SEVENTH EDITION

INNOVATION MANAGEMENT
AND NEW PRODUCT DEVELOPMENT

Pearson

PAUL TROTT

Innovation Management and New Product Development

5 *Clarity*. The need for complex instructions was avoided. For example, inserting attachments automatically set the required motor speed.
6 *Order*. All the details of the product had a logical and meaningful place.
7 *Naturalness*. The designers avoided any contrived or artificially decorative elements.
8 *Aesthetics*. Although not a primary objective, it was achieved by simplicity, attention to detail and the quest for order and naturalness.
9 *Innovation*. Braun was committed to achieving long-lasting appeal for its design so the innovations involved were carefully developed and managed.
10 *Truthfulness*. The principle that 'only honest design can be good design' was applied, avoiding any attempt to play on people's emotions and weaknesses.

This approach has been successful in producing many new products and the aesthetics of Braun's products have been recognised, with samples on display in the Museum of Modern Art in New York.

Source: Adapted from Slack, N. et al. (2007) *Operations Management*, 5th edn, Pearson, London.

The different examples of the design parameters considered illustrate the complexity of the process of design. The design brief depends on the market for which the product or service is created. For example, the aesthetics of a domestic water tap is not important when mounted out of sight under the kitchen sink. If, however, it were mounted in a visible application, the aesthetics of the tap would be very important.

A design spectrum ranges from the concept designer, whose primary concern is ensuring technical excellence, to the focus of the industrial designer on manufacturability and the ease of use of the product. For example, the design team involved in the manufacture of a hi-fi set would include:

- an electronics engineer concerned with the ability of the electrical circuits to faithfully produce sound from the CD – i.e. the function of the product;
- the marketing department members who would be concerned about the look of the product, i.e. the aesthetics, the ease of use, the market price, and so on;
- an industrial engineer who will be concerned with the sales volume required; how the product is to be made and assembled, i.e. the operations tasks involved in creating the product;
- consideration of the packaging requirements for items on display for protection during transport.

In this illustration, the knowledge required by a designer in the design spectrum ranges from acoustics, electronics, mechanics, plastic processing technology and industrial engineering to ergonomics and is, therefore, so broad and complex that no one person can be professionally competent in the whole range of disciplines required. In addition to their own specific competence, the designer also needs an appreciation of the problems of other elements of the design spectrum. Managing such a diverse range of disciplines is a complex matter.

Design and volumes

All the operations management functions involve making decisions – some are tactical or structured and have short-term consequences whilst others are more strategic with longer-term implications for both the operations function and the organisation as a whole. One such major decision relates to the implications of the production **volume** required.

The highly skilled eighteenth-century craftsman making furniture at the rate of a few per year is a different type of person from the individual on a twenty-first-century assembly line making furniture at a production rate of hundreds per day. As well as a different type of person, the machinery, the processing techniques used, the materials and the design will also be very different. Choosing the most appropriate and cost-effective method of manufacture is critical to the continued success of the organisation.

When a designer first has an innovative idea for a product, he may have made (possibly make himself) a model to look at and to handle in order to help develop the idea. He may want to show this model to his colleagues or potential customers. Even with all the modern technology available (CAD/CAM, etc.) the 'one-off' models are produced frequently to refine the design or to help gauge customer interest in the product (as witnessed by the concept cars seen at motor shows). At this stage in the innovation process, detailed drawings may not be required or appropriate and highly skilled and expensive personnel therefore make the product. At this stage of a product life cycle, the term used to describe the manufacturing process is the *project method of manufacture*. Projects are unique or one-off and the required disciplines and techniques involved can be found in projects of all scales, from an academic dissertation to that of building the Channel Tunnel.

To illustrate this point, consider the development of a simple product such as a toolbox. The design engineer (or innovator), after preliminary meetings with the marketing people and/or potential customers, makes a scale model of the product. In the earliest stage of this product, it is best made by the personnel, machinery and techniques involved in a *project* style of production process. The innovator or designer listens to the observations and is able to reflect on these points in the development of the design (see Figure 5.2).

The design is well received and, after minor modifications, the design team decides to have a sample batch made (using common fasteners) by the operations function to help evaluate the market. The toolbox is shown to a range of customers who are each keen to buy a large batch at a competitive price. The industrial design team recognises that, by changing the design and avoiding the need for fasteners, investing in tools to shape the individual elements of the box and welding the components together, the assembly time will be reduced and substantial costs saved. *As the required volume increases, the most appropriate method of manufacture changes.*

Another key point is that assembly skills required to produce the product have become *embedded in the process machinery* and the workers involved have become machine minders (see Illustration 5.3 on the production of blocks on HMS *Victory*).

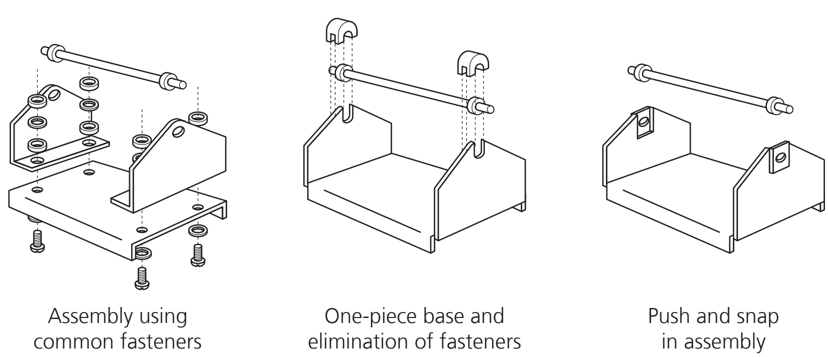

Figure 5.2 Design simplification

Illustration 5.3

Innovation and design in the manufacturing process


Source: ShutterStockStudio/Shutterstock

The first use of machine tools in mass production was during the Napoleonic Wars in the early 1800s. The British Navy, based in Portsmouth, had a need for 100,000 blocks (blocks house the sail ropes) per annum both to equip new ships and to provide spares. For example, HMS *Victory* alone required 900 blocks and each of these was individually carved by skilled craftsmen. Because the blocks were subject to storm, sea water, wind, ice and sun, each ship sensibly would set sail with a full set of replacements and the many suppliers just could not cope with such a high demand.

Marc Brunel (born in France in 1769) was, in 1798, dining with the British aide-de-camp in Washington, DC, a Major General Hamilton, when the conversation turned to ships and navies and to the particular problems with the manufacture of these wooden blocks. This was an opportunity to innovate in the process of manufacture and Brunel seized it. His idea was to simplify the manufacturing process into many more stages and to design specialist machines for each part of the operation of manufacture, thus enabling the large volume production of blocks.

In 1799, and with the help of an introduction from General Hamilton to Earl Spencer of Althorp, Brunel persuaded the British Navy to install the 43 Brunel-designed machine tools in a factory in the naval dockyards in Portsmouth. By 1807, the facility was providing all the needs of the Navy with only 10 unskilled men. Moreover, as the human element had been much removed from the process, the resulting blocks were far more likely to be consistent in dimensions and, therefore, of 'better' quality. The machines were still in use over 100 years later and 7 are on display in the Portsmouth Naval Museum.

Brunel also applied the same innovative process design logic to other manufacturing problems. In 1809, he was shocked to see the damaged feet of returning war veterans that had been caused by their poorly made and fitted footwear. Therefore, he designed a set of machines that produced boots and shoes in 9 different sizes with 24 disabled soldiers manning the machines. The boots and shoes were very successful and, in 1812, the production volume was expanded to meet the Army's total requirements.

Brunel's son, Isambard Kingdom Brunel, designed and built steamships, railways and many bridges for which he is correctly revered as one of most influential engineers in British history. However, most of what we consume and take for granted is based on the innovation in the processes of manufacture of 200 years ago by men such as Marc Brunel, who introduced the concepts of mass production.

Source: www.brunelenginehouse.org.uk/people, accessed 10 April 2015; and the Portsmouth Naval Museum, United Kingdom.

If the volume required increases even more, by having robots on the assembly line the direct labour involved is further reduced. If the product demand rises even further, it may be appropriate that the product is redesigned again and made out of a plastic material (lighter and stronger) requiring investment in a very different processing technology.

Craft-based products

Some products are craft-based and only ever will be made in small volumes – for example, products from the *haute couture* fashion houses. Unique gowns are handmade by very skilled personnel and paraded at the fashion show (a new product launch). The designs are 'copied' by other organisations and there is a rush to get copies made and supplied to the high street retailers. These copies may look similar but are usually made from different materials using different techniques and are, consequently, less costly to make and to purchase. The operations management of the supplier to the high street has to be able to respond very quickly to get the goods to the market before the fashion changes. The flexibility and speed of response of the operation is, therefore, critical to the success of the organisation. In this illustration, good marketing is also vital to avoid the end-of-season excess stocks that ambitious and unrealised sales can cause.

Pause for thought ?

Is the illustration concerning block manufacture for HMS *Victory* the first example of a mass production system?

Design simplification

The purpose of design is to develop things that satisfy needs and meet expectations. By making the design such that the product is easy to produce, the designer enables the operation to *consistently* deliver these features.

If the product is simple to make, the required quality management procedures will be less complex, easy to understand and, therefore, likely to be more effective. If a design is easy to make, there will be fewer rejects during the manufacturing process and less chance that a substandard product reaches the customer. Referring to the toolbox illustration (Figure 5.2), the reduction in the number of components from over 30 to fewer than 5, makes material control simpler. This, in turn, leads to simpler purchasing of components and less complex facility layouts. The same logic applies equally well in service sector applications (Brown et al., 2001; Johnston and Clark, 2001).

The application of technology and the technique of 'concurrent engineering' (where research, design and development work closely or in parallel rather than in sequence) have made important contributions to this area of management (Waller, 1999). Innovation within the manufacturing function involves searching for new ways of saving costs and is a continual process, and the closer designers work with operations and marketing personnel, the more likely the organisation is to succeed. This point is developed in the quality function deployment (QFD) section below.

It can take several years and cost millions of pounds to plan and build a major assembly facility, such as a car plant. With such a huge investment it is essential that the design of the product is 'correct' at an early stage, as errors detected later can be prohibitively expensive to rectify.

Reverse engineering

The process of duplicating an existing component, subassembly or product, without the aid of drawings, documentation or computer model is known as reverse engineering.

Reverse engineering can be viewed as the process of analysing a product to:

- identify the components and their interrelationships;
- create representations of the product in another form;
- create the physical representation of that product.

Reverse engineering is very common in such diverse fields as software engineering, entertainment, automotive, consumer products, microchips, chemicals, electronics and mechanical designs. For example, when a new design comes to market, competing manufacturers may buy one and disassemble it to learn how it was built and how it works. A chemical company may use reverse engineering to defeat a patent on a competitor's manufacturing process. In software engineering, good source code is often a **variation** of other good source code.

In some situations, designers give a shape to their ideas by using clay, plaster, wood or foam rubber, but a CAD model is needed to enable the manufacturing of the part. Reverse engineering provides a way of creating the physical model, which is the source of information for the CAD model.

Another reason for reverse engineering is to compress product development times. In the intensely competitive global market, manufacturers are constantly seeking new ways to shorten lead-times to market a new product. Rapid product development (RPD) refers to recently developed technologies and techniques that assist manufacturers and designers in meeting the demands of reduced product development time. For example, injection-moulding companies must drastically reduce the tool and die development times. By using reverse engineering, a three-dimensional product or model can be captured quickly in digital form, remodelled, and exported for rapid prototyping/tooling or rapid manufacturing.

Reverse engineering enables the duplication of an existing part by capturing the component's physical dimensions, features and material properties. Reverse engineering is, typically, cost effective only if the items to be reverse engineered reflect a high investment or will be reproduced in large quantities. Reverse engineering of a part may be attempted, even if it is not cost effective, if the part is absolutely required and is mission-critical to a system.

Process design

The process design is based on the technology being used within the process. The metal-forming processes, the chemical processing industry, the plastic material processing and electronic assembly are all sophisticated subjects with their own literature.

In order to illustrate a feature of innovation within process design, consider one of the important elements of operations – that of the design of the layout of the facility providing the goods or service. In service-type operations, the customer may be inside and will have **visibility** of the company's operations function and the significance of layout is even more important.

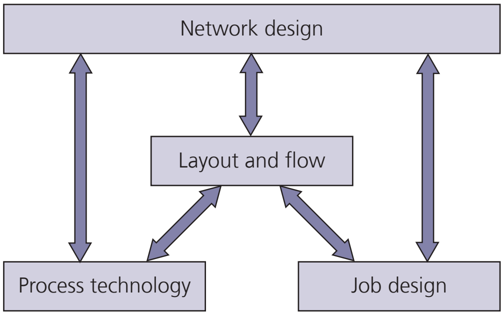

Figure 5.3 The design of processes

If an employee spends his working day assembling automotive car seats on an assembly line, he quickly becomes expert in that area of manufacture and design. Most people spend the bulk of their 'awake' time involved with work and enjoy talking about their job, if the opportunity arises. In all organisations, it is the intellect of the employees that is the source of innovation and it is the role of senior managers to create an atmosphere to encourage appropriate intellectual activity, if the organisation is to prosper. We go to art galleries or concerts to be entertained and inspired and so it should be in our place of work, in order that the elusive spark of innovation is encouraged.

The importance of the working environment is also recognised in the consideration given to the planning and layout of whole business areas (Wallis, 1995) and university campuses. The Chinese have Feng Shui, which is devoted to the impact of these factors on our working and personal environment. The design of the process is linked with the technology involved in the process and is, fundamentally, linked both to the organisation and job design.

Figure 5.3 models the relationship between the elements of process design and this is as applicable to the service sector as it is to the manufacturing sector. The flow of product within a factory operation may correspond to the flow of the customer (as with an airport design) or of information (as in the headquarters of a bank). The impact on the people involved in delivering the service is clear.

The product design engineer considers the ergonomics of the product, such as a car seat (a key feature in a car purchase decision), whilst the process design engineer considers the ergonomics of a workstation on an assembly line.

In the service sector, the process design parameters of minimising the flow of information are even more critical as the customer is often within the organisation itself. Customers may be made part of the process, as in carrying their own luggage at airports or serving themselves in what is, essentially, the organisation's stock room at the supermarket. Clear signs and directions, easy-to-understand routes through the operation, understandable forms and approachable staff are all features of a well-designed service system. These are examples of *keeping things simple* – if the customer does not have to communicate with an employee to obtain the service, there is less chance for communication and quality problems. Think of and compare the children's party game of Chinese whispers with the processing of paperwork or messages through several different departments in a large organisation. At every point of information transfer there is an opportunity for the quality of the information to be degraded.