established players find it difficult to look at and work with the fringe since it is not their core business or main focus of attention. But entrepreneurs are looking for new opportunities to create value and working at the fringe may provide them with such inspiration. So the pattern of disruptive innovation is essentially one where entrepreneurs play a role in changing and reshaping business and social markets through often radical innovation. Smart organizations look to defend themselves against disruption to their world by setting up small entrepreneurial units with the licence to explore and behave exactly as free agents, challenging conventional approaches and looking at the edges of what the business does.

6.7 EMERGING MARKETS

One powerful source of ideas at the edge comes from what are often termed 'emerging markets' – countries such as India, China and those in the Latin American and African regions. These are huge markets in terms of population and often very young in age profile, and while there may be limited disposable income they represent significant opportunities. The writer C.K. Prahalad first drew attention to this idea in his book 'The fortune at the bottom of the pyramid' arguing that nearly 80% of the world's population lived on less than $2/day but could represent a huge market of unserved needs for goods and services [20]. Since its publication in 2005, there has been an explosion of interest in exploring the innovation opportunities in meeting the needs of this significant population involving billions of people. **Table 6.2** gives some examples of this challenge.

Developing solutions which meet these needs requires considerable innovation and reconfiguration but there is a huge potential market. As the Chief Technology Officer of 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*

Table 6.2 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 – for example, borrowing money, clean water, telecommunications and basic medicines – because they cannot address 'mainstream' channels such as 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. About 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 among 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 strengthened their negotiating hand!

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

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 health care, agriculture and consumer white goods and home improvements. 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 high BoP profile.

Significantly the different conditions in BoP markets force a new look and enable the emergence of very different innovation trajectories. **Case Study 6.9** gives an example of a revolutionary approach to eye care and this is described in more detail on the website. Such approaches radically improved productivity while maintaining the key levels of quality; in the process they open up the possibilities of low-cost health care for a much wider set of people. Such models have been applied to a variety of health areas, including elective surgery for hip and knee replacement, maternity care, kidney transplants, and even heart bypass surgery where Indian hospitals are now able to offer better quality care at a fraction of the cost of major hospitals in Europe or the USA!

Importantly it isn't just the case that fringe markets trigger simpler and cheaper innovations. Sometimes the novel conditions spawn completely new trajectories. For example, one of the major sites in the emergence of 'mobile money' was in Africa where the security risks of carrying cash meant that people began to use the mobile phone system to provide an alternative way of moving money around. Systems like MPESA have now grown in sophistication and widespread application in emerging markets such as Africa and Latin America – but are also offering a template for existing markets back in the industrialized world.

CASE STUDY 6.9 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 $50–300, 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 back 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 needless 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 at its treatment in his home state of Tamil Nadu.

One of the key building blocks in developing the Aravind system was transferring the ideas of another industry concerned with low-cost, high and consistent quality provision – the hamburger business pioneered by McDonalds. 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 13 hospitals within south India offering nearly 4000 beds, the majority of which are free. It has moved beyond cataract surgery to education, lens manufacturing, R&D, and other linked activities around the theme of improving sight and access to treatment.

In making this vision come alive Dr V not only demonstrated considerable entrepreneurial flair, he 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 [21].

Source: Adapted from P. Mehta and S. Shenoy, *Infinite vision: How Aravind became the world's greatest case for compassion*. New York: Berret Koehler, 2011.

6.8 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 toward 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.

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 and so on. 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 [22].

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' (MC) is a widely used term that captures some elements of this [23]. MC is the ability to offer

highly configured bundles of nonprice factors configured to suit different market segments (with the ideal target of total customization – that is, a market size of 1 – 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 cocreating something truly unique. **Table 6.3** gives some examples of this range of options.

Until recently, the vision of mass customization outran the capabilities of manufacturing and design technologies to deliver it. But increasing convergence around this area and falling costs have meant that the frontier has now been reached. With simple user-friendly computer design tools and manufacturing technologies such as 3D printing, it now becomes possible to design and make almost anything and to do so at an increasing economic cost. While it might once have seemed a science fiction fantasy, it is now possible to design and print clothing, shoes, jewellery, furniture, toys, spare parts – essentially any three-dimensional shape. An increasing number of online service businesses are appearing, offering to translate individual ideas into physical products, and hobby users can install 3D printers and computer-aided design linked to their computers for under $5000. Recently, Microsoft released a scanning program for mobile phones that allows the users to take 3D pictures and create design information from them for feeding into 3D printers.

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

Table 6.3 Options in Customization (after Lampel and Mintzberg [24])

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 your exact requirements from a rich menu of options – but Dell only start to assemble this (from standard modules and components) when your 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 customer are involved in choosing ('designing') the configuration that best meets your needs and wishes – for engine size, trim levels, colour, fixtures and extras and so on. Only when they are satisfied with the virtual model they have chosen does the manufacturing process begin – and they 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, pensions and so on.
Design customization	Customer input stretches to the start of the production process. Products do not exist until initiated by a customer order.	Cocreation, where end-users may not even be sure what it is they want but where – sitting down with a designer – they cocreate 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. Cocreation of services can be found in fields like entertainment (where user-led models like YouTube are posing significant challenges to mainstream providers) and in health care where experiments toward radical alternatives for health-care delivery are being explored.

Source: J. Lampel and H. Mintzberg, 'Customizing, customization', *Sloan Manage. Rev.*, vol. 38., no. (1), pp. 21–30, 1996.

competitive advantages that 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 makes cocreation more of an option and there is growing interest in such models involving active users in the 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 such as Facebook, Instagram and YouTube have had a major impact.

Once again, we should be clear that this is not simply a trend in the commercial market place; social innovation is increasingly about trying to match particular needs of different groups in society with solutions that work for them. Customizing solutions for the delivery of public services to different groups is becoming a major agenda item, particularly as governments and service providers recognize that 'one size fits all' is not a model which applies well. In the wider not-for-profit space, these technologies are opening up significant innovation opportunities; for example, an organization called Field Ready is using 3D printing to create urgently needed spare parts and medical devices for applications in disaster situations. (See **Case Study 6.10**.)

CASE STUDY 6.10 Field Ready – Innovating Solutions in Disaster Areas

Take the idea of using the powerful technology around 3D printing as a way of delivering key spare parts or urgently needed devices in the middle of a disaster zone, rather than shipping them in. That's the principle behind Field Ready, a UK-based organization which is trying to use new design and manufacturing tools to change the way we respond. Long supply-chains mean that getting the right item to the right place can take weeks and these logistics are expensive; estimates suggest that they represent 60–80% of humanitarian aid costs. Vital medical equipment or water purification machinery can be left frustratingly idle for want of a small spare part.

Field Ready's approach is to reverse the conventional model and take the factory to the disaster.[10] Working alongside locals urgent supplies can be quickly configured and printed – for example in Haiti the team printed over 150 pieces of equipment including a prototype prosthetic hand (using just five parts), needle holders, S-hooks for suspending medical equipment in crowded emergency rooms and various spare parts of existing machinery. Close dialogue with midwives revealed a problem with umbilical cord clamps for newborn babies; these were arriving in the backpacks of volunteer aid workers travelling from the USA. Using 3D printing the clamps could be made locally at a much lower price and ready for instant use, reducing the risk of neonatal umbilical sepsis to babies and also mothers and health workers in the hospital.

In their work in Kathmandu after the Nepal earthquake the team uncovered a simple problem linked to a design weakness in baby warmers. These had been part of a donation but 60% of them were unserviceable due to a broken corner clip which held the sides together. Attempts to repair them with duct tape were not successful; the FR team designed a custom part to solve the problem which was then fitted to all of the cots. During the same visit another problem emerged; again a simple lack of correct pipe fittings for plastic water pipes meant that provision of clean water and safe sanitation were compromised. Improvised solutions using bicycle inner tubes, inappropriate metal fittings or simply jamming the pipes together meant that at best repairs were leaky. A simple design and printing activity using a mobile 3D printer running off a car battery meant that the residents of Banhabise refugee camp in Sindhupalchowk district once again had access to clean water and effective sanitation – for a cost of around $40c per fitting.

[10] https://www.elrha.org/wp-content/uploads/2015/01/Field-Ready-Case-Studies-Jan-2015-v2.pdf

6.9 USERS AS INNOVATORS

Understanding what it is that customers value and need is critical in pursuing a customization strategy and it leads inevitably to the next source of innovation in which the users themselves become the source of ideas. 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 the 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 of 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 and a wide range of sports goods and the Polaroid camera. **Case Study 6.11** gives some examples of user-led innovation.

CASE STUDY 6.11 Users as Innovators

- In 1926 in Vienna Slawa Duldig was looking forward to a pleasant Sunday walk in the gardens of the Kunsthistorisches Museum, a favourite haunt. Except that the prospect on this May morning with its ominous looking clouds was not so inviting – and so to prepare for the likely showers she took a heavy umbrella with her. She captured her frustration in her notebook – '*Why on earth must I carry this utterly clumsy thing? They should invent a small foldable umbrella that could be easily put in a handbag*'. A great idea – but 'they' hadn't yet done it and so Slawa decided to remedy the situation.

  She was a sculptress, a successful artist used to working with ideas and giving them form. She played around with the notion, sketched some designs and realised that to fit in her bag the umbrella would not only have to be small, it would need a folding mechanism. Where else had she seen something like that? A flash of insight and she was off peering excitedly into shop windows and talking to the owners of businesses specializing in window blinds. And she'd need some kind of frame, lightweight, to give shape – so another shopping expedition to stores specializing in lampshades.

  Gradually, just like one of her sculptures, the prototypes took physical form and her experiments continued. Having tested them out she finally decided to patent her idea – by now called the 'Flirt' – and lodged it in the Austrian Patent Office on 19 September 1929. The world's first folding umbrella was born and these days around 500 million of its descendants are sold each year.

- Similar questions led Marian Donavan, hands red raw from washing out nappies, to ask 'why can't we make these disposable?', beginning a process that led to a multibillion-dollar business.

- Owen Maclaren saw his daughter fumbling to try and assemble her pushchair whilst holding babies, handbag, assorted toys and other child paraphernalia. Being a retired engineer he asked 'why can't I make something foldable like the retractable undercarriage I designed for the Spitfire?' – and the Maclaren buggy business was born.

- Megan Grassell was shopping with her mother trying to find a bra for her 13-year-old younger sister. Their frustration at not being able to find anything suitable reminded her of her own experiences at that age and she began to explore founding a company to create suitable underwear for this 'tween' market. Her company Yellowberry was launched via Kickstarter and is now a successful and growing business [28].

  Many patients suffer from severely debilitating diseases but an increasing number of them are coming up with ideas based on their own experiences to help make living with their disease easier [29,30]. Among these is Tal Golesworthy,

a British engineer who was diagnosed with a serious heart condition and who went on to invent and have implanted a new design of aorta to deal with his problem!

Tim Craft, a practising anaesthetist, developed a range of connectors and other equipments as a response to frustrations and concerns about the safety aspects of the equipment he was using in operating theatres [27].

(He describes this experience in an audio interview which you can find via the Other Resources section at the end of this chapter.)

Importantly, active and interested users – 'lead users' – are often well ahead of the market in [27] 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 the complete diffusion of these innovations to major firms. 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 among 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 around managing innovation is thus to identify and engage with such 'lead users' to cocreate innovative solutions. **Case Study 6.12** gives an example of lead users at work in innovation.

CASE STUDY 6.12 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[11]), 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 colostomy bag as a way of helping her sister, a patient with stomach cancer. She took her idea to various plastic manufacturers, but none showed interest at first.

Eventually one, 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 colostomy 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 and factories in 5 countries around the world, with specialist divisions dealing with incontinence care, wound care, skin care, mastectomy care, consumer products (e.g., specialist clothing), as well as the original colostomy care division.

Keeping close to users in a field like this is crucial, and Coloplast has developed novel ways of building in such insights by making use of panels of users, specialist nurses and other health care professionals located in different countries. This has the advantage of getting an informed perspective from those involved in postoperative 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 COF Boards is to try and create a sense of partnership with key players, either as key customers or as key influencers. Selection is based not only 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 trial 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 experiences

[11] Eric von Hippel, *Democratization of Innovation*. Cambridge: MIT Press, 2005.

across different operation types. Their specific role is particularly to help with two elements in innovation:

- Identify, discuss and prioritize the user needs.
- 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 involvement is concerned with evaluating and responding to prototypes, suggesting detailed design improvements, design for usability and so on.

An important aspect of user innovation is that the initial incentive to innovate is much more personal – such innovators want to improve something for themselves, not necessarily to diffuse or commercialize their idea. Such patterns have been very important in key sectors – for example many sports like skateboarding, mountain biking and windsurfing have their genesis in user innovation in which the incentive was to create an exciting experience, not to make money and build a business.

Research Note 6.1 describes the emergence of a new model for innovation based on this phenomenon.

RESEARCH NOTE 6.1 Free Innovation

Recent work by von Hippel and a wide network of researchers looking at open user innovation has led to the development of an alternative model for innovation which sees users as key resources at both front end and downstream. It is well-established that users have been the original source of many innovative ideas which have later been taken up and developed to scale by manufacturers.

Free innovation (FI) represents an extreme version of this in which the motivation to innovate is essentially not profit seeking [29]. Drawing on the results of extensive research in six advanced industrial countries he suggests that this is not simply a handful of amateurs tinkering at the edge. In the area of 'household products' '*. . . tens of millions of individuals . . . have been found to collectively spend tens of billions of dollars in time and materials per year developing products for their own use*'. These included gardening implements, kitchen devices, child and pet-related equipment through to software and hardware and medical innovations. For all of these millions of innovators the primary motive was 'self-reward' – they wanted the things enough to develop them for themselves.

This appears to challenge the foundations of our thinking – after all Schumpeter's famous and influential model of innovation sees the profit-seeking entrepreneur at the heart of economic growth. But looked at more closely we can see that there are situations in which users' primary motivation is to solve a problem or develop something they desire for their own sake and not for wider consumption.

This doesn't mean that others can't benefit – first of all there are clear advantages for the wider community of people with similar interests. Here free revealing and sharing behaviour works to everyone's advantage – if we each give a little then we soon have a lot. But the opportunity also exists for mainstream producers to pick up on these early ideas and bring them to wider markets, investing their expertise in return for the income streams from those new product categories.

The 'free innovation' model argues that there are real opportunities for traditional producers/innovators and user innovators to work in tandem, exploiting the complementarity between them.

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 operating systems or the Apache server community around web server development applications, where communities have grown up and where 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 . 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 user groups around Apple's i-platform devices like the iPhone .

Within some communities, users will freely share innovations with peers, termed 'free revealing', for example, online communities for open source software, music hobbyists, sports equipment and professional networks. Participation is driven mostly by intrinsic motivations, such as the pleasure of being able to help others or to improve or develop better products, but also by peer recognition and community status. The elements valued are social ties and opportunities to learn new things rather than concrete awards or esteem. Such knowledge sharing and innovation tend to be more collective and collaborative than idea competitions (**Research Note 6.2**) [30].

RESEARCH NOTE 6.2 A Spectrum of Patient Involvement in Healthcare Innovation [31]

It is important to recognize in the growing discussion around the potential for user innovation that not every user wants to be involved. For example in the field of healthcare there is considerable emphasis being placed in 'hearing the voice of the patient' and building their insights into innovation. A major international research programme suggests that the potential for user involvement is distributed across a spectrum with a number of different potential roles from purely passive to highly active:

1. the 'informed patient', equipped to use technology based on improved understanding; not only are today's patients able to search for information with regard to their situation, they can also become active discussants of their situation with healthcare professionals
2. the 'involved patient', playing an active role within a wider healthcare delivery system and enabled to do so by technology. Here the approaches widely used in the commercial sector are finding increasing application with users actively engaged at the 'front-end of innovation', evaluating prototypes, providing valuable feedback to help pivot designs and acting as a 'crowd-sourced' laboratory for development
3. the 'innovating patient', providing ideas of their own based on their deep understanding of their healthcare issue. At the limit we find here the kind of patient who might be described as active 'hero' innovators, prototyping and trialling their ideas out on themselves or their nearest and dearest.

Source: Modified from Iakovleva, T, Bessant, J, and Oftedal, E, *Responsible innovation in digital health*. Cheltenham: Edward Elgar, 2019.

6.10 USING THE CROWD

Not everyone is an active user, but the idea of the crowd as a source of different perspectives is an important one. Sometimes people with very different ideas, perspectives or expertise can contribute new directions to our sources of ideas – essentially amplifying. Using the wider population has always been an idea, but until recently, it was difficult to organize their contribution simply because of the logistics of information processing and communication. But using the Internet, new horizons open up to extend the reach of involvement as well as the richness of the contribution people can make.

In 2006, journalist Jeff Howe coined the term crowdsourcing in his book *The Power of Crowds.* Crowdsourcing is where an organization makes an open call to a large network to provide some voluntary input or perform some function. The core requirements are that the call is open, and that the network is sufficiently large, the 'crowd'. Crowdsourcing of this kind can be enabled via a number of routes – for example, innovation contests, innovation markets, innovation communities – which we will discuss in detail in Chapter 11. But it is worth commenting here that opening up to the crowd can not only amplify the volume of ideas but also the diversity; evidence is emerging that it is particularly this feature that makes the crowd a useful additional source of innovation.

Research Note 6.3 describes this approach in more detail.

Public sector applications of this idea are growing as citizens act as user-innovators for the services which they consume. 'Citizen-sourcing' is increasingly being used; an example is the

RESEARCH NOTE 6.3 Using Innovation Markets [32]

Karim Lakhani (Harvard Business School) and Lars Bo Jeppesen (Copenhagen Business School) studied the ways in which businesses are making use of the innovation market platform Innocentive.com. The core model at InnoCentive is to host 'challenges' put up by 'seekers' for ideas which 'solvers' offer. They examined 166 challenges and also carried out a web-based survey of solvers and found that the model offered around a 30% solution rate – of particular value to seekers looking to diversify the perspectives and approaches to solving their problems. The approach was particularly relevant for problems that large and well-known R&D-intensive firms had been unsuccessful in solving internally. Currently, InnoCentive has around 200,000 solvers and as a result considerable diversity; their study suggested that as the number of unique scientific interests in the overall submitter population increased, the higher the probability that a challenge was successfully solved. In other words, the diversity of potential scientific approaches to a problem was a significant predictor of problem-solving success. Interestingly, the survey also found that the solvers were often bridging knowledge fields – taking solutions and approaches from one area (their own specialty) and applying it to other different areas. This study offers systematic evidence for the premise that innovation occurs at the boundary of disciplines.

UK website fixmystreet.com in which citizens are able to report problems and suggest solutions linked to the road infrastructure. The approach also opens up significant options in the area of social innovation – for example, the crisis response tool 'Ushahidi' emerged out of the Kenyan post-election unrest and involves using crowdsourcing to create and update rich maps which can help direct resources and avoid problem areas. It has subsequently been used in the Brisbane floods, the Washington snow emergency and the aftermath of the Tsunami in Japan.

Innovation contests are growing in popularity; a recent McKinsey report cited in the *Wall Street Journal* suggested that more than 30,000 significant prizes are awarded every year worth $2 billion. The total value of the 219 largest prizes on offer has tripled in the past 10 years and most contests are now specifically targeted. And while there is big prize money available some organizations are seeing the value in 'crowdsourcing' simpler innovation challenges. For example, the French food supplier Petit Navire offers a prize of €5000 for anyone coming up with new uses for their canned tuna fish. KLM – Royal Dutch Airlines and Schiphol Airport in Amsterdam offer €10,000 for new ideas in baggage handling. And Hershey Chocolate Co. offers a $25,000 prize for ideas to stop chocolate from melting on the way to stores [33].

Increasing interest is being shown in such 'crowdsourcing' approaches to cocreating 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 children developers in its Lego Ideas and other online activities linked to its manufactured products. Adidas has taken the model and developed its 'mi Adidas' concept where users are encouraged to cocreate 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. Such models offer considerable promise, but there is a risk; in 2016, the crowdsourcing manufacturer Quirky filed for bankruptcy having failed to create a sustainable business model for the approach [34].

User engagement provides a powerful new resource for the 'front end' of innovation. One example is Goldcorp – a struggling mining company that threw open its geological data and asked for ideas about where it should prospect. Tapping into the combined insights of 1200 people from 50 countries helped them find 110 new sites, 80% of which produced gold. The business has grown from $100 million in 1999 to over $9 billion today [35]. Companies like Swarovski have recruited an army of new designers using 'crowdsourcing' approaches – and in the process have massively increased their design capacity.

Case Study 6.13 provides some examples of what might be termed 'open collective innovation'.

CASE STUDY 6.13 Open Collective Innovation

An increasingly important element in the innovation equation is *co*creation – using the ideas, experience and insights of many people across a community to generate an innovation. For example, Encyclopaedia Britannica was founded in and currently has around 65,000 articles. Until 1999, it was available only in print version; however, in response to a growing number of CD and online-based competitors (such as Microsoft's Encarta), now it has an online version. Encarta was launched in 1993 and offered many new additions to the Britannica model, through multimedia illustrations carried on a CD/DVD; like Britannica it was available in a limited number of different languages.

By contrast, Wikipedia is a newcomer, launched in 2004 and available free on the Internet. It has become the dominant player in terms of online searches for information and is currently the sixth most visited site in the world. Its business model is fundamentally different – it is available free and is constructed through the shared contributions and updates offered by members of the public. A criticism of Wikipedia is that this model means that inaccuracies are likely to appear, but although the risk remains there are self-correcting systems in play, which mean that if it is wrong it will be updated and corrected quickly. A study by the journal *Nature* in 2005 (15 December) found it to be as accurate as Encyclopaedia Britannica yet the latter employs around 4000 expert reviewers, and a rewrite (including corrections) takes around five years to complete.

Encarta closed at the end of 2009, but Encyclopaedia Britannica continues to compete in this knowledge market. After 300 years of an expert-driven model it moved, in January 2009, to extend its model and invite users to edit content using a variant on the Wikipedia approach. Shortly after that (February 2010) it discovered an error in its coverage of a key event in Irish history, which had gone uncorrected in all its previous editions and only emerged when users pointed it out!

In a similar fashion, Facebook chose to engage its users in helping to translate the site into multiple languages rather than commission an expert translation service. Its motive was to try and compete with MySpace which in 2007 was the market leader, available in five languages. The Facebook 'crowdsource' project began in December 2007 and invited users to help translate around 30,000 key phrases from the site: 8000 volunteer developers registered within two months and within three weeks the site was available in Spanish, with a pilot version in French and German also online. Within one year Facebook was available in over 100 languages and dialects – and like Wikipedia it continues to benefit from continuous updating and correction via its user community.

Another important feature of crowdsourcing across user communities is the potential for dealing with the 'long tail' problem – that is, how to meet the needs of a small number of people for a particular innovation. By mobilizing user communities around these needs it is possible to share experience and cocreate innovation; an example is given on the website where communities of patients suffering from rare diseases and their careers are brought together to enable innovation in areas which lie at the edge of the mainstream health system radar screen.

6.11 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 that 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 [28].

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' [36]. 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 and so on, and opened up a wide frontier for changes in aerospace and related fields [37]. 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 MPESA system (described earlier) 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 underserved users – and represents a powerful laboratory for new concepts which companies such as Vodafone are working closely to explore [38]. 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*'.

6.12 PROTOTYPING

We've emphasized the importance of understanding user needs as a key source of innovation. But one challenge is that the new idea – whether knowledge push or need pull – may not be perfectly formed. Innovations are made rather than born – and this means we need to think about modifying, adapting and configuring the original idea. Feedback and learning early on can help shape it to make sure it meets the needs of the widest group and has features which people understand and value. For this reason, a core principle in sourcing innovation is to work with potential users as early as possible and one way of doing this is to create a simple prototype. It serves as a 'boundary object', something everyone can get around and give their ideas and in the process innovation becomes a shared project.

It enables a move from vague notions, hunches and half-formed ideas towards something more workable, providing a series of stepping-stones, bridges and scaffolding – essentially playing with ideas about the problem. It forms the core of the approach taken by companies such as Dyson where '*. . . prototypes allow you to quickly get a feel for things and uncover subtle design flaws . . .*'

Prototyping offers some important features to support sourcing innovative ideas:

- It creates a 'boundary object', something around which other people and perspectives can gather; a device for sharing insights into problem dimensions as well as solutions
- It offers us a stepping stone in our thought processes, making ideas real enough to see and play with them but without the lock-in effect of being tied into trying to make the solutions work – we can still change our minds
- It allows plurality – we don't have to play with a single idea, we can bet on multiple horses early on in the race rather than trying to pick winners
- It allows for learning – even when a prototype fails we accumulate knowledge which might come in helpful elsewhere
- It suggests further possibilities – as we play with a prototype, it gives us a key to open up the problem, break open the shell and explore more deeply

- It allows us to work with half-formed ideas and hunches – enables a 'conversation with a shadowy idea'
- It allows for emergence – sometimes we can't predict what will happen when different elements interact. Trying something out helps explore surprising combinations

Prototyping has always been an important part of innovation – even when the solution trajectory is clear there is plenty of room for using test pieces to refine the product and get the bugs out. It is extensively used to improve the product concept – for example, beta testing of software or pilot projects, which are deliberately setup to explore and learn rather than provide the finished product or service. And it has an increasingly important role to play at the fuzzy front end of the innovation process.

It is of particular value to entrepreneurs trying to start new ventures. The 'lean start-up' method, for example, argues that the process needs to be one of the fast learning and modifying of the original idea. By putting a 'minimum viable product' out into the marketplace, it becomes possible to test and adapt the idea, and it may well be that there is a need to 'pivot' around that idea to a new way of delivering it. This prototype doesn't have to be perfect, but it provides a live experiment to help learn about what things in the new venture need to change [39]. We will return to this theme in Chapter 10.

6.13 WATCHING OTHERS – AND LEARNING FROM THEM

Another important source of innovation comes from watching 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 postwar years was based on a strategy of 'copy and develop', taking Western ideas and improving on them [40]. 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 [41].

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 [42].

One powerful variation on this theme is the concept of benchmarking [43]. 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 United States 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 [44].

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 [12]. 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 [45].

6.14 RECOMBINANT INNOVATION

Another easy assumption to make about innovation is that it always has to involve something new to the 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 [46]. 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 which 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 microbladder 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 [47].

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 month 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 such as mass production and precision machining (gun industry), telegraphy and telecommunications, food processing and canning, automobile manufacture and so on. 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.

One of the key characteristics of 'open innovation' is its emphasis on knowledge flows in and out of organizations and this creates a considerable scope for recombinant innovation. Examples of established knowledge from one sector being applied elsewhere include the use of ground management systems for aircraft handling in the United Kingdom air traffic control system – this uses software originally developed in Formula 1 motor racing by the Maclaren racing team.

Case Study 6.14 gives some examples of recombinant innovation.

Recombinant innovation is also possible *within* large organizations where opportunities to use knowledge created in one area and applied in another can be exploited. For example, DuPont scientists were working in the 1960s on fibres, which were similar to nylon but had much greater strength – an idea which had potential for the tire cords used in one of their core business areas. In 1965, Stephanie Kwolek developed a process for making aramide fibres which the company called 'Kevlar' – it had the property of being five times stronger than its equivalent weight in steel. However, the tire makers were initially slow to adopt and so the technology was offered to other divisions, finding new markets in bulletproof vests, helmets, ropes and boats – and eventually the tire market itself.

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 [48]. 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.

CASE STUDY 6.14 Bridging Different Worlds – the Power of Recombinant Innovation

Wandering round Chicago in 1912, William Klann was a man on a mission. He was part of a team setup to explore ways in which they could reduce the costs of manufacturing a car to fulfil Henry Ford's vision of '*a motor car for the great multitude*'. They had already developed many of the ideas behind mass production – standardized and interchangeable parts, short task cycle work, specialist machinery – but what Klann saw while walking past the Swift Meat Packing Company's factory gave him an insight into a key piece of the puzzle. The workers were effectively *dis*-assembling meat carcasses, stripping off various different joints and cuts as the animals were led past them on a moving overhead conveyor. In a classic moment of insight, he saw the possibility of reversing this process – and within a short space of time the Ford factory boasted the world's first moving assembly line. Productivity rocketed as the new idea was implemented and refined; using the new approach Ford was able to cut the assembly time for a Model T to just 93 minutes.

(Not that the meat packers had invented something new – back in the early sixteenth century the Venetians had already developed an impressive line in mobile assembly. By moving ships along canals in order to fit them out for battle they were able to produce, arm and provision a new galley at a rate of one per day!)

Forty years later, Ray Croc was running the hamburger business that he originally established with his friends the McDonald brothers. He was looking for ways to improve the productivity and began applying Ford's assembly line techniques in making hamburgers. The rest is fast food history, with the company now selling more than 75 hamburgers every second and feeding 68 million people every day!

And the Aravind Eye Care system found its inspiration in McDonalds. Developing and refining the same principles has enabled it to become the world's largest and most productive eye-care service group, responsible for treating over 35 million patients with its low-cost/high-quality model.

All of these are variations on the same basic theme – and importantly the solutions developed in one world can be adapted and applied elsewhere. Turnaround time was a major challenge in the car industry where the concern to reduce the setup and changeover time of huge body presses led engineers at Toyota under the direction of Shigeo Shingo to develop the 'single minute exchange of die' (SMED) approach, which enabled reductions from several hours to less than five minutes. SMED principles underpin the turnaround revolution in the airline industry and the success of Ferrari's record-breaking team who can carry out a complete pitstop in less than six seconds!

It's not a one-way process; part of the power of recombinant innovation is the cross-over learning through sharing different experience of dealing with the same basic problem. In a recent visit to the Great Ormond Street children's hospital in London, the Ferrari team not only delivered some important insights for UK hospitals but also took back some new ideas to apply on the racetracks of the world.

In today's open innovation landscape 'recombinant innovation' of this kind is a powerful opportunity offering a number of advantages:

- It reduces learning costs since much of the original development of an innovation has been undertaken in a different context. While there is still a need for local adaptation, there is a chance to adopt an innovation further up the learning curve and thus with lower risk.
- It opens up new and different innovation space; by moving the search focus to outside a particular sector 'box', we can establish a new trajectory for further innovation. (For example, the Aravind model of safe low-cost health care has been applied to perinatal care, other elective surgery and even heart bypass operations – all with similarly dramatic results.)
- It opens connections to new networks, effectively enriching the 'gene pool' of ideas with which both organizations can work and enabling further open innovation opportunities.

6.15 DESIGN-LED INNOVATION

'Market? What market! We do not look at market needs. We make proposals to people.'
– Ernesto Gismondi, Chairman of Artemide, quoted in Verganti

One increasingly significant source of innovation is what Roberto Verganti calls 'design-driven innovation'. Examples include many of the successful Apple products, where the user experience is one of surprise and pleasure at the look and feel, the intuitive beauty of the product. This emerges not as a result of analysis of user needs but rather through a design process which

seeks to give meaning, shape and form to products – features and characteristics which they didn't know they wanted. But it is also not another version of knowledge or technology push in which powerful new functions are installed – in many ways design-led products are deceptively simple in their usability. Apple's iPod was a comparative latecomer to the MP3 player market yet it created the standard for the others to follow because of the uniqueness of the look and feel – the design attributes. Its subsequent success with iPad and iPhone owes a great deal to the design ideas of Jonathan Ive, which bring a philosophy to the whole product range and provide one of the key competitiveness factors to the company.

As Verganti points out, people do not buy things only to meet their needs – there are important psychological and cultural factors at work as well [49]. He suggests that we need to ask about the 'meaning' of products in people's lives – and then develop ways of bringing this into the innovation process. For example, Apple's iPhone changed the meaning of the phone from a communication device to the core of a highly interactive social system, while Nintendo's Wii changed the meaning of computer gaming from a largely solitary activity to an interactive family pursuit. This is the role of design – to use tools and skills to articulate and create meaning in products – and increasing services as well. He suggests a map (see **Figure 6.4**) in which both knowledge/technology push and market pull can be positioned – and where design-driven innovation represents a third space around creating radical new concepts which have meaning in people's lives.

The increasing importance of design as a source of innovation also engages with the world of services. Joseph Pine used the term 'experience economy' to describe the evolution of innovation from meeting needs towards creating experiences [50]. In an increasingly competitive world, differentiation comes increasingly from such 'experience innovation', especially in services where fulfilling needs takes second place to the meaning and psychological importance of the experience. For example, the restaurant business moves from emphasis on food as an essential human need towards increasingly significant experience in innovation around restaurants as systems of consumption involving the product, its delivery, the physical and cultural context and so on. Increasingly service providers such as airlines, hotels or entertainment businesses are differentiating themselves along such 'experience innovation' lines [51]. And the model is being widely used in public sector services such as health care [52,53].

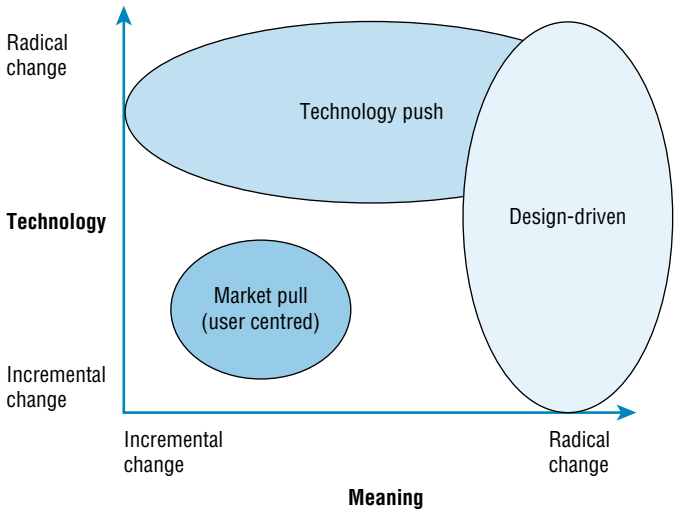

FIGURE 6.4 The role of design-driven innovation

Source: Based on Verganti, R., *Design driven innovation*. 2009, Harvard Business School Press.

6.16 REGULATION

Photographs of the pottery towns around Stoke on Trent in the Midlands of the United Kingdom taken in the early part of the twentieth century would not be of 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 that regularly enveloped the area. Yet, 80 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 in the United Kingdom. They provide a clear reminder of another important source of innovation – the stimulus given by changes in the rules and regulations that 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 [54]. 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 programs 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 while switching on our hands-free phone devices (both the result of safety legislation) the role of regulation in shaping innovation can be seen [55].

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 [56].

6.17 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 Game changer program [57]. Sometimes, various 'transitional objects' are used, such as concept models and prototypes in the context of product development, to explore reactions and provide a focus for different kinds of input, which might shape and cocreate future products and services [58,59].

Chapter 10 explores this theme and the related toolkits in detail. **Research Note 6.4** discusses the theme of futures thinking.

RESEARCH NOTE 6.4 Thinking About the Future

Innovation futures are likely to be very different from the current context – the trouble is that we don't know how!

Tim Jones has been working with another network of researchers, practitioners and policy makers trying to pull together current themes in effective innovation management. In particular, the focus is on innovation and growth and how leading organizations in the public and private sectors are meeting these challenges. There is a website and an accompanying book that has more detail on the project: https://www.futureagenda.org/ and a link to a video interview with Tim about the project can be found in the Other Resources section at the end of this chapter.

6.18 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 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 [60]. 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.

Case Study 6.15 gives some examples of 'accidental' innovations.

CASE STUDY 6.15 Accidents Will Happen

Accidents will happen – and as far as innovation is concerned, that's often a good thing. While much of our attention is on the focused efforts to bring new ideas to market or to effect process changes in systematic, planned and strategically targeted fashion, there are some times when Fate takes a hand. What might appear to be a failed experiment or a strange but ultimately useless outcome can sometimes turn out to be the basis of a game-changing innovation. Think about these examples . . .

- Percy Spencer, working on microwave-based radar equipment at Raytheon in 1945 discovered that a chocolate bar in his pocket had melted – and made the connection which led not just to a dry cleaning bill but the development of the microwave oven.
- Kutol Products was a struggling company trying to sell a paste originally invented in the 1930s for cleaning dirty wallpaper discoloured by soot and coal-fire residues. By the 1950s, changes in home heating meant that coal fires were on their way out – and so was their business. Fortunately for them, their imminent bankruptcy was held off by the discovery by children of the potential for using the paste as a moulding clay toy. Repackaged, Play-Doh persists to this day, finding its way into carpets and furniture in millions of homes around the world.
- Roy Plunkett was working on chlorofluorocarbons in DuPont's labs in 1938 trying to improve refrigeration materials. While returning to examine the results of his latest experiment, he was bitterly disappointed to find one canister

no longer contained the gas he expected but some white flaky material. But he took time to play with it and realized its incredible properties as a lubricant with a very high melting point – perfect for a host of military applications and, eventually, for making omelettes in frying pans coated with Teflon.

- For example, metallurgist Harry Brearley was working hard in his lab in 1912 trying to improve the design of guns. He needed an alloy that wouldn't erode over time as bullets spinning fast along grooved barrels rubbed against their walls – but his efforts proved fruitless. After months next to a growing pile of steel scrap representing failed efforts, he noticed one particular piece that had managed to retain its original shine rather than oxidizing. He explored this 12% chromium alloy a little further and found it also resisted marks and scratches as well; not very useful in gun-making but 'stainless steel' had an impressive future elsewhere!
- In 1942, Harry Coover was working in Eastman Kodak labs trying to perfect material for a precision gun sight. But the cyanoacrylate he experimented with was a bitter disappointment – sticking annoyingly to everything it touched. But six years later in trying to use it for cockpit canopies, he suddenly realized that the incredibly strong bonding powers could have a different application – and Superglue was born. The final version of his product hit the market 16 years after his original experiments.

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 themselves as '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.

Part of the answer is undoubtedly to create an environment in which there is space and time to experiment and fail. It's no coincidence that all of those discoveries in Case Study 6.14 took place in contexts where the individuals concerned could explore, experiment and accept failure without fear of being penalized.

But another part of the story is recognizing the role of timing in 'accidental' innovation. We can see many of these innovations as an extreme version of the 'knowledge push' model in which we create something new for which there is no apparent need or where the intended need isn't met. It's only later as an alternative need emerges that the real potential of the innovation comes through – and this different need often comes from a very different direction.

One last aspect of accidents and unexpected events – shocks to the system which fundamentally change the rules provide not only a threat to the existing status quo but also 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 such as security, alternative transportation, fire safety and evacuation and so on [55].

SUMMARY

- Innovations don't just appear perfectly formed – and the process is not simply a spark of imagination giving rise to changing the world. Instead innovations come from a number of sources and these interact over time.
- Sources of innovation can be resolved into two broad classes – knowledge push and need pull – although they almost always act in tandem. Innovation arises from the interplay between them.

- There are many variations on this theme – for example, 'need pull' can include social needs, market needs, latent needs 'squeaking wheels', crisis needs and so on.
- Whilst the basic forces pushing and pulling have been a feature of the innovation landscape for a long time it involves a moving frontier in which new sources of push and pull come into play. Examples include the emerging demand pull from the 'bottom of the pyramid' and the opportunities opened up by an acceleration in knowledge production in R&D systems around the world.
- User-led innovation has always been important but developments in communications technology have enabled much higher levels of engagement – via crowdsourcing, user communities, cocreation platforms and so on.
- Regulation is also an important element in shaping and directing innovative activity – by restricting what can and can't be done for legal reasons new trajectories for change are established which entrepreneurs can take advantage of.
- Design-driven approaches and the related toolkit around prototyping are of growing importance.
- Accidents have always been a potential source of innovation – but converting them to opportunities requires an open mind. As Pasteur is reputed to have said, 'chance favours the prepared mind!'
- 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. That is the theme of the next chapter which explores how we might mobilize search strategies for innovation.

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 book *The economics of industrial innovation*. 3rd ed. Cambridge: MIT Press, 1997. Particular discussion of fringe markets and unmet or poorly met needs as a source of innovation is covered by Christensen and colleagues and by Ulnwick (C. Christensen, S. Anthony and E. Roth, *Seeing what's next*. Boston: Harvard Business School Press, 2007; J. Utterback, *High end disruption. International Journal of Innovation Management*, 2007; A. Ulnwick, *What customers want: Using outcome-driven innovation to create breakthrough products and services*. New York: McGraw-Hill, 2005) whilst the 'bottom of the pyramid' and extreme user potential is explored in Prahalad's work (C.K. Prahalad, *The fortune at the bottom of the pyramid*. New Jersey: Wharton School Publishing, 2006) and in N. Radjou, J. Prabhu, and S. Ahuja, *Jugaad innovation: Think frugal, be flexible, generate breakthrough innovation*. San Francisco: Jossey Bass, 2012. The collection edited by Gerry George and colleagues on '*Inclusive innovation*' (Edward Elgar, 2019) is also useful. Keith Goffin, Fred Lemke and Ursula Koeners cover the challenge of identifying hidden needs (*Identifying hidden needs creating breakthrough products*. Basingstoke: Palgrave Macmillan, 2010) whilst Kelley offers a description of how this approach is used in IDEO (*The art of innovation: Lessons in creativity from Ideo, America's leading design firm*. New York: Currency, 2001).

User-led innovation has been researched extensively by Eric von Hippel (http://web.mit.edu/evhippel/www/) and his books offer considerable research-based insight. See in particular 'Free innovation' (2017) and 'The democratization of innovation' (2005) both published by MIT Press. Frank Piller,

Professor at Aachen University in Germany, has a rich website around the theme of mass customization with extensive case examples and other resources (http://www.mass-customization.de/); the original work on the topic is covered in Joseph Pine's book (B.J. Pine, *Mass customisation: The new frontier in business competition*. Cambridge, MA: Harvard University Press, 1993). High-involvement innovation is covered in J. Bessant, *High involvement innovation*. Chichester: John Wiley & Sons, 2003 and lean thinking ideas and tools in Dan Jones and Jim Womack, *Lean solutions*. New York: Free Press, 2005. Andrew Hargadon has done extensive work on 'recombinant innovation' (*How breakthroughs happen*. Boston: Harvard Business School Press, 2003) and Mohammed Zairi provides a good overview of benchmarking (*Effective benchmarking: Learning from the best*. London: Chapman and Hall, 1996). And open innovation is extensively explored, for example, in H. Chesbrough, W. Vanhaverbeke and J. West, *Open innovation: Researching a new paradigm*. Oxford: Oxford University Press, 2006 and R. Reichwald, A. Huff and K. Moeslein, *Leading open innovation*. Cambridge: MIT Press, 2013.

OTHER RESOURCES

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

Resource type	Details	Access
Video/audio	Interview with Michael Bartl of Hyve, talking about the use of 'netnography' in the search for new innovation opportunities	All at https://johnbessant.org/resources/media-resources/the-innovators-media-library/
	Interview with Emma Taylor talking about mobilizing employees as a source of innovation	
	Interview with Hugh Chapman, Veeder Root, about mobilizing employee involvement in innovation	
	Interview with Helle-Vibeke Carstensen of the Danish government, talking about citizens as a source of innovation	
	Interview with Tim Craft (audio and video) talking about his experience as a user-innovator	
	Interview with Catharina van Delden and her company Innosabi which mobilizes external communities as a source of innovation for businesses	
	Interview with Pedro Oliveira talking about the Patient Innovation platform, a way of mobilizing user innovators in the healthcare space	
	Interviews with doctors from Torbay Hospital in the UK talking about their approaches to finding process innovation opportunities	
	Interview (audio) with Helen King of the Irish Food Board talking about their use of futures methods to search for innovation opportunities	
	Interview with Lynne Maher, UK National Health Service talking about user experience as a source of innovation	
	ITN/ISPIM film about user innovation	
	EUWIN film about mobilizing employee involvement in innovation	
	Eric von Hippel talking about user innovation	

(*continued*)

Resource type	Details	Access
Case studies	• Spirit, a Russian company which draws on the extensive knowledge base built up during the Cold War around voice recognition technology to provide solutions for major global companies like Cisco and Oracle • Dyson demonstrates a similar theme, using a science-based approach to rethink appliances like washing machines, cooling fans and hand driers • Case studies of Philips, Kodak and Cerulean that offer examples of disruptive innovation challenges and responses • Case study of MPESA and the development of mobile money solutions in East Africa • Case studies of Lego, Adidas and Threadless which illustrate the move toward mass customization • Case study of Kodak which has been able to reuse its strong knowledge base in coating photographic film (which became redundant as the industry moved to digital images) in the field of high speed, high volume printing. There is also a case study of Fujifilm which made a similar move away from photography, deploying its deep knowledge base to enter new fields in skincare • Aravind, NHL and Lifespring all offer insights into how emerging and underserved markets can drive different innovation trajectories • Yellowberry gives an insight into user innovation • Lego, Threadless and Local Motors all offer insights into how user communities can be mobilized to support innovation	All at https://johnbessant.org/case-studies/
	• Case studies of humanitarian innovation	https://www.alnap.org/help-library/more-than-just-luck-innovation-in-humanitarian-action

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