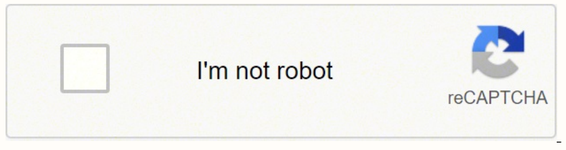

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Types of process design in production and operations management

Why is production and operations management important in both manufacturing and service firms? Production, the creation of products and services, is an essential function in every firm. Production turns inputs, such as natural resources, raw materials, human resources, and capital, into outputs, which are products and services. This process is shown in (Figure). Managing this conversion process is the role of operations management. With new oil reserves now available through “fracking,” the United States is challenging Saudi Arabia and is set to become a vast supplier of oil worldwide. Unlike the smooth petroleum that gushes from Arabian wells, however, America’s black gold in the Marcellus, Bakken, and other shale regions has to be drilled horizontally through new technology. The process is rigorous: oil and gas companies drill into the ground to extract crude oil and natural gas from the shale rock that lies thousands of feet under the ground. Once the formation is reached, gallons of water, sand, and an extensive list of man-made chemicals are injected into the well under high pressure. This combination inserted in the well will fracture the rock and release crude oil and natural gas. It is estimated that the gas within these rock formations could supply the United States for generations to come as technologies evolve to drill below the earth’s surface. What are key inputs in the fracking process? (Credit: Mark Dixon/ Flickr/ Attribution 2.0 Generic (CC BY 2.0)) The goal of customer satisfaction is an important part of effective production and operations. In the past, the manufacturing function in most companies was inwardly focused. Manufacturing had little contact with customers and didn’t always understand their needs and desires. In the 1980s, many U.S. industries, such as automotive, steel, and electronics, lost customers to foreign competitors because their production systems could not provide the quality customers demanded. As a result, today most American companies, both large and small, consider a focus on quality to be a central component of effective operations management. Production Process for Products and Services (Attribution: Copyright Rice University, OpenStax, under CC BY 4.0 license.) Stronger links between marketing and manufacturing also encourage production managers to be more outwardly focused and to consider decisions in light of their effect on customer satisfaction. Service companies find that making operating decisions with customer satisfaction in mind can be a competitive advantage. Operations managers, the people charged with managing and supervising the conversion process, play a vital role in today’s firm. They control about three-fourths of a firm’s assets, including inventories, wages, and benefits. They also work closely with other major divisions of the firm, such as marketing, finance, accounting, and human resources, to ensure that the firm produces its goods profitably and satisfies its customers. Marketing personnel help them decide which products to make or which services to offer. Accounting and human resources help them face the challenge of combining people and resources to produce high-quality goods on time and at reasonable cost. They are involved in the development and design of goods and determine what production processes will be most effective. Production and operations management involve three main types of decisions, typically made at three different stages: Production planning. The first decisions facing operations managers come at the planning stage. At this stage, managers decide where, when, and how production will occur. They determine site locations and obtain the necessary resources. Production control. At this stage, the decision-making process focuses on controlling quality and costs, scheduling, and the actual day-to-day operations of running a factory or service facility. Improving production and operations. The final stage of operations management focuses on developing more efficient methods of producing the firm’s goods or services. All three decisions are ongoing and may occur simultaneously. In the following sections, we will take a closer look at the decisions and considerations firms face in each stage of production and operations management. An important part of operations management is production planning. Production planning allows the firm to consider the competitive environment and its own strategic goals to find the best production methods. Good production planning has to balance goals that may conflict, such as providing high-quality service while keeping operating costs low, or keeping profits high while maintaining adequate inventories of finished products. Sometimes accomplishing all these goals is difficult. From its storied creation in post-war Italy to its big-screen immortalization in movies such as Roman Holiday and Quadrophenia, the Vespa scooter has a reputation for romance, rebellion, and style. Manufactured by Italy’s Piaggio Group, the Vespa’s svelte, stainless-steel chassis and aeronautic-inspired designs are seen everywhere in Europe and more and more in the United States. The Piaggio Group presently operates factories in Italy, Vietnam, India, and China. What important production-planning decisions does Piaggio need to make as it considers expanding into more overseas markets? (Credit: Steve Watkins/ Flickr/ Attribution-2.0 Generic (CC BY2.0)) Production planning involves three phases. Long-term planning has a time frame of three to five years. It focuses on which goods to produce, how many to produce, and where they should be produced. Medium-term planning decisions cover about two years. They concern the layout of factory or service facilities, where and how to obtain the resources needed for production, and labor issues. Short-term planning, within a one-year time frame, converts these broader goals into specific production plans and materials management strategies. Four important decisions must be made in production planning. They involve the type of production process that will be used, site selection, facility layout, and resource planning. What are the three types of decisions that must be made in production planning? What are the three phases of production planning? operations management Management of the production process. production The creation of products and services by turning inputs, such as natural resources, raw materials, human resources, and capital, into outputs, which are products and services. production planning The aspect of operations management in which the firm considers the competitive environment and its own strategic goals in an effort to find the best production methods. Differentiate between the different types of processes. Understand common layouts and their challenges. Calculate takt time based on product demand. Every firm that produces a good or a service will do so by the use of a process. This process will use the firm’s resources in order to transform the primary inputs into some type of output. In designing the actual process, particularly the number and sequence of steps, several important factors need to be considered. Product variety – Is the product highly standardized, or is the product highly customized? Volume of output – Is the business created to produce large volumes or a small amount of output? Is the technology to be used general purpose or specialized? Is it capital intensive? The skill level of employees, it is very high or low? What is the expected duration? Make-to-order and Make-to-stock It is useful to categorize processes as either make-to-order or make-to-stock. In a make-to-order business, the customer’s order is not manufactured until the order is received. This allows customization to the exact specifications that the customer requires. It may also be referred to as build-to-order. This type of production is considered a pull type system. The work is “pulled” through the process when customer demand is present. The disadvantage of this type of system is that it takes time for the firm to acquire any materials and needed components, and then to schedule and produce the customers order. Goods are made in small amounts, and may be more expensive. The advantage of this type of process is that inventory is lower than in a typical make-to-stock system. There is not any uncertainty about what the customer desires and there is no obsolete stock to be disposed of. Dell Computer has utilized this type of system to produce personal computers very successfully. In a make-to-stock process, goods are produced in anticipation of customer demand, usually from a sales forecast. These products are generally made in larger amounts and put into storage to wait for customer orders. Although the unit cost may be lower due to large production volumes, there may be losses due to forecast error, excess inventory, obsolescence and theft. Lead times however are short because goods are available when the customer places the order. These goods are not customized, but standardized. Process Types Project A one-time event, such as construction of an apartment building, implementation of a new ERP system, or writing a book, would all be considered a project type of process. Each of these projects have a high degree of customization, substantial use of resources, and a complex set of related activities. There is only a single output at the end of the project. Job Shop Many businesses have a job shop type of process. This is most commonly used when the product being produced is unique for each customer. It is a make-to-order type of business where production is intermittent (i.e. rather than one entire product being completed at a time, work will continue on multiple products as time permits). Often the product has unique characteristics for each customer. The workers in this type of business are very highly skilled in their craft or trade. Often they are referred to as craftsmen or makers. The volume of output is low in a job shop. The equipment used is quite general purpose. Examples include a small bakery that produces beautiful custom wedding cakes, or a business that makes custom guitars or bicycles based on the customers measurements and preferences of materials and components. Batch Some businesses are in the situation where they make groups of identical products on a regular basis. These groups are referred to as a batch. The batch will progress through a set of steps to be completed from the start to the end. An organization may have multiple batches at different stages coming through the process. This type of processing is also intermittent. (start, stop, start) There is less variety in this type of business (compared to a job shop) and the equipment used will be relatively general purpose and suited to the industry that they are in. Employees need to be skilled and experienced at operating that equipment and producing these products. Examples of products made using batch production are baked goods, aircraft parts, clothing, and vaccines. An important decision by these firms is how big the batch should be. Repetitive This type of business produces products that are more standardized in nature. Usually the output is high. Since the goods are quite standardized, the equipment used tends to be quite specialized and often highly customized for that process. The skill level of the employees is usually low because the steps are highly standardized. Although these types of jobs may not require a trade or extensive experience, they often do require skills such as multi-tasking, concentration, problem solving, and teamwork. Often, these processes use flexible automation that allows for customization such as the addition of upgraded features. Examples of a repetitive process include assembly lines such as assembling automobiles or electronics, a carwash, or a cafeteria line. Attribution: Tansiis / Wikimedia Commons Continuous A continuous process is when a very high volume of standardized product is produced. The type of product being made is described as non-discrete. This means that these businesses do not produce individual products, rather a product that is often a liquid or a product such as sugar, gasoline, or steel. An example of this type of process is an oil refinery. There are not separate individual workstations, rather the product flows from one step to the next within the system. The equipment in this type of process is highly complex and designed solely for that product at that facility. There are very few workers except for those that are responsible for process monitoring, maintenance, and cleaning. Hybrids There are many firms using mixtures of process types. One such common exception is the Mass Customization model of production. In mass customization, a company combines low-cost high volume of output, but each and every customer order is customized to the customers specifications. Usually the use of computer-aided manufacturing systems is what permits this customization. Examples include furniture makers who wait to produce the exact model of sofa based on the customers dimensions and fabric choice, or the vehicle manufacturer that has dozens of customization packages and paint options such that each vehicle is custom for the purchaser. A key requirement for successful mass customization is a modular design to allow fast seamless change from each product to the next. Facility Layout Layout refers to the way in which organizations position their equipment, departments, or workcentres. Having an effective layout can streamline production activities, eliminate wasted or redundant movement and improve safety. The general types of layouts are: a fixed position layout, a process layout (functional), a product (line) layout, and a cellular layout, which is considered a hybrid. Other common layouts include office layouts, retail layouts, and warehouse layout. Fixed Position Layout When producing a product that is not easily able to be moved, it may require that the worker, their tools and equipment are brought to the site where the production is taking place. This is a common layout in manufacturing a building, a ship or performing repairs to major equipment. Process Layout A process layout is a layout in which departments, equipment, or workcentres are arranged according to their function. In a manufacturing environment, all of the milling machines may be in one area or “department,” the lathes may be in another area, and the drilling machines all in another area. This layout is also common in services. In a department store, similar goods are arranged together such as footwear, jewelry, and housewares. At a hospital, cardiology is in one area, maternity in another location, and pediatrics elsewhere. The specific dedicated equipment and skilled practitioners work in each of these areas. An advantage to a process layout is that equipment tends to be quite general-purpose. If one particular piece of equipment breaks down, it will not halt the entire process. This type of process gives flexibility to handle a variety of products or customers. It is ideal for job shops or small batch manufacturing. A disadvantage of a process layout is that a particular product will likely have to travel from department to department to get the set of processes completed. This often leads to lots of material handling and movement of goods throughout the facility. A flexible material-handling system is needed such as forklifts. Inventory will sit in each area waiting for its turn to be processed. This waiting inventory is referred to as queue. When examining the total throughput time of jobs through the system, it is often discovered that each order spends much more time waiting in queue than it does actually being processed. For that reason, this type of layout is generally very inefficient. A major consideration in a process layout is to ensure that departments with a large amount of interaction are located nearby one another. Below is an example of a machinery plant with a process layout: Product (Line) Layout These are used in businesses that use assembly lines or production lines. If the product has high volume an assembly line might be the best option. The equipment in these types of layouts are often very capital intensive and are laid out according to the progressive steps of the process. Each work station is located along the line and may consist of a worker with equipment, or robots. Often each work station is adding components (assembly line) or modifying a product (production line). It is important to note that it is not necessarily a straight line, often assembly lines zig zag or are in a shape to use the maximum amount of space available. Some services may use a line layout, such as preparing hospital meals, or a cafeteria line. Due to considerable cost involved with setting up an assembly line, a large volume of product needs to be produced. Demand that is steady and consistent is ideal. The goods produced in a line layout are generally very standardized, and the work processes are also highly standardized. Each product follows the same set of steps so that a fixed path material handling system is used such as a conveyor belt. This conveyor belt may be manual or automatic. It may operate at a pre determined speed, or it may be worker paced. It may run continuously or pulsed. The speed of the conveyor will determine the amount of product that will be produced per shift. In contrast to a process layout a product layout is very efficient. There are a number of reasons for this. Because of the division of labour and the repetition, there is less variability in the work performed There is no build up of inventory, and no waiting. When completed at one work station, the job automatically moves to the next workstation. Only the inventory that is in process is in the system. Goods tend to be shipped when they are completed. Due to the material handling system, goods move quickly and not very far. Changeovers are not necessary so very little time is lost in changing between products. It is important that assembly lines are balanced. The amount of time required at a preceding work station should be relatively similar to the amount of time required at the following work station. Challenges in a product (line) layout include: The fact that the line may be susceptible to shut downs if there are equipment malfunctions so preventative maintenance is critical. Preventative maintenance involves the inspection and replacement of any parts that have a high probability of failures, as well as holding ample spare parts in stock and having a detailed maintenance schedule for each piece of equipment. Training and job rotation are critical activities to make sure employees are capable of completing the work tasks and that there are multiple people that can work at each individual job With repetitive standardized jobs, it is critical that good ergonomic job design is performed. Organizations that ensure the health, safety and comfort of their employees reap rewards in terms of the quality of work they receive from employees. Here is a fun video; see Rick Mercer on the Assembly line in GM Oshawa: Cellular Layout Cellular layouts are considered a “hybrid” type of layout because it includes characteristics of both a Process layout and a product (line) layout. It is very common that a business may have multiple product lines, with far too much variety in order to take advantage of one assembly line. Often these businesses may have been using a process layout, with all of the associated product movement and waiting times. An alternative that became popular beginning in the late 1980s is the Cellular layout type. This type of production layout is still heavily utilized today. This type of layout begins with the company performing a thorough analysis of their products and deciding which products are similar to one another and often share common geometry and processing requirements in terms of equipment, machinery, technology and employee skills. These products are grouped together and manufactured in a work cell. This is referred to as group technology. Each work cell will contain a unique set of equipment to manufacture this family of parts in an assembly line type of layout. The equipment is laid out in a U shape with equipment located close together so jobs do not have to move very far. Advantages of a cellular layout include: Reduced set up times for each piece of equipment because each machine is making products that are very similar, often set-ups are very fast or non-existent. Speed is greatly enhanced because batches can now be small and goods that enter the system will continue until they are complete. Small batches means fast run times and short wait times. Inventory investment is now reduced due to small batch sizes enabled because of the low set up times required. Quality is enhanced because employees work only within that cell on a narrow range of products. Cross training of employees ensures good and thorough knowledge of the entire production process. Employee morale is improved due to working as part of a team that has responsibility for the throughput and quality of the cell. The U-shaped design heightens collaboration among workers. Less floor space is required due to machines being placed close together and less movement of product. An example of a U-shaped layout can be found below: Here is a video on cellular manufacturing: Other Layouts Include Office Layout: In 2020 office spaces are a great deal different than in generations past. Floor space per employee has dropped significantly. There is far less worry about the flow of paperwork than in the past. Often employees are grouped according to the tasks they perform and the work teams they participate in. Workspaces now tend to be more flexible with less paper and less furniture to hold files and documents. Many organizations put more emphasis on having comfortable spaces for collaboration. Layouts are much more open concept with lower partitions to improve visibility of the workspace. Retail Layout: The overall goal when laying out a retail location is to try and maximize the amount of sales per square foot in the facility. This is done by careful study of traffic patterns in the store in order to try and maximize the amount of product to which each customer is exposed. That is why you will often find the milk at the far end of the store causing customers the need to walk past all other departments to reach it. Warehouse Layout: Effective warehouse layout aims to make effective use of the total volume of space contained in the building. The relationship between the receipt of incoming goods, the storage space and the picking, packing and shipping of outbound goods is carefully analyzed. An important consideration is the placement of inventory items in order to minimize distance goods and employees are need to travel. Many warehouses have special holding requirements such as freezers, cold storage and high security areas. Some important “Times” to be familiar with: Throughput time is the time between the beginning – the very first operation in the process until the product is actually completed at the end of the process. Remember that this includes not only the process time, but also any waiting time, inspection time, time spent on rework and movement. Lead time is the amount of time between when the customers order is received and when the product is completed and ready to ship. Cycle time is the rate at which the operation is actually producing each unit. If you stood at the end of the process and measured the time between completion of each unit, that is the true cycle time. Takt time is a calculated value which determines the rate at which a firm needs to process their product in order to meet customer demand. It can be calculated by: available production time ——————————————- demand

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