

## Innovation, research and development

Businesses must be able to develop new products, materials, systems and processes and improve existing ones in order to grow and to survive. Today, the pace of technological change, coupled with the rising wants and spending power of consumers, has forced firms to respond by investing in research and development (R&D).

- **RESEARCH** is the investigation and discovery of new ideas in order to solve a problem or create an opportunity. Methods used to generate new ideas include laboratory research, product evaluation of a business' own and its competitors' products and discussion groups designed to think up new ideas.
- **DEVELOPMENT** involves changing ideas into products, materials, systems or processes. Quite often a business will identify a number of possible ideas which have scope for development. The first stage is to select the idea which shows the most promise. One of the problems with development is the time scale involved. Some projects take many years to complete and success cannot be guaranteed.
- **INNOVATION** in business is the commercial exploitation of an invention. It involves committing resources and bringing a new idea to the market. Innovations are intended to make someone better off, and the succession of many innovations grows the whole economy over a period of time.

## The purpose of innovation, research and development

Certain purposes of innovation and R&D may be identified.

**Solving problems** Some R&D is designed to solve problems. For example, in the pharmaceuticals industry most R&D is aimed at developing new drugs and medicines to cure diseases, save or prolong life and reduce human suffering.

**Improving quality** It is possible to improve the quality of existing products through R&D. In the motor industry a lot of R&D is aimed at improving the safety of cars by improving braking systems for example. Or enhancing the performance of cars by developing new technology, such as the turbo charger. Improving quality is also a means of extending the life cycle of products.

**Developing new products** One of the main reasons why businesses invest in R&D is to extend their product range or replace products that have come

to the end of their life cycle. For example, the development of laptop computers helped to increase the range of products offered by the computer industry. In the electronics industry MP3 players have replaced CDs. The development of new products can help a business discover new markets.

**Reducing costs** The purpose of some R&D is to find cheaper ways of doing things. A great deal of innovation has focused on the machinery used by businesses. New technology in production and other areas of business has helped to lower costs. For example, the development of robots has reduced labour costs in factories.

**Developing new materials** Some R&D is designed to develop new materials. Synthetic materials have helped to reduce the use of natural resources. New materials often have features and characteristics which make them better than natural ones. They might be more durable, heat resistant or malleable, cheaper or lighter. DuPont, for example, created Tactel, a lightweight fabric with great strength. Two years after its invention it had captured 50 per cent of the skiwear market. In addition, the development of new materials often results in the creation of new products.

**Reducing environmental damage** An increasing amount of R&D has been directed at measures to help reduce the damage done to the environment. For example, some businesses are trying to find new ways of reducing energy consumption, cutting toxic emissions and recycling materials.

## The cost of innovation, research and development

R&D is often a highly expensive business activity. For example, in the pharmaceuticals industry it can cost up to a £1 billion to

Table 1: The amount of money spent on R&D by the UK's top 10 firms

Rank	Company	R&D (£bn)	Growth	Sector
1	GlaxoSmithKline	3.14	10%	Pharmaceuticals
2	Astra Zeneca	1.97	-11%	Pharmaceuticals
3	BAE Systems	1.45	31%	Aerospace
4	BT	0.73	39%	Telecommunications
5	Ford*	0.69	-10%	Automotive
6	Unilever	0.65	-8%	Food products
7	Rolls Royce	0.35	25%	Aerospace
8	Pfizer*	0.35	-41%	Pharmaceuticals
9	Airbus*	0.34	-1%	Aerospace
10	Royal Dutch Shell	0.34	6%	Oil and gas

\* Foreign-owned UK company.  
Source: adapted from [www.innovation.gov.uk](http://www.innovation.gov.uk).

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bringing a single new product to the market. About 45 per cent of all R&D in the UK is in the pharmaceuticals and aerospace industries. Table 1 shows the amount of money spent on R&D by the top 10 UK firms.

The amount of money allocated to R&D by different businesses varies greatly and may depend on a number of factors.

- It is common for businesses to vary their investments according to the funds available in any year. If profits fall for a period of time, R&D spending might fall. Also, a business might be criticised by shareholders if too much profit is allocated to R&D at the expense of dividends.
- Certain industries, such as pharmaceuticals, chemicals, motor cars, computers and defence, tend to have high levels of spending on R&D. This is due to the nature of the industry. For example, new drugs are constantly needed to prevent or cure new or existing illnesses.
- Larger public limited companies tend to be more committed to R&D. They are better able to meet the cost and bear the risk involved than smaller businesses. All the companies listed in Table 1 are plcs.
- Some businesses are committed to high levels of R&D spending because it is part of their corporate objectives and culture. This is certainly the case in pharmaceuticals and aerospace.
- In some industries businesses are forced to invest in R&D to compete. Failure to keep pace with the investment of rivals may mean that a business struggles to survive in the market.
- Businesses are more likely to invest in R&D when the economy is booming. During a recession R&D funding might be cut or frozen.

## The benefits of innovation, research and development

Those businesses that do spend on R&D may enjoy a number of benefits.

**Competitive edge** R&D leads to the development of new products. Firms which are able to develop new products ahead of their rivals will enjoy a competitive advantage in the market. If they can obtain a patent, they will be able to sell the product without competition from other businesses for a period of time. During this time they may be able to raise prices and make **higher profits**. Examples of businesses benefiting from new products include Dyson, the bagless vacuum cleaner manufacturer, and Microsoft, the creators of the world's main operating system for computers.

**Improved working environment** In some industries, such as mechanical and electrical engineering, research projects are designed to develop new types of machines. Computer controlled machines, for example, have been introduced into many component and textile manufacturers and assembly plants. New technology is capable of cutting costs and raising

## Question 1.

Wolfson is a global leader in the supply of high performance mixed-signal chips for the digital consumer market. Its products can be found at the heart of consumer electronic applications in the home, in the office and on the move. Wolfson's headquarters are in Edinburgh, where it employs some of the most experienced and innovative designers and engineers in the industry. Over the past few years Wolfson has established an enviable reputation for its audio brand. Many of the world's leading electronics manufacturers are customers, with their chips providing the audio in products such as MP3 players, personal media players, mobile phones, digital cameras, games consoles, flat screen TVs and hi-fi systems. The company has developed a broad range of products and continues to invest heavily in research and development to expand its product portfolio. Wolfson targets growing consumer markets, where added functionality and increased performance are essential to meet customers' expectations. It believes the digital revolution is still in its early stages of development and further advances in technology will allow ever more complex and sophisticated consumer products to be created, providing new opportunities for the company. In 2006 Wolfson spent \$29.3 million on research and development. Its turnover was \$204.1 million. In 2005 its net profit was \$29.0 million.

Source: adapted from Wolfson, *Annual Report and Accounts*, 2006.

- Using this case as an example, explain what is meant by innovation and research and development.
- How important do you think innovation and R&D is to Wolfson?
- What do you think is the main purpose of R&D and innovation to Wolfson?

productivity. In addition, new machinery is often safer, cleaner and more ERGONOMICALLY designed. This helps to make the working environment better for employees.

**Image** It is often argued that expenditure on R&D helps to enhance a firm's image. Consumers may be impressed by businesses which are committed to R&D. This is because consumers themselves appreciate the benefits of R&D and often recognise that such expenditure is risky. Also, breakthroughs in R&D can be highly prestigious. For example, a pharmaceuticals company developing an effective vaccination to combat Aids would receive a huge amount of positive publicity and recognition.

**Motivation** Investment in R&D creates opportunities for creativity and invention. Many employment positions in the R&D department will help staff to satisfy their higher order needs, such as self-esteem and self-actualisation. A successful R&D department might also generate a mood of optimism and anticipation in the organisation. This is likely to have a positive effect on the motivation of staff.

**Consumer benefits** Consumers enjoy an increasing variety of goods and services as new products come onto the market. They

are likely to pay lower prices for products because new technology lowers costs. They may also enjoy better quality products resulting from higher grade materials and more effective production methods. New medicines and drugs will improve health.

### Risk and innovation

Allocating resources to R&D is extremely risky. Expenditure on R&D does not guarantee new products. Quite often money spent on R&D is wasted. For example, in the pharmaceuticals industry, many of the drugs invented do not reach the market. Trials may be carried out to see whether the drugs have the intended effect and if they have any serious side effects. If drugs fail the trial process they cannot be marketed.

Setting a budget for R&D expenditure is also fraught with uncertainty. R&D departments often spend more than they are allocated. Businesses may have to raise funds externally to finance R&D projects. In recent years a number of pharmaceutical companies have had to use rights issues, to raise extra finance to fund research in medicines and drugs. There are several reasons why setting an R&D budget might be difficult.

- The cost of a scientific research project may be difficult to estimate accurately. This is because researchers will not know when a breakthrough is going to occur. Some research, for example into cancer and AIDS cures, has been ongoing for many years.
- During an R&D project, there may be unforeseen spending. For example, a business might have to unexpectedly recruit staff with specialist knowledge and experience to further the programme.
- Some R&D programmes run for many years. Therefore their costs tend to rise with inflation. There is a tendency to underestimate inflation and businesses then have to obtain further funding to meet rising costs.

It may be possible to reduce risks by taking out a PATENT. A patent aims to protect the inventor of a new product or manufacturing process. It allows a business to design, produce and sell a new invention and attempts to prevent competitors from copying it. New inventions are protected for 15 years. The developer must make details of the invention available to the Patent Office.

Obtaining a patent can be a lengthy process. To qualify for a patent the invention must be brand new. Checks are then made to ensure it is authentic. The patent is published 18 months after its application and signed and sealed some time after this. The developer must pay annual fees to the Patent Office, which become more expensive after the first four years. This is to encourage production of the new idea. Both the inventor and the consumer can benefit from patents. Some benefits to businesses of patents are:

- a higher level of sales;
- reduced competition;
- legal protection that encourages continued research;
- higher profits, which can be ploughed back into further research and development;

- the benefits to the industry of having the technical information as a result of the patent;
- high risk research and development is encouraged.

Consumers also benefit. New products mean more variety and perhaps a better standard of living. New, more efficient, productive techniques mean lower costs and lower prices.

There is a number of criticisms of the patent system. The granting of sole production and distribution rights to one firm creates a legal monopoly. If this monopoly power is abused then consumers may be exploited.

### Implications of innovation strategies

Innovative companies that are committed to high levels of R&D are likely to have differences in the way they operate. The culture of the organisation might be quite different. For example, in companies that emphasise creativity and innovation there is often an informal culture. There may also be more trust and less supervision. If a company pursues innovative strategies there are likely to be implications for other functional areas of the business. The possible implications for finance, marketing and human resources are outlined briefly below.

**Finance** Innovative companies are likely to have different financial priorities. Inevitably they will spend much larger

### Question 2.

In 2006, Rolls-Royce invested a total of £747 million in research and development, of which £395 million was funded from Group resources. Some of the money invested in R&D is being used to address the environmental challenge. During 2006 Rolls Royce launched a new £95 million technology demonstrator programme, the Environmentally Friendly Engine (EFE), which will deliver further improvements in turbine efficiency and combustion emissions. EFE involves a range of industrial and university partners and will validate technologies for pull-through from 2008 into all of their gas turbine products.

Rolls-Royce is a lead partner in the development of the European 'Clean Sky' Joint Technology Initiative. Alongside its industrial partners, it hopes to gain European Commission approval to launch this seven-year programme in mid 2007. In combining this programme with the EFE programme, Rolls Royce will continue with its progress towards achieving the Advisory Council for Aeronautics Research in Europe (ACARE) goals for environmental improvements by 2020. Also, during 2006 Rolls Royce filed a record 330 patent applications.

Source: adapted from [www.rolls-royce.com](http://www.rolls-royce.com).

- Rolls Royce spent a total of £747 million on R&D in 2006. Outline two factors that might influence the amount a business spends on R&D.
- Discuss whether some of the R&D expenditure carried out by Rolls Royce was designed to reduce environmental damage.
- During 2006 Rolls Royce filed a record 330 patent applications. Explain the purpose of a patent.

amounts on R&D. This may have implications for fund raising. For example, many investors may not be prepared to risk their money in companies that rely heavily on innovation and R&D. This is because they know that R&D can often result in failure. Consequently such companies may struggle to attract funding. They often have to rely more on share capital than on loans when raising money.

Another issue for the finance department is cash flow. R&D has a habit of draining the cash resources of a business. The finance department must monitor cash flow carefully. On the one hand ensuring that the R&D department has enough cash to be effective, but on the other making sure that all of the company's cash does not disappear into a 'black hole'.

**Marketing** Innovative companies have to work very closely with the marketing department. One of the main sources of new ideas is from customers. Businesses must be responsive to the needs of consumers and R&D projects must address these needs. The marketing department must gather up to date and reliable information from the market and communicate it effectively to R&D centres. Innovative companies will be far more successful if their new products meet the needs of consumers.

When a new product is developed, it may take a time to get accepted in the market. For example, consumers may not believe that a new technical product really works. The marketing department will have to use all their skill to launch the new product successfully. However, once established, innovative products will get good distribution. Large retailers are likely to prefer innovative new products when allocating shelf space to manufacturers.

**Human resources** Innovative companies may have a more relaxed approach to working. This is to accommodate the needs of their creative people. Working practices may be more flexible and less regimented. Innovative companies may also have to recruit different types of people. They may require a lot of graduates for example. An increasing number of research companies are 'spin-offs' from university departments. For example, privately owned Molecular Profiles was founded in 1997, as a spin-off company from the School of Pharmacy at the

University of Nottingham UK. The company specialises in advanced solid state analysis.

Workers in innovative companies are more likely to be involved in the introduction of new methods and working practices. For example, innovative companies may adopt a kaizen (continuous improvement) approach to business, where it is the responsibility of everyone to look for improvements. This view is supported by the management guru Tom Peters. He believes that innovation is the responsibility of everyone in the organisation. In this way, the organisation can harness the creative power of an even wider range of specialists. Also, innovation often comes when people from different backgrounds work in teams. An innovative business must be prepared to adopt such working practices with its employees.

## KEYTERMS

**Development** – the changing of new ideas into commercial propositions.

**Ergonomics** – the study of people in their working environment and the adaptation of machines and conditions to improve efficiency.

**Innovation** – the commercial exploitation of an invention.

**Patent** – a licence which prevents the copying of an idea.

**Research** – an investigation involving the process of enquiry and discovery used to generate new business ideas.

## KNOWLEDGE

1. What is the difference between R&D and innovation?
2. State four purposes of innovation.
3. Why is R&D risky?
4. State four benefits of R&D to a large clothes chain.
5. State three benefits of R&D to businesses.
6. State two industries where R&D expenditure tends to be high.
7. What might be the implications of innovative strategies for human resources?

## Product choice

New businesses have to decide what product to manufacture or what service to provide. Once a business is established, it is unlikely to supply exactly the same product or service indefinitely. Over time businesses modify products, withdraw declining products and introduce new ones. They tend to extend product lines and may even diversify into completely different product areas. Decisions to launch new products or adapt existing ones are often complex and outcomes can be uncertain. Most businesses will carry out marketing research before making these decisions. This will help to evaluate the likely success of a new product before production begins.

What influences the products a firm chooses to produce?

**The approach of the business** Some businesses may be product orientated. The nature of the product itself (what it could do and its quality) would be enough to make sure that it sold. For example, when cars were first produced they were unique and a novelty and so the product sold itself. Many firms recognise the need to design products that meet consumers' wishes. These are market orientated firms. Increasingly businesses are becoming asset-led. They are launching products based on the strengths of the business. For example, a company with a strong brand name for a product may develop other related products.

**Competitors' behaviour** In order to survive in a competitive market, businesses must supply products which customers prefer at the expense of those supplied by competitors. This may mean developing products which are not available, or copying rivals' ideas and improving them.

**Technology** New inventions and innovations often result in new products. For example, research has resulted in mobile telephones, flat screen televisions, satellite television with pay per view options, and digital television, with improved picture quality and interactive options. New materials have been created which have led to improved products. Kevlar is a fibre which is used in the manufacture of bullet proof vests because of its resistance to impact. Carbon fibre racing cycles have been created which are lighter and faster than traditional cycles. Totally new products may be created. DVD players play films stored on discs similar to CDs. However, they contain far more information.

**Management** The choice of product is often made by senior management. It is a crucial decision because it may decide the fate of a company.

**Financial viability** Do the benefits of new or adapted goods or services outweigh the costs? The benefit to the firm might be the

revenue it gains from selling the product. Accountants often act as a constraint on production decisions. They are unlikely to approve funds for products which will make long-term losses.

## Approaches to product development

Businesses may prefer to develop a new product which is unique. In practice this is difficult. New product development is expensive and highly risky. As a result most 'new' products tend to be adapted from those which already exist. Product ideas can come from a number of sources.

**Ideas from customers** The most successful firms will be those which provide products which match the wants of customers. Thus it makes sense to listen to the views of customers when forming ideas for new products. The marketing department is likely to play an important role. Questionnaires and interviews can be used to gather data from customers. However, it is often argued that less structured methods are more appropriate for collecting new ideas. The use of focus groups, where seven to ten participants sit to discuss and share ideas about new products, is one approach. Another is to analyse all customer communications, such as complaints and suggestions. It is important for all staff who are in contact with customers to pass on such comments.

**Ideas from competitors** Companies sometimes rely on copying the products of competitors. This is to avoid the cost and risk of new product development. It is also difficult to be original. A firm will gain a competitive advantage if it can develop a brand new product and be the first in the market. However, a large number of firms wait for competitors to launch new products and then bring out their own versions. Supermarkets often copy famous brand names when launching their own-label brands of goods. In some cases the copying extends to closely imitating the packaging as well as the product. TV companies are quick to bring out their own versions of new quiz games, cookery programmes and other popular TV shows which rival broadcasters launch. Some companies undertake REVERSE ENGINEERING. This process involves taking apart a product to understand how a competitor has made it. A business will closely analyse the product's design and how it has been produced, and identify those key features which are worth copying.

**Ideas from staff** Businesses may rely on the ideas of their staff for new products. Some staff will work closely with customers and might pass on suggestions for new products as a result of their conversations. Suggestion schemes, where staff might be rewarded for offering new product ideas, are often used.

**Ideas from research and development (R&D)** Many organisations have research and development facilities. Money is allocated specifically for the invention, experimentation and exploration of new product ideas. This is probably the most expensive source of new ideas. However, the money invested can generate huge returns if a unique product is developed. R&D is discussed in more detail later in this unit.

**Ideas from other products** Businesses may adapt their own products into new goods or services. They tend to concentrate on best selling brands. Examples might be the development of 'bite sized' versions of well known chocolate bars or diet and low fat versions of drinks or meals.

## Product design

In practice, once a business has identified a need for a product, a design brief can be written. This will contain features about a product which the designers can use. For example, a firm aiming to produce a new travel iron may write a design brief such as 'a new travel iron is needed which is compact and possesses all the features of a full-sized model'. Designers can work from this design brief. When designing the new travel iron they may take into account:

- the shape and appearance of the iron;
- whether it fits the intended need;
- how easily and cost effectively it can be produced from the design;
- the dimensions and preferred materials to be used;
- the image it gives when displayed;
- whether the design should create a 'corporate identity', saying something about the image of the company.

## The design process

The design process has a number of stages which take the design from an initial idea to a final product. These stages are shown in Figure 1.

Figure 1: Steps in the design process



## Question 1.

Deborah Brady, a keen equestrian, identified the need for carrying basic equipment while horse riding in a more convenient and comfortable way. The idea was developed during a horse orienteering competition where various equipment including map, phone and pens were used on a regular basis but were difficult to access from a coat or rucksack while 'on the move'. Over a four year period, Deborah developed a range of prototypes in collaboration with local fashion designers and manufactures and with the support of Design Wales and The Wales Innovation Network (WIN) refined the initial concept into a functional activity vest, named 'Q-Pak'. The vest is a multifunctional piece of outdoor apparel incorporating an integral, detachable map case for improved accessibility, together with specifically shaped ergonomic pockets for carrying essential safety equipment and field kit such as compass, space blanket, mobile phone, hand warmer, medical card, whistle, etc. The vest also incorporates high visibility edging to improve safety while on the road.

Although the product was initially designed for use during equestrian orienteering events, further research identified many other sporting activities that would also benefit from a product of this nature including walking, rambling, cycling, mountain biking, climbing, orienteering, fell running, fishing, and rescue units. The product was also entered into the World Invention Show in Geneva in 2005 and was awarded a silver medal in the textile category. The positive feedback gained from the exhibition inspired Deborah to launch the product commercially. The vest, now named the i-Quip Explorer, is marketed by her company, i-Quip Ltd.

Source: adapted from [www.designwales.org.uk](http://www.designwales.org.uk).

- Where did the idea for the i-Quip Explorer come from?
- During the design process how did Deborah 'investigate alternative solutions'?
- The i-Quip Explorer has ergonomically designed pockets. Explain what this means.

The design process usually begins when a need is found for a new, adapted or redesigned product. Needs may be identified by the marketing department in a design brief for the design team, like the one described for the travel iron above.

The next stage is to produce a design specification and analysis. One way of achieving this is for the design team, market researchers and the client to meet and discuss their ideas. The design specification and analysis will give a clear description of the purpose of the product, state any functions the product must have and mention constraints, such as cost, size or quality.

Several techniques can be used to produce specifications. One way is to note down all the essential features of a product and to be less interested in those which are only desirable. A pair of walking boots might have essential features such as durability, being waterproof, made of leather and comfortable, and desirable features such as attractiveness, lightness and economy in manufacture. Another technique involves listing all

able alternatives or solutions, even those which initially might be considered unlikely.

Next it is necessary to find some practical solutions to the design brief. Solutions which the design team have suggested should be assessed. Sketches and working examples will help the evaluation. Finally, the team must decide which model or prototype is the most suitable solution to the problem.

The firm can then realise the design solution by making the product. The first production run is likely to be very small because the total design process is not yet complete.

The final stage in the design process is testing. Most designs are tested to check that they satisfy the customer. It is often necessary to refine or modify the product. Sometimes new ideas are generated once the design solution is in a working condition.

## Design features

When designing any product a number of features have to be considered by the designer or design team.

**Commercial viability** Businesses must be able to produce and sell a product at a profit. Thought must be given to the choice of materials and the production techniques that are used so that production costs can be kept down. If the costs are likely to be too high, the design may well be dropped.

**Reliability** Designers must ensure their designs satisfy customers' expectations about the reliability of the product. Unreliable products may harm the company's image in the eyes of the consumer. The business will also incur costs if products are frequently returned.

**Safety** Designers must ensure that their design solutions are safe. Safety is particularly important if products are used by children, the elderly, pregnant women and people with injuries. Safety features which might be important could include:

- ensuring that products do not contain poisons or other dangerous materials such as toxic paint;
- designing products which do not have sharp edges or spikes or providing adequate protection if such features are necessary;
- ensuring that products are finished properly so that edges and faces are smooth and clean;
- incorporating safety features such as child proof caps on bottles;
- ensuring that products are durable because a product which breaks could be dangerous.

**Maintenance** Technical and mechanical products often need maintenance. Products should be designed so that this can be easily carried out. This is particularly important in the design of machinery.

**Environment** In recent years consumers have begun to question

## Question 2.

Barbara and Peter Blackburn are gardeners rather than inventors. Their original product was exhibited at the Geneva Inventors and New Products Exhibition in April 2006, where they won a Bronze Medal in their category. This resulted in public, media and trade interest in the product, both in the UK and in Europe. The product started life as a simple frame that had been discarded from another item. It kept open a refuse bag, but needed to be refined in terms of design and materials used. It was the start of the concept of the B-tidy range. After months of building prototypes and using them in their garden, the B-tidy Home and Garden Tidy was developed. The product has had extensive trials with consumers during its development. Market Research indicated very positive potential consumer interest. Blackburn Associates have now developed accessories to complement the Garden & Home Workstation.

The B-tidy range has been manufactured to the highest of standards. Materials used are strong, robust and will withstand the rigors of climate changes. The Home and Garden Tidy solves the two most common problems for gardeners when tidying their gardens – keeping a refuse bag open and upright and keeping tools in one place. It has a robust steel frame with a tough tear resistant waterproof polyethylene pocketed support.

- It will support up to 15 kgs.
- It supports and keeps open any standard size refuse bag.
- It has 8 handy size pockets to keep all those garden tools in one place.
- It can be easily wheeled around the garden.
- Pocketed support easily removes from frame to facilitate removal of heavy bags or for cleaning.
- Convenient working height for standing or kneeling.
- At the end of the day it folds away for easy storage.

Source: adapted from [www.b-tidy.co.uk](http://www.b-tidy.co.uk).

- (a) Explain how the following design features were important when Barbara and Peter Blackburn developed the B-tidy Home and Garden Tidy.
- (i) Convenience and efficiency. (ii) Reliability and durability. (iii) Commercial viability.

the effect certain products have on the environment. Designers now have to take this into account.

**Convenience and efficiency** Products should be designed so that they are convenient and practical to use. For example, some tin openers are 'hand held' whilst others are electrically operated. Consumers are increasingly prepared to pay for products which are easier to use. Businesses also look for machinery and equipment that will lead to a more efficient workforce. Products which are well designed ergonomically should increase efficiency and operator safety and also involve less effort for the user.

**Manufacture** Designers must ensure that their designs are not

expensive or technically difficult to make. For example, they may suggest a cheaper material for lining the inside of a suitcase.

**Market** The designer must consider the marketing mix when designing products. Products are very difficult to market if they are unattractive, clumsy to store and display, expensive to distribute and overpriced.

**Aesthetics** Designers must consider the colour, size, appearance, shape, smell and taste of products. Many consumers would not wish to be seen wearing poorly designed clothes, for example.

**Legal** The product should be designed so that it is legally 'fit for purpose'. For example, if a manufacturer claims that a new type of paint is designed to dry within two hours after application, then legally, it must.

## Computer aided design

Computer aided design (CAD) is an interactive computer system which is capable of generating, storing and using geometric and computer graphics. It helps design engineers to solve design problems. CAD is used in many industries today. What benefits does CAD offer to a designer?

- CAD has meant huge cuts in lead time, i.e. the length of time between the initial design and actual production. Long lead times result in lower profits as firms lose out to competitors in the race to launch new products.
- A wide range of designs can be shown on the computer screen. Two and three dimensional engineering drawings, wire-framed models, electronic circuit board designs and architectural drawings are examples.
- CAD systems handle repetitive work, allowing the designer more time to concentrate on 'creating' the design. The need for specialists is also reduced, which helps keep down costs.
- Modifications and changes are easily made. The size or shape of a design can be changed in seconds, for example.
- Problems are often more quickly identified. This sometimes prevents the need for expensive reworking later on. Also, the final design, once manufactured, is more likely to be right.
- Increasing use is being made of CAD by businesses. In America, customers entering the Digitoe shoe store in Seattle sit in a seat which has a scanner attached to a computer. The equipment takes detailed pictures of their feet. It sends them to a factory where a shoe mould is made and a pair of custom made leather shoes are produced. The first pair are ready in two weeks, but the moulds can be reused and further pairs can be produced within hours of a new order. This sort of individualised production line, called mass customisation, is a direct result of improvements in CAD and manufacturing software.

## Value analysis and value engineering

The aim of VALUE ENGINEERING is to reduce costs and avoid unnecessary costs before production begins. This technique is used by most manufacturers in Japan. It aims to eliminate any costs which do not add value to, or improve the performance of, products and services. VALUE ANALYSIS is a similar process, but is concerned with cost reduction after a product has been introduced.

Value engineering helps businesses to design products at the lowest cost. It is usually carried out by cross departmental teams. Team members might include designers, operations managers, purchasing specialists and cost accountants. The process involves carefully checking the components of a product to find ways to reduce their costs. The team will analyse the function and cost of each element and investigate ways to reduce the number of separate components, using cheaper materials and simplifying processes.

The success of value engineering will often depend on how departments work together. Value engineering cannot be undertaken by an individual. Costs can only be reduced if departments take into account each other's needs. For example, in an effort to cut costs, the quality of a product may suffer to such an extent that the marketing department may find it impossible to sell it. The advantages of value engineering include:

- lower costs, resulting in lower prices for consumers;
- more straightforward methods of manufacture;
- fewer components in products, resulting in lower maintenance and repair costs;
- improved co-operation and communication across departments;
- possible 'spin-offs' for other products.

Value analysis has been used by the government to help improve efficiency in some of its departments. For example, the Edinburgh Healthcare NHS trust set up value analysis groups to look at catering services, portering services and laundry. As a result around £400,000 of savings were made on a budget of £5 million. In addition, the quality of services was also improved in some cases.

The Co-op Bank carried out an ethical and ecological value analysis to estimate the possible costs and benefits of pursuing sustainable development. The bank takes seriously its responsibilities as a practitioner of sustainable development. The bank found that its ethical and ecological positioning makes a sizable contribution to the bank's profitability. Twenty six percent of profits can be assigned to customers who cite ethics as an important factor, and 14 per cent to customers who cite ethics as the most important factor. Recently, the profit attributable to ethically-minded customers was put at between 15 and 18 per cent of the bank's profit before tax.



## Lean design

LEAN DESIGN or SIMULTANEOUS ENGINEERING or CONCURRENT ENGINEERING, as it is sometimes known, involves speeding up the whole design process so that a business can bring new products to the market far more quickly. Lean design was first used by Toyota and involves the integration of production and design so that production and design tasks can be undertaken at the same time. Lean design also aims to reduce waste in the design process which may result from a number of factors.

- Looking for information and waiting for test results.
- Generation of unnecessary documents.
- Development of unnecessary physical prototypes.
- Not learning from past design experiences.
- Building in too many features.
- Unused or incomplete designs.

## KNOWLEDGE

1. How can the behaviour of competitors and the state of technology affect the product a firm chooses to produce?
2. How might a business find out if there is a need for a product?
3. What is meant by a design brief?
4. Describe the stages in the design process.
5. What is meant by a design feature?
6. State six design features that a firm might consider important when designing a product.
7. How does CAD improve business efficiency?
8. How will value analysis benefit consumers?
9. What is the difference between value analysis and value engineering?

- Underuse of design knowledge.
- Late discovery of manufacturing errors.
- Poor designs.
- Warranty issues.

B/E Aerospace used a lean design approach on a lie-flat first class seat order for Japan Airlines (JAL). The project challenge was how to pack the many internal components of the seat into an extremely tight space, requiring very close collaboration between the industrial designers and the engineers. By using lean design the company was able to reduce waste in its product development process. The lie-flat seat also won B/E Aerospace an award for innovative design. Concept designers and engineers on the seat project avoided data translations by working with CAD software that had functions for concepts and detailed engineering. This let their work proceed concurrently instead of serially – one of the key features of lean design.

## KEY TERMS

- Lean design (or simultaneous engineering or concurrent engineering)** – an approach to product design which involves cutting waste in the design process to reduce the amount of time it takes to design a product.
- Reverse engineering** – a method of analysing a product's design by taking apart the product.
- Value analysis** – a procedure to evaluate a product after manufacture to see how costs may be reduced
- Value engineering** – a procedure designed to reduce and avoid unnecessary costs before production begins.