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PRODUCTION

Production is about designing and making things, products or services, which are then provided to customers or clients. The production department was once regarded as the heart of the business, the single most important element in any commercial organization. Today, the marketing orientation has changed this view and we now take a much more holistic view of organizations, but 'production', however it is defined, remains a vitally important element. Without an efficient and effective production department, the promises marketing makes to customers cannot be fulfilled, or at least not at a profit. This is equally true whether we are talking of a steel mill, a software consultancy, a hotel, a hospital ward or a charity working with homeless people; in the case of the latter, 'production' refers to the delivery of services to people in need.

Organizations need to produce the goods customers need, in the right quantity, at the right quality, at the right time and to the right cost. Meeting all four of these objectives requires careful planning and commitment of resources. It is easy to concentrate on one of these needs to the detriment of others: for example, getting the quality right but taking too long to complete the job, or overrunning on costs. All four targets must be met if the marketing aim of meeting customer needs profitably is to be fulfilled.

There is always a certain amount of creative tension between production and the other functions, especially marketing, human resource management and finance. Production requires investment, while the finance function seeks to control costs; how much investment is put into production is often a series of constant

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negotiations between the two departments. Production requires skilled labour, and must make its needs known to the human resources function, which then must find the people production needs. Marketing will demand products that meet customer needs, and production must find a way of providing them without allowing the costs to become excessive. The relationship between marketing and production can be particularly problematic, but neither function can do without the other; one determines what is made, the other actually makes it and delivers it.

More, better and cheaper are the words which every production manager hears. The pressure is always to produce a higher volume of high-quality goods while simultaneously driving costs down. In difficult times, production management becomes a matter of squaring the circle. As a result, production managers are often engaged in near-constant innovation, seeking to improve both the goods they make and the processes by which they make them.

The bulk of this chapter deals with production of both products and services. As with marketing, however, there are some differences between services and tangible products, and these will be discussed in more detail at the end of the chapter.

DEFINITIONS

Some of the following terms will be encountered in any study of production systems.

Process Process is a generic term for how things are developed and made. It can be applied to individual stages of production, or to the whole production system. For example, brake units for cars are manufactured through a process. Completed brake units are installed in cars through another process. The whole business of making components and assembling them into a finished automobile can also be referred to as a process. The design of the car in the first place is a completely different process, and so on.

Flows Flows are a production concept that describes the movement of information and knowledge, raw materials, components and finished goods through the production system, either a single production facility or a group of facilities. Flows are often mapped using diagrams known as flowcharts, useful aids for planning and studying production systems. The complete flow, from supply of goods and services into the organization to finished products delivered to customers, is known as the *supply chain*.

Efficiency We defined efficiency generally in Chapter 1, but in production efficiency has two specific connotations: the elimination of waste, either of time or materials, and reliability in terms of output from production systems. Reliability in turn reflects the performance of machines – how well do they work, how frequently do they break down – and people – do they work efficiently, are they on hand when required? An efficient system is one which is both reliable and minimizes waste.

Quality Quality refers in the first instance to ensuring that the product or service meets a pre-determined standard, and is consistently made to that standard without variance or defects. Two key tasks are involved: setting the standard accurately, and ensuring the standard is adhered to. We will discuss quality in more detail below.

Resources Resources are what production requires to make products, sometimes also known as the factors of production. These too will be discussed in more detail below.

THE CIRCULAR ECONOMY

The traditional model of production is sometimes known as 'take, make, dispose'. The company takes resources from wherever it can find them and converts these into products and services which are provided to customers. Customers, when they have finished with the product, then throw it away. We can see the results of this system in the millions of tons of food that are thrown away each year, or the empty plastic bottles and bags that litter the streets and countryside, or the mountains of garbage that were formerly buried in landfill. With rapidly rising populations, the take, make, dispose system is both depleting resources and degrading the environment at unsustainable rates.

The circular economy and related concepts like 'cradle to cradle' production seek to reduce both resource depletion and environmental degradation through a variety of means. First, end-of-life products should be repaired, reused or recycled. Food waste is turned into compost or biofuel, electronics products are upgraded rather than being replaced, plastics, glass and metal are recycled.

The European Union now requires that all components for cars made in Europe must be capable of being recycled, which should reduce waste from scrap cars.

The circular economy does not happen automatically. It requires careful forethought and planning production systems, to use components and elements that either have a minimal impact when disposed of, or can be easily repaired or recycled to give them a longer lifespan. This requires deep attention to detail at every step of the production process, and just like quality, has to be designed into the process. There are similarities between circular economy management and total quality management, which we will come to in a moment.

All the concepts discussed in this chapter need to be thought of in light of the circular economy. How can we get away from take, make, dispose, and make our production processes truly circular, reducing their harmful impacts? That is the challenge to production managers of both products and services in the years to come.

FACTORS OF PRODUCTION

The first theoretical considerations of how goods are produced came from the writings of economists such as Richard Cantillon and Adam Smith in the eighteenth century. These writers believed that there were three 'factors of production', inputs required to achieve an output, or in other words necessary ingredients for the making of things. These were:

- **Land.** Land was seen as particularly important for industries such as agriculture and mining, but it was also necessary for setting up factories. The location of factories was particularly important when machinery was powered by water or steam, as it had to be close to fresh water.
- **Labour.** Labour was initially seen as the 'brute force' that made goods, with or without the aid of machinery. But from Adam Smith's time onward, the importance of skilled labour also became recognized. In other words, labour was not just muscle and hands, but thinking intelligence as well.
- **Capital.** Capital originally meant simply money, required to build and maintain facilities such as farms, mines and factories.

> Any business venture required capital, but manufacturing ventures required large amounts of it to build machinery and power sources.

As time passed, however, other factors began to be acknowledged. During the nineteenth century economists such as Nassau Senior, Charles Babbage, Karl Marx and Alfred Marshall all acknowledged the role that knowledge played in making production effective (see Chapter 8). By the late twentieth century the idea that 'knowledge capital' played a role in production was becoming widely accepted: as well as investing money, businesses also brought knowledge and skills to bear on production. Further, management itself began to be seen as a factor. Early theories had focused on the business owner (the 'promoter' or 'entrepreneur' in early literature) as merely a provider of capital. In the 1920s, the Austrian economist Joseph Schumpeter asserted that business owners, and by implication managers, were a more active force, serving as catalysts to get production going, and monitoring and guiding its progress. The Austrian-born American management guru Peter Drucker, influenced by Schumpeter, took this still further, asserting that management is the central focus of any organization. Production is ultimately not just a matter of labour and machines, but also of management.

THE INDUSTRIAL REVOLUTION

Two events changed the nature of production. The first of these was the Industrial Revolution, which saw the mechanization of production. Prior to the Industrial Revolution, most production had been done on a craft basis. In craft production, businesses were small and a single individual would often be responsible for production of an object from start to finish; for example, a pair of shoes would be made by a single shoemaker. Beginning in the British textile industry in the 1770s and gradually spreading to other industries and then, in the early nineteenth century to other countries such as France, Germany and the USA, the Industrial Revolution changed the dominant mode of production to what we now call a 'line' basis. Production became concentrated on assembly lines, each of which might employ tens or even hundreds of workers, each of whom was responsible for one stage of production only. Thus in mechanized shoe-making, one worker might make patterns, one might cut out the sole, third might cut out the uppers, a fourth might operate the machine that sews the parts together and so on.

At the heart of this new industrial process was what economists call the division of labour. Instead of a single worker taking charge of most or all of the production process, that process was broken down into a series of tasks. Each worker was responsible for a single task within the larger process. This meant in turn that work became highly specialized, especially as machinery became more complex; the range of each worker's knowledge was reduced, but that knowledge also had to be more detailed and specific. The system known as scientific management, developed in the USA around the turn of the nineteenth and twentieth centuries, took this division of labour and specialization to extremes, breaking down tasks into the smallest possible parts and then re-designing tasks to make work more efficient.

THE ELECTRONIC AGE

The second important event was the dawning of the electronic age. Computers were first used to handle financial and accounting systems; the first computer to be used in a business setting, the LEO (Lyons Electronic Office) by the British company Lyons in the 1950s, also had the ability to store records of inventories of goods. During the 1960s and 1970s, advances in the technology resulted in systems such as computer-numerical control (CNC), which meant that precision machines could be guided by pre-set computer programmes rather than the human eye and hand, and this in turn reduced errors and waste. The first robots were introduced onto production lines in the late 1970s, in Japan and Sweden. By 2000, advanced communications technology offered the opportunity to link machines and create entire computerized production systems. Today we have gone well beyond that point and artificial intelligence now gives us the capacity to create production systems that require only minimal human input.

The increasing reliance on technology meant that the nature of labour changed. Much specialized work was now being done by machines. The emphasis of human labour turned to controlling and guiding processes, rather than carrying out laborious tasks. This in turn meant that work became less repetitive and more involved in monitoring and problem-solving; also, a single individual could manage a wider range of tasks within the overall process. This has led to what the Czech-American scholar Milan Zeleny calls the 'recombination of labour'. That is, from the extreme division of labour with a focus on specialized tasks, we are moving back towards a system where people take on multiple tasks and require a broader range of knowledge. The balance between the factors of production – land, labour, capital, knowledge, management – is thus constantly shifting and changing.

PRODUCTION STRATEGY AND PLANNING

The process of making goods requires strategic thinking and planning just as any other area of business. Production strategy requires two key sets of decisions: *structural* decisions which concern what will be made and how, and *infrastructural* decisions which determine what support and resources will be required.

STRUCTURAL DECISIONS

The primary structural decisions concern capacity. Simply put, management must decide what products will be made, when they will be made, and where. All these decisions are made with several factors in mind. The primary aim must be to make goods in such a way that they will be available to customers when the latter want them, and thus information and feedback from the marketing function of the business is very important when making these decisions. At the same time, circular economy principles mean the goods must be designed with their life cycle in mind. Can original components be recycled into new goods? If not, can they be repurposed in some other way? How can we work towards net zero inputs?

The issue of quantity of goods to be made is particularly critical. If too few goods are produced, sales will be lost and disappointed customers will go elsewhere, unless new goods can be produced very quickly. If too many are made, goods will sit in warehouses for lengthy periods of time until they can be sold. Getting this decision right is particularly difficult for complex goods that take a long time to produce, such as precision instruments or aircraft.

Once capacity decisions have been taken, managers need to determine what production facilities will be required. Again, location can be a significant issue, depending on where customers are. The cost, including the environmental cost, of transporting goods from the factory to customers needs to be taken into account. In modern manufacturing, most large companies use a number of different production facilities in different locations, taking advantage of issues such as access to markets, access to skilled labour and other resources, for example. An increasing trend in recent years is for businesses to relocate production from Europe and North America to places such as South America or China, where skilled labour is available at a much lower cost. This of course has ethical implications; many of these low-paid workers also work in hazardous conditions and have poor living conditions. As ethical managers, do we want to employ them? But what will they do for a living if we don't employ them? These are not easy questions to answer.

Another set of decisions concerns the process by which goods will be made, and in particular the technology required. Processes need to be designed to ensure maximum efficiency and effectiveness in order to achieve the required capacity at the best cost. The best cost is often but not always the lowest cost; sometimes a higher level of spending can achieve better results in terms of efficiency and effectiveness. This is particularly true when we look at environmental impact and the circular economy. Ideally, in a circular economy the reuse of goods should lower costs, but there may well be high set-up costs to get systems into place, which will need to be recouped over time. Decisions about processes are inextricably linked to those about technology, as virtually every process will depend on technology to some degree.

Once the nature and volume of the finished products have been determined, a further stage in planning calculates what components and resources will be required, and in what quantities. One important structure decision which must also be made is known as the 'make or buy' decision. Every finished product requires a series of components and parts. The decision facing managers is whether to make these parts themselves from raw materials, or to buy them from other specialist manufacturers. For example, when General Motors builds cars, should it make its own electrical switches, or should it buy them from a company which makes them? When Hewlett-Packard makes computers, should it manufacture its own semiconductors and hard disks, or buy them from specialist makers? The answer depends always on a variety of factors, but ultimately the decision is made on the basis of cost, quality and convenience. If the company can make components more effectively than it can buy them, and if setting up a separate production facility would not divert too many resources from the main task, then it may be wisest to make components. But if the cost of setting up such a facility would be too great, then buying in components is usually the best course of action. Computer companies buy in virtually all their major components such as chips and hard disks for precisely this reason.

INFRASTRUCTURAL DECISIONS

Decisions about infrastructure are made with a view to supporting the main production system. Some of the decisions that have to be made at this point include:

- **Human resource decisions.** How many staff will be required, and where will they be deployed? What skills will they need? These decisions should be made in close co-operation with the human resource management department.
- **Capital requirements.** How much investment is required to set up a production facility, and to keep it running efficiently? Calculations such as profitability and rate of return on investment need to be made here (see Chapter 7), and these will require input from the finance department.
- **Quality control.** How will quality be assured and maintained? This involves the design of a quality control system as part of the manufacturing process. Input from the marketing department or function is an essential part of this, as quality is, initially at least, defined by customer needs (see below).
- **New products and new technologies.** Production strategy has to plan for the future, of course, and this means the

possible introduction of either new products or new, more efficient and more environmentally friendly processes for making products. Research and development is carried out on a regular basis in order to forecast and introduce new products and new technologies, and this function too requires the allocation of resources.

PRODUCTION SYSTEMS

There are a huge variety of production systems, of course, as every product has different specifications and different companies may use different systems and technologies to produce very similar products. There are, however, some basic tasks that are common to all production management. Every system has to be (1) designed, (2) set up and installed, (3) operated in order to make products, and (4) maintained so as to retain operating efficiency.

Design of the system follows on from the development of the manufacturing strategy and plan. The actual design of the system depends on what products are to be made and in what quantity. The design of the system brings together human and mechanical resources, labour and technology, and combines them in the most efficient and effective way.

Once designed, the system is then physically installed: the technology is set up and tested and the workers rehearse the tasks required of them. Blast furnaces will be tested in a steel mill; robotic equipment on an assembly line will be checked; workers in a hotel kitchen will cook practice meals before opening to the public; delivery drivers will check out their routes and be trained in how to use the satnav equipment. No matter how simple or how complicated the system might be, it still has to be tested to make sure it works.

During the actual process of production, management monitors input and output and checks to see that targets and schedules are being met, that the supply of materials is unimpeded, and the finished goods are of the appropriate quality (see below for more on quality). Finally, technology requires maintenance. Often production managers schedule regular maintenance periods, when production is stopped and technology is serviced and checked, perhaps replacing some components or upgrading software to ensure full functionality.

Ideally, production systems are characterized by simplicity, repetition, and homogeneity. Simple systems are less costly to implement and less prone to failure. Repetition means that if the same tasks are done in sequence, practise means that tasks can be performed more quickly and more efficiently over time. This does not mean that work has to be repetitive and boring, nor does it mean that changes and improvements cannot be made; but unnecessary change should be avoided as it is costly and time-consuming. Changes should be made only with a view to improving the system, and should be carefully planned in advance. Finally, homogeneity means that common elements and materials should be employed where possible. In cases where a production system switches from making one product to making another, the same machinery and components should be employed as far as possible. This too is in line with the principles of the circular economy, which stress the avoidance of waste.

EFFICIENCY AND EFFECTIVENESS

We discussed these two concepts in the opening chapter, but in production terms they have slightly more specific connotations. Effectiveness, for a production system, becomes a measure of how well the system is able to meet its targets in terms of producing the goods that customers need and putting them into the distribution chain so that customers are able to buy them. Efficiency becomes a measure of how cost-effective the system is: has it managed to achieve the maximum possible productivity from the inputs of human resources, technology and raw materials/parts? Two key issues in production efficiency are waste and time.

WASTE

Early manufacturing businesses were highly inefficient, and large portions of raw materials and parts were wasted. The scientific management movement of the first decade of the twentieth century concentrated on reducing waste by standardizing work and ensuring that jobs and tasks were given exact specifications. Although scientific management has since been largely discredited, a number of its key ideas were incorporated into later management thinking. One of these is the idea that waste is the enemy of efficiency.

Ideally, all the materials the business buys in should be completely consumed and used to make finished products. This does not always happen: there are accidents, spillages and breakages, and some materials are always lost. This is particularly the case in the food processing industry, for example, where problems such as contamination of the processing equipment with foreign (and potentially unhealthy) substances is a frequent cause of materials being wasted. In many companies, rather than eliminating waste entirely, management works to keep waste within tolerable limits. A food processing company might set itself a target of ensuring that no more than 5 per cent of the raw food it processes will be wasted, and the other 95 per cent will be made into finished products and sold. So long as it budgets for this and sticks to this target, the company can accept a limited amount of waste.

However, the new thinking around ideas such as the circular economy suggests that this is not enough. Even 5 per cent wastage can have a huge environmental impact; and, at the same time, that 5 per cent represents a cost to the business. Wasted food still has to be paid for. Why not seek to achieve zero wastage, just as quality management seeks to achieve zero defects, thus reducing costs and environmental impact at the same time? That is the challenge production managers now face.

TIME

There is also the problem of the waste of time. If a machine malfunctions and has to be shut down, or an employee does not turn up for work and there is no one there to operate the machine, then part or all of the production system must be shut down. When this happens, production time is wasted. Consider the following. A production system making soft drink bottles has an output of 3,000 bottles per hour. The company sells the bottles to customers at 20 cents a bottle. If the system has to be shut down for two hours because a key piece of machinery has failed, then 6,000 bottles will not be made, with a loss in revenue of $1,200. What is more, other people who work on the same system are left standing idle, but the company still has to pay their wages. That money and time are lost irrevocably; and in order to fulfil its order, the next job the company does will have to be delayed by two hours so that it can catch up on the first order. The final loss could end up being far more than the initial $1,200.

The old saying that 'time is money' still applies in production systems. Writers on management, especially specialists in marketing and human resources, sometime criticize production managers and engineers for their 'linear' thinking and old-fashioned approaches to problem solving. The problems of production management are usually simple in their essence: how do we keep the system going, to deliver the right goods of the right quality to the right people at the right cost? But remember: just because the problem appears simple, it does not mean the solution will be easy.

QUALITY

Quality is one of the issues on which production managers spend a great deal of time and energy. Again, the basic problem is simple. Customers, through the marketing department, demand goods of a certain level of quality. If the production department cannot deliver goods that fulfil or exceed customer needs, then customers will be dissatisfied and will turn elsewhere.

'Low quality' does not necessarily mean that a product or service is 'bad', although it can be that too. We as customers might reject a soft drink because it has unpleasant-looking sediment in the bottom of the bottle; this means the product was not made properly and may taste bad or even, in extreme cases, be dangerous. But we might also reject it because it is too sweet, or not sweet enough, and does not conform to what our tastes imagine a soft drink should be.

This brings us to one of the first principles of quality: ultimately, quality is what the customer says it is. It is not necessarily dependent on high standards or luxury, though it can be. The Rolls-Royce Silver Ghost and the Volkswagen Beetle were each, in their own way, high-quality automobiles; each met or exceeded customer expectations, the one for a top of the range luxury automobile, the other for a car that was cheap, affordable and reliable. As noted in the previous chapter, the marketing department plays a pivotal role in deciding what customers want and in defining the standards that the production department must meet.

ACHIEVING QUALITY

For production, the challenge is then to meet the quality targets that have been set and to do so consistently. This means first, defining exactly how the product should be produced, drawing up a very detailed specification that describes the finished product and its components: a processed food product would have a very exact list of ingredients, cooking times, materials to be used for packaging, temperature at which ingredients and finished product are to be stored, and so on. Second, it is necessary to ensure that the production system delivers the product to these specifications as consistently as possible.

There are, in essence, two ways of ensuring that only products of the right quality get to the customer. The first is through inspection, checking finished goods as they come off the production line and ensuring that they meet the specification. This can work when the volume of goods being produced is relatively low; there may then be time to stop and examine each one. But when hundreds of products are being made each hour, it simply is not feasible to examine every one for defects. And in some cases, physical examination is impossible; one can only check the quality of a tin of tomatoes by opening it, and this of course renders the tin unfit for sale. So in high-volume production inspectors can only sample occasional items, and assume that the proportion of defects they find is on average correct across the board. This in turn means that some defective products are getting through to customers. Companies that use this system work to what they feel is an acceptable defect rate, say, one defect in every thousand products; if the inspectors find more defects than this, the company will look at the system again to find out what is going wrong, but otherwise will let the system be.

The second method is to literally 'build in' quality from the beginning of the system, ensuring that the right products are made through system design. This is more expensive in terms of initial investment, but should result in less wastage, more satisfied customers and higher sales. Because a quality system should ultimately result in greater profitability, it is sometimes said that 'quality is free'; whatever management spends on getting quality will be made back several times over. The most famous system for building in quality is known as total quality management.

TOTAL QUALITY MANAGEMENT

In the 1970s, so the story goes, an American computer maker ordered a batch of silicon microchips from a Japanese supplier and set what the Americans regarded as a very rigid requirement: the company would only accept one defective chip per one thousand ordered. When the first batch of ten thousand chips arrived, American managers were puzzled to find a small box containing a further ten chips. Unable to work out what these were for, they finally telephoned their opposite numbers in Japan. 'Oh,' came the reply. 'Those are the ten defects you asked for'.

The story may be apocryphal, but it illustrates a point. The essence of total quality management is that instead of inspecting for quality at the end of the production process, quality is managed at every stage of the process: from selection of raw materials through every element of design and manufacture. In many products, a mistake at any point can have serious consequences for later stages of manufacture: if the sole of a shoe is cut to the wrong size the upper will not fit, or if a car's brake unit is wrongly made then the whole car becomes dangerous. This means too, that everyone in the company, management and workers, has to be conscious of quality and to make it a priority. Rather than having 'quality managers' who were solely responsibility for quality, in the words of the quality management guru W. Edwards Deming, 'quality is everyone's business'.

Deming and other engineers, Joseph Juran and Philip Crosby, argued that quality was an issue not only for production departments but for everyone in the organization, and urged that a 'quality philosophy' be adopted to ensure that the whole company made quality a priority. It was not acceptable that marketing and production should argue over what quality really meant, or that the two departments should have to unite against a finance department wanting to reduce quality so as to cut costs. Quality, they said, must be a company-wide issue, and everyone should agree on quality targets and how to meet them.

CONTINUOUS IMPROVEMENT

Even under total quality management and a policy of zero defects, it is recognized that some problems will still occur. Moreover, even if quality targets are achieved absolutely, because the customer defines the nature of quality, the targets themselves will be constantly moving. A ‘perfect’ bicycle, free of defects and giving full customer satisfaction, is built, and this suffices for the needs of the market for the moment. But in a few months or a few years, the market will change. People will want longer handlebars, or brake levers closer to the centre of the bars, or thicker and wider tyres for off-road use. The manufacturer has to respond to this.

Continuous improvement is another term derived from Japanese management (the Japanese term is *kaizen*), particularly from Toyota. Like total quality management, continuous improvement is a management philosophy which, it is argued, everyone in the organization needs to embrace. Even if customer requirements are currently being met, the future must always be considered. Continuous improvement allows the steady improvement of the quality of products with minimal disruption to production systems.

The circular economy, if properly implemented in organizations, relies on many of these same concepts. One hundred per cent reuse and recycling may be very hard to achieve, at least at first. But total quality management has been likened to a journey, not a destination, and the same is true of the circular economy. We make progress towards a goal, without perhaps ever reaching the final goal itself, but in the process we improve things, eliminate waste, make better products and reduce environmental impacts. Every little helps.

PRODUCTION FLOWS AND SUPPLY CHAINS

From total quality management there also evolved a view of production not so much as a series of processes but as a single continuous process or ‘flow’, starting with raw materials and parts and ending with the finished goods. Likewise there developed the notion of the supply chain, which sees raw materials being produced, perhaps being manufactured at a first stage as parts or components or services, then bought by the primary manufacturer who creates finished goods, which are then shipped through distributors to retailers and finally to customers, or else sold directly through e-commerce platforms.

Compare this integrated idea of the supply chain to Michael Porter’s value chain, mentioned in Chapter 4, p. 73 (Figure 6.1

shows this comparison in more detail). It can be seen that the two are closely related. Both see a continuous flow from supplier to customer. The supply chain concept shows how the flow is managed; the value chain concept shows how the flow acts to add value for the customer or consumer. In recent years, advances in communications technology have made fully integrated supply chain management possible. Increasingly, manufacturing companies are no longer just buying from suppliers and selling on to distributors or customers. They are working in partnership with suppliers, distributors and retailers to manage the whole process in an integrated way, to both increase productivity and profits and to add further value for customers.

GLOBAL FLOWS

Increasingly, the production of sophisticated goods such as cars and IT services is taking place all around the world, as companies seek for cheaper and more efficient means of production. In some industries, especially those such as electronics components where prices may be stable or falling, keeping production costs low is a major competitive strategy. Planners are constantly looking for locations where advantages can be gained. Not only are materials

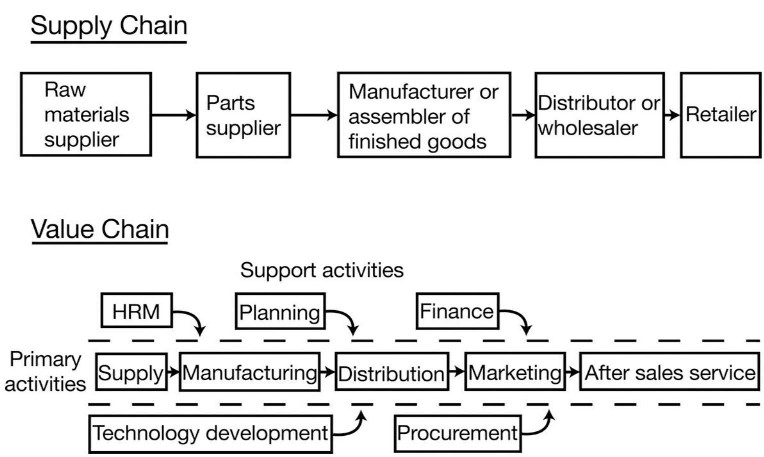

Figure 6.1 Supply chains and value chains

and production facilities sourced, quite literally, from all over the world, but even individual stages of production may be scattered widely. The production of a single microprocessor, for example, might take several stages from the production of the initial silicon wafer to the finished and tested product, and each of those stages might be carried out in a different country, the chip migrating from Singapore to Brazil, to France to the United States as each stage in the chain is passed.

Global production of this kind requires very detailed planning and also strong communications links so that managers can have access to knowledge about the current state of production, any problems that may be arising at any time, and anywhere in the world. Global production systems are also rendered more complex by different work cultures that may exist at different points in the system. A good understanding of the role played by knowledge (see Chapter 8) and culture (see Chapter 9) is essential for managing these systems.

JUST IN TIME

Another concept to come out of Japanese management practice is the idea of 'just-in-time' (JIT) ordering and supply. JIT means that companies order parts and materials when they need them, so that rather than holding large stocks of parts and materials in advance (which ties up warehouse space and capital), the parts and materials are only ordered and paid for as they are actually used or consumed. JIT can be turned around the other way, as well, with the organization only making and shipping goods when customers order them. Retailers also use just-in-time ordering systems to reduce the volume of stock they hold in warehouses.

JIT has been proven to work, and has many cost and efficiency advantages. However, communications between the organization and its suppliers and customers up and down the supply chain have to be very good indeed. Delays in processing or transmitting orders can mean that ready stocks of parts, materials or goods will run out and the entire system will then slow or halt. Some large businesses will insist on controlling the location of their suppliers; the Vauxhall works at Luton in Britain (part of General Motors), for example, once required many of its key suppliers to establish their own factories and workshops directly outside Vauxhall's own front gate, so as to improve communications and limit transport times. Other car companies use more geographically distributed networks of suppliers.

Another aspect of JIT is that industrial relations also need to be good. A single strike or work stoppage can again block the whole system. In 2000, a strike at three main suppliers to General Motors, which uses a global JIT system, resulted in other production facilities quickly running out of necessary parts. Stopping work at these factories meant further slowdowns elsewhere, and within a week more than 200 General Motors production facilities worldwide had either had to stop work or were running at drastically reduced capacity. JIT shows once again the importance of harmony and coordination, ensuring that all elements of the organization – and indeed all elements of the entire supply chain – are working closely together.

RESEARCH AND DEVELOPMENT

Research and development (R&D) properly comes before production, and will in fact be discussed in more detail in the chapter on knowledge (see Chapter 8). Most companies of any size will have a separate R&D department, the primary function of which is to create new knowledge which can be turned into either new products or new and better processes for making products.

Research and development is the focus for innovation in any business, but it is not the sole source of innovation. Innovation can, and should, come from anywhere in the company. However, a formal R&D department can do things that other managers and workers do not have time or resources to do, like pioneering new basic technologies and testing new ideas in detail. To this end R&D also works closely with marketing, carrying out much of the detailed testing of new products and product features. Some organizations link their R&D function closely to marketing, others see it as part of the overall production department, and still others keep it independent of both, with the director of R&D sometimes reporting directly to the chairman or chief executive.

The basic aim of R&D is to create knowledge, and then find ways for knowledge to be usefully employed. While the R&D

department is the focus of this activity, it is worth repeating that other managers and employees need to be involved as well.

PRODUCING SERVICES

The bulk of this chapter has dealt with the production of physical, tangible products, whether produced one at a time or in tens of thousands on a production line. However, most of the comments above also apply to services, with some adaptation. The same kinds of structural and infrastructural decisions have to be made when planning; the same criteria of efficiency and effectiveness apply; quality is equally important; the concept of flow can be applied to services in very much the same way as to tangible products.

However, services do have some differences. In Chapter 5, Marketing, we referred to some of these differences, and it is worth reminding ourselves again of the two most important differences and noting their consequences for the production of services.

First, services cannot be stored. Services are consumed as they are produced; it is not possible to keep a stockpile of services ready to be offered when consumers want them. It *is* possible to keep stocks of goods that consumers need as part of the services, such as hamburger patties or car parts, but these are not the same as the service itself. This has obvious implications for efficiency. It is at least theoretically possible to configure a production line so it runs at 100 per cent efficiency, with no wasted time or materials, and this is indeed the standard to which production managers often aspire. But it is not possible to run a restaurant so that its full seating capacity is used 100 per cent of the time; for if this should be the case, there will almost certainly be consequences for customer satisfaction. Nor should a hospital aim to have 100 per cent of its beds occupied all the time, as this means some people will not be able to get beds and will go untreated.

The best that services production people can do is try to plan for peak times and minimize inefficiency, while at the same time focusing on effectiveness and delivering the best possible service. There are threshold levels of efficiency that can be planned for; hotels, for example, plan for a 95 per cent occupancy rate, and hospitals plan on the basis that 90 per cent of beds should be occupied; in both cases, to give them sufficient flex to cope with surges in demand.

Second, the customer is part of the service; as marketers sometimes say, 'the customer is part of the factory'. A service has to be consumed as well as delivered, and the interaction between customer and service provider is an important part of the service. This in turn has implications for quality, which will tend to be more subjective and will depend in part on that interaction and how successful it is. Indeed, the same restaurant customer and the same waiter can create two quite different interactions at different times; one day the waiter may be friendly and pleasant, the next day surly and disgruntled, or the customer may enjoy the food one day and dislike it the next. It is difficult to inspect quality at the end of the service process, and the imperative to build as much quality as possible into the process becomes very strong. Finally, services managers must plan for the possibility of service failure and develop procedures for recovery from failure in order to ensure customers are happy once more.

SUMMARY

- The production function makes the goods that the organization provides to its customers.
- Production must be co-ordinated with other functions, including marketing, human resources, finance and R&D.
- Production can be seen in terms of flows, from raw materials and goods and knowledge into the company, to finished goods out of it and down the supply chain.
- Production aims to be both efficient and effective, producing the right goods at the right time at a cost which allows the company to make a profit.
- Quality is an essential feature of production, and the management of quality is the responsibility of everyone in the production department – indeed, of everyone in the company.
- The concept of the circular economy means that efficiency and effectiveness are not just about creating value for money for the customer, but also minimising impacts on the environment and society.

SUGGESTIONS FOR FURTHER READING

Deming, W.E., *Out of the Crisis*, Cambridge, MA: MIT Center for Advanced Engineering Study, 1986. One of the best books ever written about making things, talking about quality and much else besides. See also Andrea Gabor's biography of Deming, *The Man Who Discovered Quality* (New York: Times Books, 1990), and the key works of the other two quality gurus, Joseph Juran's *Juran on Leadership for Quality: An Executive Handbook* (New York: The Free Press, 1989) and Philip Crosby's *Quality is Free: The Art of Making Quality Certain* (New York: McGraw-Hill, 1979).

Green, A., *Managing to Change the World: The Non-Profit Manager's Guide to Getting Results*, San Francisco: Jossey-Bass, 2012. A useful comparison with commercial production principles, this book shows how some of those same principles are put into action in charities.

Highsmith, J.R., *Agile Project Management*, New York: Addison-Wesley, 2009, 2nd edn. Classic work on agile management by one of the founders of the concept.

Hill, T., *The Strategy Quest*, London: Prentice Hall, 1994. Despite its title, this book is actually a novel about how to focus and re-orient a manufacturing system and align it with other parts of the organization. It is light and easy to read for beginners, but has some very powerful themes and ideas nonetheless.

Jeanrenaud, S., Jeanrenaud, J.-P. and Gosling, J. (eds), *Sustainable Business: A One-Planet Approach*, Chichester: Wiley, 2016. This is a collection of chapters on various aspects of managing sustainable businesses.

Lacy, P., Long, J. and Spindler, W., *The Circular Economy Handbook: Realizing the Circular Advantage*, Basingstoke: Palgrave Macmillan, 2020. An excellent introduction to the circular economy by leading experts in the field.

Ohno, Taiichi, *Toyota Production System*, Cambridge, MA: Productivity Press, 1988. A description of the world-famous Toyota system of manufacturing, by one of the people most closely involved with that system. For an outsider's view of the same, see

J.P. Womack, D.T. Jones and D. Roos, *The Machine That Changed the World*, New York: Macmillan, 1990.

Timings, R., *Basic Manufacturing*, London: Routledge, 2004, 3rd edn. Good introductory text to the principles of production given above.

Weetman, C., *A Circular Economy Handbook: How to Build a More Resilient, Competitive and Sustainable Business*, London: Kogan Page, 2020. A good, accessible and practical introduction to the circular economy.