Operations Management

Technology Decisions

6.1 Automation

An important decision in designing processes is whether the firm should automate, to what degree, and the type of automation that should be used. **Automation** is the use of machinery able to perform work without human operators and can involve a single machine or an entire factory. Although there are tremendous advantages to automation, there are also disadvantages. Companies need to consider these carefully before making the final decision.

Automation has the advantage of product consistency and ability to efficiently produce large volumes of product. With automated equipment, the last part made in the day will be exactly like the first one made. Because automation brings consistency, quality tends to be higher and easier to monitor. Production can flow uninterrupted throughout the day, without breaks for lunch, and there is no fatigue factor. However, automation does have its disadvantages.

- First, automation is typically very costly. These costs can be justified only by a high volume of production.
- Second, automation is typically not flexible in accommodating product and process changes.

Therefore, automation would probably not be good for products in the early stages of their life cycle or for products with short life cycles. Automation needs to be viewed as another capital investment decision: financial payback is critical. For all these reasons automation is typically less present in intermittent than in repetitive operations.

6.1.1 Automated Material Handling

Automated material handling - In the past, the primary method of moving products was the conveyor in the form of belts or chains. Today's material handling devices can read bar codes that tell them which location to go to and which are capable of moving in many directions. One such device is an ***automated***

***guided vehicle* (*AGV*)**, a small battery-driven truck that moves materials from one location to the other. The AGV is not operated by a human and takes its directions from either an onboard or central computer. Even AGVs have become more sophisticated over time. The older models followed a cable that was installed under the floor. The newer models follow optical paths and can go anywhere there is aisle space, even avoiding piles of inventory in their way. One of the biggest advantages of AGVs is that they can pretty much go anywhere, as compared to traditional conveyor belts. Managers can use them to move materials wherever they are needed. Another type of automated material handling includes ***automated storage and retrieval systems* (*AS/RSs*)**, which are basically automated warehouses. AS/RSs use AGVs to move material and also computer-controlled racks and storage bins.

The storage bins can typically rotate like a carousel, so that the desired storage bin is available for either storage or retrieval. All this is controlled by a computer that keeps track of the exact location and quantity of each item and controls how much will be stored or retrieved in a particular area. AS/RSs can have great advantages over traditional warehouses. Though they are much more costly to operate, they are also much more efficient and accurate.

6.1.2 Flexible Manufacturing Systems (FMS)

A **flexible manufacturing system** (**FMS**) is a type of automation system that combines the flexibility of intermittent operations with the efficiency of repetitive operations. As you can see by the definition, this is a *system* of automated machines, not just a single machine. An FMS consists of groups of computer-controlled machines and/or robots, automated handling devices for moving, loading, and unloading, and a computer-control center.

Based on the instructions from the computer-control center, parts and materials are automatically moved to appropriate machines or robots. The machines perform their tasks and then the parts are moved to the next set of machines, where the parts automatically are loaded and unloaded. The routes taken by each product are determined with the goal of maximizing the efficiency of the operation. Also, the FMS "knows" when one machine is down due to maintenance or if there is a backlog of work on a machine, and it will automatically route the materials to an available machine.

Flexible manufacturing systems are still fairly limited in the variety of products that they handle. Usually they can only produce similar products from the same family. For this reason, and because of their high cost, flexible manufacturing

systems are not very widespread. A decision to use an FMS needs to be long-term and strategic, requiring a sizable financial outlay.

6.1.3 Robotics

A robot in manufacturing is usually nothing more than a mechanical arm with a power supply and a computer-control mechanism that controls the movements of the arm. The arm can be used for many tasks, such as painting, welding, assembly, and loading and unloading of machines. Robots are excellent for physically dangerous jobs such as working with radioactive or toxic materials. Also, robots can work 24 hours a day to produce a highly consistent product.

Robots vary in their degree of sophistication. Some robots are fairly simple and follow a repetitive set of instructions. Other robots follow complex instructions, and some can be programmed to recognize objects and even make simple decisions. One type of automation similar to simple robotics is the **numerically controlled** (**NC**) **machine**. NC machines are controlled by a computer and can do a variety of tasks such as drilling, boring, or turning parts of different sizes and shapes. Factories of the future will most likely be composed of a number of robots and NC machines working together.

The use of robots has not been very widespread in U.S. firms. However, this is an area that can provide a competitive advantage for a company. Cost justification should consider not only reduction in labor costs but also the increased flexibility of operation and improvement in quality. The cost of robots can vary greatly and depends on the robots' size and capabilities. Generally, it is best for a company to consider purchasing multiple robots or forms of automation to spread the costs of maintenance and software support. Also, the decision to purchase automation such as robotics needs to be a long-term strategic one that considers the totality of the production process. Otherwise, the company may have one robot working 24 hours a day and piling up inventory while it waits for the other processes to catch up.

Robots can be used to improve operations of almost any business—even literal "operations." Increasingly, robots have been used to perform certain medical surgeries. For example, at New York University doctors use minimally invasive robotic surgery to repair human heart valves. To perform the surgery, doctors use a robot arm to cut a 6-cm incision between the ribs and to place an endoscope that allows the surgeons to see what they are doing. The robot arm is controlled through a complex robotic surgical system. The doctors, seated at a workstation, manipulate conventional surgical instruments while the robotic surgical system mirrors these movements on an ultra-fine scale. The advantage of robots is that

they can perform delicately fine, small, motor movements, have consistent finger dexterity, and require only tiny incisions. The prediction is that robots will become involved in performing many surgeries, such as eye surgery, neurosurgery, and cosmetic surgery.

6.1.4 Manufacturing

Today's Web-based environment has created numerous opportunities for business collaboration. This includes collaboration in product and process design, where customers, buyers, and designers can share information and jointly make decisions in real time. Let's look at some of the computer systems that can aid e-manufacturing.

6.2 Computer-Aided Design (CAD)

Computer-aided design (**CAD**) is a system that uses computer graphics to design new products. Gone are the days of drafting designs by hand. Today's powerful desktop computers combined with graphics software allow the designer to create drawings on the computer screen and then manipulate them geometrically to be viewed from any angle. With CAD the designer can rotate the object, split it to view the inside, and magnify certain sections for closer view.

CAD can also perform other functions. Engineering design calculations can be performed to test the reactions of the design to stress and to evaluate strength of materials. This is called ***computer-aided engineering*** **(*CAE*)**. For example, the designer can test how different dimensions, tolerances, and materials respond to different conditions such as rough handling or high temperatures. The designer can use the computer to compare alternative designs and determine the best design for a given set of conditions.

The designer can also perform cost analysis on the design, evaluating the advantages of different types of materials. Another advantage of CAD is that it can be linked to manufacturing. We have already discussed the importance of linking product design to process selection. Through CAD this integration is made easy. ***Computer-aided manufacturing*** **(*CAM*)** is the process of controlling manufacturing through computers. Since the product designs are stored in the computer database, the equipment and tools needed can easily be simulated to match up with the processing needs. Efficiencies of various machine choices and different process alternatives can be computed.

CAD can dramatically increase the speed and flexibility of the design process. Designs can be made on the computer screen and printed out when desired.

Electronic versions can be shared by many members of the organization for their input. Also, electronic versions can be archived and compared to future versions. The designer can catalog features based on their characteristics—a very valuable feature. As future product designs are being considered, the designer can quickly retrieve certain features from past designs and test them for inclusion in the design being currently developed. Also, by using *collaborative product commerce* (*CPC*) *software*, sharing designs with suppliers is possible.

6.2.1 Computer-Integrated Manufacturing

Computer-integrated manufacturing (CIM) is a term used to describe the integration of product design, process planning, and manufacturing using an integrated computer system. Computer-integrated manufacturing systems vary greatly in their complexity. Simple systems might integrate computer-aided design (CAD) with some numerically controlled machines (NC machines). A complex system, on the other hand, might integrate purchasing, scheduling, inventory control, and distribution, in addition to the other areas of product design.

The key element of CIM is the integration of different parts of the operation process to achieve greater responsiveness and flexibility. The purpose of CIM is to improve how quickly the company can respond to customer needs in terms of product design and availability, as well as quality and productivity, and to improve overall efficiency.

6.3 Designing Services

Most of the issues discussed in this chapter are as applicable to service organizations as they are to manufacturing. However, there are issues unique to services that pose special challenges for service design. Most of us think we know what is needed to run a good service organization. After all, we encounter services almost every day, at banks, fast-food restaurants, doctor's offices, barber shops, grocery stores, and even the university. We have all experienced poor service quality and would gladly offer advice as to how we think it could be better. However, there are some very important features of services you may not have thought about. Let's see what they are.

6.3.1 Intangible Product

Service organizations produce an intangible product, which cannot be touched or seen. It cannot be stored in inventory for later use or traded in for another model. The service produced is ***experienced*** by the customer. The design of the service needs to specify exactly what the customer is supposed to experience. For example, it may be relaxation, comfort, and pampering, such as offered by Canyon

Ranch Spa. It may be efficiency and speed, such as offered by FedEx. Defining the customer experience is part of the service design. It requires identifying precisely what the customer is going to feel and think and consequently how he or she is going to behave. This is not always as easy as it might seem. The experience of the customer is directly related to customer expectations. For services to be successful, the customer experience needs to meet or even exceed these expectations. However, customer expectations can greatly vary depending on the type of customer and customer demographic, including customer age, gender, background, and knowledge. The expectation is developed through product marketing to a particular market segment. It is highly important in designing the service to identify the target market the service is geared to and to create the correct expectation.

6.3.2 High Degree of Customer Contact

Service organizations typically have a high degree of customer contact. The customer is often present while the service is being delivered, such as at a theater, restaurant, or bank. Also, the contact between the customer and service provider is often the service itself, such as what you experience at a doctor's office. For a service to be successful, this contact needs to be a positive experience for the customer, and this depends greatly on the service provider.

Unfortunately, since services often have multiple service providers, there can be great variation in the type of service delivered. We have all had experiences where the service of one organization varied greatly depending on the skills of the service provider. This could be a hairdresser at a hair salon, a food server at a restaurant, or a teller at a bank. We have all heard people say something similar to "I often have dinner at Aussie Steak Grill and I insist that Jenny be my server." Similarly, someone might say, "I go to Olentangy Family Physicians, but I won't see Dr. Jekyl because he is rude and unfriendly." For a service to be successful, the service experience must be consistent at all times.

This requires close quality management to ensure high consistency and reliability. Many of the procedures used in manufacturing to ensure high quality, such as standardization and simplification, are used in services as well. Fast-food restaurants such as McDonald's and Wendy's are known for their consistency. The same is true of hotel chains such as Holiday Inn and Embassy Suites. To ensure that the service contact is a positive experience for the customer, employees of the service need to have training that encompasses a great array of skills that include courtesy, friendliness, and overall disposition. The service company also needs to structure the proper incentive system to motivate employees.

6.3.3 How Are Services Classified?

We can classify service organizations based on similar characteristics in order to understand them better. A common way to classify services is based on the degree of customer contact. Services with low customer contact are called "quasi-manufacturing." These firms have a high degree of service standardization, have higher sales volumes, and are typically less labor intensive. These firms have almost no face-to-face contact with customers and are in many ways similar to manufacturing operations. Examples include warehouses, distribution centers, environmental testing laboratories, and back-office operations.

Services with high customer contact are called ***"pure services."*** These firms have high face-to-face contact and are highly labor intensive. There is low product standardization, as each customer has unique requirements, and sales volumes tend to be low. Pure service firms have an environment of lowest system efficiency compared to other service firms. The reason is that the service is typically customized. As each customer has unique requirements, there is less predictability in managing the operating environment.

Examples include hospitals, restaurants, barber shops, and beauty salons. Services that combine elements of both of these extremes are called ***"mixed services."*** Some parts of their operation have face-to-face customer contact, though others do not. They include offices, banks, and insurance firms. It is important to understand that companies with different levels of customer contact need to be managed differently. These differences also apply to high-contact and low-contact areas of firms. For example, companies should specifically hire people oriented workers for high-contact areas, whereas technical skills are more important in low-contact areas. Also, noncontact activities should be partitioned from the customer to avoid disruptions in the flow of work. Noncontact areas can be managed borrowing tools from manufacturing, whereas high-contact areas need to focus on accommodating the customer.

6.3.4 The Service Package

The really successful service organizations do not happen spontaneously. They are carefully thought out and planned, down to every employee action. To design a successful service, we must first start with a service concept or idea, which needs to be very comprehensive. We have learned that when purchasing a service, customers actually buy a **service package** or service bundle. The service package

is a grouping of features that are purchased together as part of the service. There are three elements of the service package:

1) the physical goods,
2) the sensual benefits, and
3) the psychological benefits

The physical goods of the service are the tangible aspects of the service that we receive, or are in contact with, during service delivery. In a fine-dining restaurant the physical goods are the food consumed, as well as facilities such as comfortable tables and chairs, tablecloths, and fine china. The sensual benefits are the sights, smell, and sounds of the experience—all the items we experience through our senses. Finally, the psychological benefits include the status, comfort, and well-being provided by the experience.

It is highly important that the design of the service specifically identify every aspect of the service package. When designing the service, we should not focus only on the tangible aspects; it is often the sensual and psychological benefits that are the deciding factors in the success of the service. The service package needs to be designed to precisely meet the expectations of the target customer group.

Once the service package is identified, it can then be translated into a design using a process that is not too different from the one used in manufacturing. Details of the service, such as quality standards and employee training, can later be defined in keeping with the service concept. The service providers—the individuals who come in direct contact with the customers—must be trained and motivated to precisely understand and satisfy customer expectations.

Imagine going to a fast-food restaurant and having the server take his time asking you how you want your hamburger cooked and precisely what condiments you would like to accompany it, then waiting a long time to receive your food. Similarly, imagine going to an expensive hair salon and having the staff rush you through the process. In both cases, you as the customer would not be satisfied because the service delivery did not meet your expectations. Next time you might choose to go somewhere else. These examples illustrate what happens when there is a mismatch between the service concept and the service delivery.

6.4 Differing Service Designs

There is no one model of successful service design. The design selected should support the company's service concept and provide the features of the service

package that the target customers want. Different service designs have proved successful in different environments. In this section we look at three very different service designs that have worked well for the companies that adopted them.

Substitute Technology for People Substituting technology for people is an approach to service design that was advocated some years ago by Theodore Levitt.1 Levitt argued that one way to reduce the uncertainty of service delivery is to use technology to develop a production-line approach to services. One of the most successful companies to use this approach is McDonald's. Technology has been substituted wherever possible to provide product consistency and take the guesswork away from employees. Some examples of the use of technology include the following:

- Buzzers and lights are used to signal cooking time for frying perfect french fries.
- The size of the french fryer is designed to produce the correct amount of fries.
- The french fry scoop is the perfect size to fill an order.
- "Raw materials" are received in usable form (e.g., hamburger patties are premade;

pickles and tomatoes are presliced; french fries are precut).

- There are 49 steps for producing perfect french fries.
- Steps for producing the perfect hamburger are detailed and specific.
- Products have different-colored wrappings for easy identification.

In addition to the use of technology in the production of the product, there is consistency in facilities and a painstaking focus on cleanliness. For example, the production process at McDonald's is not left to the discretion of the workers. Rather, their job is to follow the technology and preset processes.

Today we are all accustomed to the product consistency, speed of delivery, and predictability that are a feature of most fast-food restaurants. However, this concept was very new in the early 1970s. It is this approach to services that has enabled McDonald's to establish its global reputation. Substituting technology for people is an approach we have seen over the years in many service industries. For example, almost all gas stations have reduced the number of cashiers and attendants with the advent of credit cards at self-serve pumps. Also, many hospitals are using technology to monitor patient heart rate and blood pressure without relying exclusively on nurses. As technologies develop in different service industries, we will continue to see an ever-increasing reliance on its use and an increase in the elimination of workers.

6.5 Get the Customer Involved

A different approach to service design was proposed by C. H. Lovelock and R. F. Young. Their idea was to take advantage of the customer's presence during the delivery of the service and have him or her become an active participant. This is different from traditional service designs where the customer passively waits for service employees to deliver the service. Lovelock and Young proposed that since the customers are already there, ***"get them involved."***

We have all seen a large increase in the self-serve areas of many service firms. Traditional salad bars have led to self-serve food buffets of every type. Many fast-food restaurants no longer fill customer drink orders, but have the customers serve themselves. Grocery stores allow customers to select and package baked goods on their own. Many hotels provide in-room coffee makers and prepackaged coffee, allowing customers to make coffee at their convenience.

This type of approach has a number of advantages. First, it takes a large burden away from the service provider. The delivery of the service is made faster, and costs are reduced due to lowered staffing requirements. Second, this approach empowers customers and gives them a greater sense of control in terms of getting what they want, which provides a great deal of customer convenience and increases satisfaction. However, since different types of customers have different preferences, many facilities are finding that it is best to offer full-service and self-service options. For example, many breakfast bars still allow a request for eggs cooked and served to order, and most gas stations still offer some full-service pumps.

A third approach to service design is providing a high level of customer attention. This is in direct contrast to the first two approaches. The first approach discussed automates the service and makes it more like manufacturing. The second approach requires greater participation and responsibility from the customer. The third approach is different from the first two in that it does not standardize the service and does not get the customer involved. Rather, it is based on customizing the service to the needs unique to each customer and having the customer be the passive and pampered recipient of the service. This approach relies on developing a personal relationship with each customer and giving the customer precisely what he or she wants.

There are a number of examples of this type of approach. Nordstrom, Inc. department stores is recognized in the retail industry for its attention to customer

service. Salespeople typically know their customers by name and keep a record of their preferences. Returns are handled without question, and the customer is always right. Another example of this is a midwestern grocer called Dorothy Lane Market. Dorothy Lane prides itself on its ability to provide unique cuts of specialty meats precisely to customer order. As at Nordstrom, a list is kept of primary customers and their preferences. Customers are notified of special purchases, such as unique wines, specialty chocolates, and special cuts of meat.

Whereas the first two approaches to service design result in lowered service costs, this third approach is geared toward customers who are prepared to pay a higher amount for the services they receive. As you can see, different approaches are meant to serve different types of customers. The design chosen needs to support the specific service concept of the company.