Chapter 2
Joseph Schumpeter's gales of creative destruction

All economic and social progress ultimately depends on new ideas that contest the introspection and inertia of the status quo with possibilities for change and improvement. Innovation is what happens when new thinking is successfully introduced in and valued by organizations. It is the arena where the creation and application of new ideas are formally organized and managed. Innovation involves deliberate preparations, objectives, and planned benefits for new ideas that have to be realized and implemented in practice. It is the theatre where the excitement of experimentation and learning meets the organizational realities of limited budgets, established routines, disputed priorities, and constrained imagination.

There are a great many ways of understanding innovation that provide a wide range of rich insights and perspectives. The variety of different analytical lenses used depends on the particular innovation issues being studied. Some analyse the extent and nature of innovation: whether any change is incremental or radical, how it sustains or disrupts existing ways of doing things, and if it occurs in whole systems or their components. Other analyses are concerned with how the focus of innovation changes over time, that is, from the development of new products to their manufacture, their patterns of diffusion, how particular design

configurations, such as video recorders and music players, come to dominate in the market, and how organizations appropriate value from innovation.

Defining

The English language allows broad definitions of innovation, which can be both helpful and confusing. This is helpful in as much as it can usefully cover a wide range of activities and is confusing for the same reason – the word can be used promiscuously. Even the relatively simple definition of innovation we use – ideas, successfully applied – raises questions. What is 'success'? Time is influential, and innovations may be initially successful and eventually fail, or vice versa. What does 'applied' imply? Is it applied within a single part of an organization, or diffused internationally amongst a massive group of users? What and who are the sources of 'ideas'? Can anyone lay claim to them, especially as they inevitably combine new and existing thinking?

Typologies of innovation also face difficulties because of blurred boundaries and overlaps between categories. Innovation occurs in products, for example in new cars or pharmaceuticals; and services, for example in new insurance policies or in health monitoring. But many service firms describe their offerings as products, such as new financial products. Innovation occurs in operational processes, in the way new products and services are delivered. These processes may take the form of equipment and machinery, which are the providers' products, and logistics in the form of transportation, which are providers' services.

There are some similar definitional problems when thinking about levels of innovation. A minor innovation for one organization may be substantial for another. It is difficult in practice to develop anything but a nominal scale of the differences between levels of innovation, and categorization is best thought of as ideal types

along a continuum. Most innovations are incremental improvements – ideas used in new models of existing products and services, or adjustments to organizational processes. They might include the latest versions of particular software packages, or decisions to add more representatives from the marketing department to development teams. Radical innovations change the nature of products, services, and processes. Examples include the development of synthetic materials, such as nylon, and decisions to use open-source software to encourage community development of new services, rather than doing it proprietarily. At the highest level, there are rarer, periodic transformational innovations, which are revolutionary in their impact and affect the whole economy. Examples would be the development of oil as an energy source, or the computer or internet.

We think about innovation as ideas, successfully applied in organizational outcomes and processes. Innovation can be thought of as practical and functional: the outcomes of innovation are new products and services, or they are the organizational processes supporting innovation that occur in departments such as R(esearch)&D(evelopment), Engineering, Design, and Marketing. Innovation can also be thought of more conceptually: the outcomes of innovation are enhanced knowledge and judgement, or they are the processes that support the capacity of organizations to learn.

We have chosen to focus on innovations other than those described as 'continuous improvement' that tend to be routine and highly incremental in nature. Although these small improvements are cumulatively important, our concern lies rather with ideas that stretch and challenge organizations as they attempt to survive and thrive. By concentrating on innovations beyond the ordinary that occur in both the outcomes of organizational efforts and the processes that produce them, we capture a great degree of what is generally understood to be innovation.

Importance

The reason why innovation is so important has to be seen in the context of the relentless demands made of contemporary organizations as they face the challenges of a complex and turbulent world. Innovation is crucial for their continuing existence as they struggle to adapt and evolve to deal with constantly changing markets and technologies.

In the private sector, the threat of new competitors in globalized markets is ever present. In the public sector, the demand for efficiencies and enhanced performance is continual, as governments attempt to manage demands for expenditure to improve the quality of life that exceed their incomes. The motivation to innovate in all organizations is stimulated by the knowledge that if they are not capable of innovation, others are: new players that may threaten their very existence. Simply, if organizations are to progress – to develop and grow, become more profitable, efficient, and sustainable – they need to successfully implement new ideas. They have to be continually innovative. As the economist Joseph Schumpeter put it, at its most blunt, innovation 'offers the carrot of spectacular reward or the stick of destitution'.

One of the features of innovation is that it can be found in every organization. Although the cost of innovation can be very high – it can, for example, cost up to $800 million to develop a new pharmaceutical – new ideas can be successfully implemented cheaply. It is not only high-tech firms making semiconductors or working with biotechnology that rely on innovation in their businesses, it is all parts of the economy. Insurance firms and banks continually search for new ideas for services for customers; shops use computer-controlled ordering and stock management; farms use new seeds, fertilizers, and irrigation technologies, satellites can assist the optimization of their planting and

harvesting, and new uses are being made of their products, such as biofuels and health-promoting functional foods. Innovation is found in construction, in new materials and building techniques; in packaging that keeps food fresher; and in clothing firms introducing new designs more quickly and cheaply. Innovation is sought by public services, in health, transportation, and education. While one might not wish for too much innovation in some areas, such as amongst the firms investing our pension funds or designing the aeroplanes in which we fly, generally the business or organization that doesn't benefit from using new ideas is rare indeed.

Challenges

The challenges of innovation are immense. Many people are uncomfortable with the change brought about by innovation. Especially when it is broad-ranging, innovation can have negative effects on employees, inducing uncertainty, fear, and frustration. Organizations have social contracts by which their members develop loyalty, commitment, and trust. Innovation can disrupt this contract by redistributing resources, altering the relationships between groups, and emphasizing the ascendancy of one part of the organization to the disadvantage of others. It can disturb the technical and professional skills people acquire over many years, and with which they strongly identify themselves. Its organizational context means it is inseparable from the exertion of power and resistance to it.

Most attempts at innovation fail. History is littered with unsuccessful attempts to apply the – often very good – new ideas of individuals and organizations. The ill-fated development of a cost-effective battery electric car with significant environmental benefits in the USA in the 1990s is illustrative of the way innovation can provide a serious threat to established interests. A coalition of political and business interests combined to prevent this new idea reaching the market. Although the product was

popular with consumers, it had to compete with the interests of the established energy infrastructure, oil companies, and petrol distribution networks, and massive existing automotive industry investments in petrol engine car manufacture and maintenance.

Organizations simultaneously need to do things that allow them to operate in the short term, exploiting their existing know-how and skills, and explore new things that will develop capacities to support their continued long-term existence in a changing world. These demand different and sometimes conflicting behaviours and practices. Indeed, organizations are occasionally confronted with the paradox of needing to apply new ideas threatening to the practices that have created their current successes. If generals are said to fight the last rather than the current war, managers rely on ways of doing things that contributed to their organizations', and their own, past progress, rather than ways that will deal more effectively with the future. Since Edison established the first organization dedicated to producing innovations at the turn of the 19th century, many different ways of organizing the creation and use of ideas have periodically been favoured. As the business environment has changed, the large, centralized corporate Research and Development (R&D) laboratory, and the distinctly separate innovation team (sometimes called the 'skunkworks'), are no longer used as often as in the past. The search for ways of balancing routines with innovation is constant.

Organizations rarely innovate alone: they do so in association with others, including their suppliers and customers. They innovate in particular regional and national contexts. Access to innovation-supporting skills and university research, for example, often has a local dimension, as seen in the case of Silicon Valley in California and other international centres of innovation. Government policies and regulations affect innovation, as do national financial and legal systems that influence issues such as the availability of risk-taking investment capital, the creation of

technical standards, and protection of intellectual property rights. Availability and cost of infrastructure for communications and transportation matter greatly. These factors add to the complexity, and hence unpredictability, of innovation, as innovators are never completely masters or mistresses of their destiny. They also point to the essentially idiosyncratic nature of innovation: each innovation occurs in its own particular set of circumstances.

In all the major elements of contemporary economies – in the services, manufacturing, and resources industries, and in the public sector – organizational progress depends upon owning or accessing and using knowledge and information. Being competitive and efficient relies on being innovative with all the resources organizations possess: their people, capital, and technology, and the ways they connect with those contributing to and using what they do.

Innovation thinking

The American economist William Baumol argues that virtually all of the economic growth that has occurred since the 18th century is ultimately attributable to innovation. The successful application of ideas has been recognized within industry as the primary source of its development since this time.

The 18th century also saw the beginning of the study and recognition of the importance of the relationships between organization, technology, and productivity with the publication of Adam Smith's *Wealth of Nations* in 1767. Smith produced his now famous analysis of the importance of the division of labour in a pin factory, which was so influential on Wedgwood's factory organization. Smith showed how specialization in specific manufacturing processes in pin production significantly increased the productivity of the workforce compared to when individuals produced each pin themselves. A man alone, even with the 'utmost

industry', could produce 1 to a maximum of 20 pins a day, yet with a division of labour, 'very poor' labour 'indifferently accommodated with the necessary machinery', could produce 4,800 'when they exerted themselves'.

A century later, Karl Marx was highly aware of the significance of innovation, but more concerned with its negative consequences. In the first volume of *Capital*, he declared:

> Modern industry never views or treats the existing form of a production process as the definitive one… By means of machinery, chemical processes and other methods, it is continually transforming not only the technical basis of production, but also the functions of the worker and the social combinations of the labour process.

The possibilities of technological change, Marx argued, were contradicted by its use under capitalism, which inevitably led to the suppression of workers. Capitalism, he contended, subordinated workers to machines, but he believed technology held the possibility of liberating them from the burden of mechanical and repetitive work and enriching social relations.

Marx's emphasis on the strong social dimensions to technological development and use is a recurrent theme in research into the history of innovation. Study of the development of automated machine tools in the USA, for example, illustrates how often technology is shaped by dominant social forces. The automated, or numerical, control of machine tools, such as lathes, could have been configured in various ways to give the machine's operator more or less discretion over how it was used. The technology was constructed in such a way that control resided in engineering planning offices, not with their operators. This was less economically efficient, but complied with the expectations of the major customer for the new technology, the US Air Force, and hence reflected existing power structures.

At a more aggregate level, all the past revolutions in technology – in steam power, electricity, automobiles, information and communications technology – have required enormous adjustment and adaptation in industry and society. The economists Christopher Freeman and Carlota Perez show how in history the diffusion of new technologies since the Industrial Revolution required massive structural adjustments in industry and society, and also in the legal and financial framework, education and training systems for new skills and professions, new management systems, and new national and international technical standards.

The importance of clever 'human capital' has long been recognized. Observing the development of German industry in the mid-19th century, the political scientist Friedrich List declared that national wealth is created by intellectual capital: the power of people with ideas. In 1890, the British economist Alfred Marshall noted that knowledge is the most powerful engine of production available to economies. An economic theorist who unusually kept his feet on the ground by regularly visiting companies, Marshall celebrated the importance of innovation and is especially remembered for his analysis of the benefits of the 'clustering' of progressive firms in 'industrial districts'.

If any economist lays claim to be the first to include innovation centrally within their theory of development, it is Joseph Schumpeter (1883–1950), who remains today as one of the most influential thinkers on the subject. A complex man with a rich history, including being one time Finance Minister in Austria, director of a failed bank, and Harvard professor, Schumpeter argued that innovation unleashed the 'gales of creative destruction'. It arrives in a great storm of revolutionary technologies, such as oil and steel, that fundamentally change and develop the economy. Innovation is creative and beneficial, bringing new industries, wealth, and employment, and at the same time is destructive of some established firms, many products

2. Schumpeter placed innovation centrally in his theory of economic development

and jobs, and the dreams of failed entrepreneurs. For Schumpeter, innovation is essential for competitive survival:

> the competition from the new commodity, the new technology, the new source of supply, the new type of organization... competition which commands a decisive cost or quality advantage and which

> strikes not at the margins of the profits and the outputs of the existing firms but at their foundations and their very lives...

Schumpeter's views on the primary sources of innovation altered during his lifetime, reflecting changes in the practices in industry. His early 'Mark I' model, published in 1912, celebrated the importance of individual, heroic, risk-taking entrepreneurs. His 'Mark II' model, by contrast, published 30 years later, advanced the role of the formal, organized innovative efforts in large companies. It was during this period that the modern research laboratory became firmly established, initially in the chemical and electrical industries in Germany and the USA. By 1921, there were more than 500 industrial research laboratories in the USA.

Five models

One of the first and most influential studies of the relationship between scientific progress and industrial innovation was conducted immediately after the Second World War by Vannevar Bush, the USA's first presidential science advisor. In his report *Science: The Endless Frontier*, Bush advocated a national policy for open-ended research on a massive scale. The book proved popular; it was serialized in *Fortune* magazine, and Bush appeared on the front page of *Time*. The view that investments in research held the solutions to most seemingly intractable problems was a legacy of Bush's association with the Manhattan Project to develop the atom bomb, which, to the minds of many, successfully curtailed the war in the Pacific. Although it took a simplistic interpretation of Bush's report, the view that all product and process innovations are founded in painstaking basic research became the fundamental precept of the 'science push' model of innovation, a perspective that remains popular with many in the scientific research community to this day.

An alternative view, which emphasized the importance of market demand as the primary source of innovation, emerged in the 1950s and 1960s. This resulted from a number of factors, including

studies that showed that in sectors such as the military, technological outcomes resulted more from the demands of its users rather than any scientifically predetermined configurations. At the same time, there was a growth of large, corporate planning offices with belief in the conceit that sufficient market research could identify what was required of new science and technology to meet consumer needs. This mirrored the rise of social science at the time with its claims to predictive powers. Counter to the post-war enthusiastic embrace of science and technology, social movements – such as Ralph Nader's car safety campaign in the 1960s, developed in response to dangerous car designs – began to question the use to which they were being put and demand greater attention to consumer needs. In housing, research into the demographics of the baby-boomer generation led to 'predict and provide' strategies internationally, where innovation was sought to help satisfy growing demand. This view became known as the 'demand-pull' model of innovation.

Both these models of innovation are linear in their progression: research leads to new products and processes introduced into the market, or market demand for new products and processes leads to research to develop them. But increasing volumes of research conducted in the 1970s questioned the assumption of linearity. Pioneering studies, such as Project SAPPHO at the University of Sussex, UK, found differences between sectors: for example, the chemical industry innovated differently from the scientific instruments industry. And, furthermore, the pattern of innovation changed over time. Abernathy and Utterback at MIT developed the theory of product life cycles, with high levels of innovation in the development of products occurring initially, then reducing in scale and being replaced by high levels of innovation focusing on their application and their processes of production. Innovation was seen not to be unidirectional, but more iterative, with feedback loops.

The organizational and skills issues underlying this 'coupling' model of innovation came to the fore in the 1980s, driven primarily

by the remarkable success of Japanese industry. A study of the car industry at the time showed Japanese auto manufacturers were twice as efficient as their international competitors in every measure of innovative performance, such as how long it takes to design and make a car. The explanation for this was an approach described as 'lean production', which contrasted with the mass-production techniques used in other countries. Mass production, typified by Henry Ford, is based on assembly lines producing standardized products. 'You can have any colour Model T car you want, as long as it is black', as Ford is reputed to have said. Lean production introduced greater flexibility into the assembly line, allowing a broader range of products to be made. It includes a system of relationships with suppliers of components that allow them to deliver 'just-in-time' to be assembled, thereby reducing the cost of holding inventory, and increasing the speed of response to market changes. Lean production also entailed an obsessive concern for quality control, which in many areas became the responsibility of shop-floor workers.

When analysing the differences between the way Japanese and Western firms organized themselves to innovate, the metaphors were used at the time of the former playing rugby (although netball is similarly suitable) and the latter running a relay race. In the West, innovation entailed one part of the organization, say R&D, beginning the process, running with it for a while, then handing it over to another, say Engineering, which similarly worked on it before passing it over to Manufacturing and then on to Marketing. This linear process was considered hugely wasteful to Japanese firms, with the likelihood of significant miscommunication as projects moved from one part of the organization to another. A rugby or netball player metaphor can be used, as their games involve the simultaneous combination of different kinds of players, with various skills and abilities, some big and tall, but generally slow, and some smaller, skilful, and fast, all working to the same objective. All parts of the organization were combined in innovation activities.

Collaboration between, as well as within, innovative Japanese companies was a feature of their 1980s' success story. As well as the extensive collaboration between customers and suppliers in the same industrial groups – Keiretsu – the Japanese government also encouraged collaboration between competing firms. The Fifth Generation Computer programme, for example, attempted to encourage the usually highly competitive computer manufacturers to cooperate around shared research agendas. This 'collaborative' model of innovation strategies and public innovation policies was also enthusiastically pursued in Europe in information technology and the USA in semiconductors.

By the 1990s, Roy Rothwell, one of the founders of innovation research, began to identify a number of changes occurring in the strategies firms were using to innovate and the technologies they were using to support it. He argued firms were developing innovation strategies that were highly integrated with its partners, including 'lead customers', demanding users, and co-developers of innovation. Also important, he contended, was the use of new digital technologies, like computer-aided design and computer-aided manufacturing, that brought different parts of the firm together when developing innovations, and helped link external parties into internal development efforts. Rothwell called this the 'strategic integration and networking' model of innovation. The trend towards greater strategic and technological integration in support of innovation is one that continues with the use of massive computing power, the internet, and new visualization and virtual-reality technologies.

These models of the innovation process have their antecedents in an industrialized economy where innovation predominantly occurs in the manufacturing industry. We are now in economies where services dominate, accounting for around 80% of Gross Domestic Product in most developed nations. Economies based on tangible, physical objects that can be measured and

seen have been transformed into ones where outputs are weightless and invisible. Furthermore, as the global financial crisis that emerged in 2008 shows, we live in an era of extraordinary turbulence and uncertainty where any established formulae and prescriptions are likely to be tested by emerging and unforeseen circumstances. The models of innovation in the future will be far more organic and evolutionary where the sources of innovation are unclear, the organizations involved initially unknown, and the outcomes highly constrained by unpredictabilities. In these circumstances, it will be valuable to assess whether or not anything we know of the past might be a guide to the future. It will also be useful to understand how theory of innovation might help.

Theory

There is no single, unified theory of innovation. There are partial explanations from, for example, economics, political science, sociology, geography, organizational studies, psychology, business strategy, and from within 'innovation studies', which draws on all these disciplines. This is to be expected given innovation's multiple influences, pathways, and outcomes. The utility of various theories will depend on the particular issues being explored. Theories from psychology may be more useful when the subject is an individual innovator, business strategy when it is organizational innovation, and economics when it is national innovation performance. It is important to consider theories of innovation not only to explain contemporary issues, significant as they are, but also to enlighten its future use in helping to deal with major social, economic, and environmental concerns.

Over recent years, there has been an emergence of a number of perspectives that share common ground in their theories of innovation. These include evolutionary economics and 'dynamic capabilities' frameworks for business strategy.

The challenge for any theory of innovation is that it has to explain an empirical phenomenon that takes many guises. It also has to encompass its complexity, dynamism, and uncertainty, often compounded by the way innovation results from the contribution of many parties with occasionally divergent and not fully established agendas. In this way, innovation has emergent properties: it results from a collective process whose outcomes may not be known or expected when it begins.

Evolutionary economics – with a Schumpeterian legacy – sees capitalism as a system that produces continuous variety in the new ideas, firms, and technologies created by entrepreneurs and the innovative activities of research groups. Decisions by organizations, consumers and governments make selections from within this variety. Some selections are successfully propagated and are fully developed into new organizations, businesses and technologies that provide the basis and resources for future investments in creating variety. Much of the variety and selections that occur are disruptive or fail to be propagated, so the evolutionary development of the economy is typified by significant uncertainty and failure.

Dynamic capabilities theory includes the ways firms search for, select, configure, deploy, and learn about innovations. Its focus is on the skills, processes, and organizational structures that create, use, and protect intangible and difficult to replicate assets, such as knowledge. This approach to strategy reflects the continual dynamism of technology, markets, and organizations where the capacity to sense threats and realize opportunities – when information is constrained and circumstances unpredictable – is the key to sustainable corporate advantage.

These theoretical explanations for innovation embrace complexity and emergent circumstances. They incorporate the messy organizational realities of innovation found in economies where

there is constant change and adaptation and when the strategies of firms are often experimental.

Time

There has to be a time dimension to any understanding of innovation. Whether considering outcomes, what happened, or processes of innovation, how it came about, it is necessary to know the period in which they occurred. Comparisons to what existed before the innovation determine the extent of novelty.

If an innovation is ahead of its time, as perhaps might be argued to have happened in the case of the battery electric car, no matter how much effort is expended, it will not gain the momentum needed for its wide diffusion and sustained growth. If an innovation takes too long to be developed, it may fail because a superior or cheaper idea emerges. Sometimes markets and technologies shift quickly, and rapidly move on from what at one point seemed like a good idea. Innovative organizations therefore have to think about timescales of new ideas. They can do this by considering their position based on past innovation diffusion patterns, and use tools and techniques to speed up innovation through formal project management techniques that progressively decide on the levels of resources needed. Returns on innovation investment are planned over periods of years, and decisions are made to invest if they pay back suitably over an acceptable time period. Risk is managed by attempts to reduce how long it takes to develop and introduce innovation. Speed is usually, but not always, seen to be a benefit. Compressing time reduces the chance of being caught up by competitors or wastefully squandering resources. Moving too quickly, however, leads to mistakes and failures to learn from them.

Short-term horizons are appropriate for incremental innovation, but long-term perspectives are needed to provide a wider view

on where, why, and how radical innovation has occurred or failed. Understanding the relationships between scientific discovery, innovation, and societal changes requires deep historical interpretation.

Innovative organizations – as we shall see in the case of Edison in Chapter 5 – can improve their future chances of success by creating options that allow different potential paths to be followed, delaying decisions that do not need to be made until a later date when their consequences may be clearer. By organizing and equipping themselves for unforeseen eventualities, innovators can change course, or re-calibrate timetables. As Louis Pasteur observed about scientific discovery through experimentation, 'chance favours the prepared mind'.

Rates of innovation and diffusion vary considerably between different business sectors. In pharmaceuticals, for example, it usually takes between 12 and 15 years to bring a new drug to market, but new digital services can grow large within months. Organizations can make strategic choices on whether they should attempt to lead innovation in their sector, or follow others. Sometimes leaders have the best opportunity for reaping the greatest rewards from their ideas. The chemical company DuPont, for example, has consistently led other firms in bringing new products to market for over a century. But 'first-mover advantage' may be difficult to capture and sustain. It often brings greater risks, as the market may not be fully formulated, and higher costs may be accrued to stimulate demand.

Other organizations choose to learn from leaders, emulating innovations that appear to work well, and avoiding any pitfalls they have observed. Fast-followers can receive huge rewards, as Microsoft has done for consistently reacting quickly to the innovations of others who have borne initial risks. Many organizations do not have the skills or resources to be first-movers

or fast-followers. They may, nevertheless, benefit from innovation that improves upon, adapts, or extends products, processes, or services. Whatever its position as an innovator, and whichever strategy an organization may wish to pursue, its ability to appreciate the time dimension is likely to have a significant bearing on its performance.

Chapter 3
London's wobbly bridge: learning from failure

Schumpeter's analysis of innovation being a process of creative destruction implies the outcomes of innovation can simultaneously be positive and negative. It both creates and destroys wealth and jobs. Innovation profoundly affects us all by creating new industries, firms, and products, as seen in the new industry established by Wedgwood. It is seen in services such as discount airlines, and infrastructure such as airports. It improves productivity, and quality of life in the form, for example, of new pharmaceuticals, means of transportation, communication, entertainment, and greater variety in and accessibility of food. It has helped lift millions out of poverty, especially over recent decades in Asia. Jobs can be more creative, interesting, and challenging as a result of innovation. But the successful application of ideas can also have profoundly adverse consequences. Nations and regions get left behind when they are not as innovative as their competitors, and increasing disparities in wealth result. Jobs can be deskilled, job satisfaction decreased, and unemployment increased, because of innovation. Innovation has given us the environmental consequences of the internal combustion engine and chlorofluorocarbons, and the toxic results from the complex financial instruments behind 2008's global financial crisis.