Chapter 6

Capacity Planning

What is capacity?

The Merriam-Webster Dictionary defines capacity as: "the largest amount or number that can be held or contained."[36] This does not really help when looking at capacity and capacity planning for operations management. APICS defines capacity a couple of ways that are relevant to operations management: "1) The capability of a system to perform its expected function. 2) The capability of a worker, machine, work center, plant, or organization to produce output per time period."[37] A simpler definition for an introduction to operations management is that capacity is the maximum amount of *quality* output that can be produced. It is important to mention the link to quality as any output that is not quality is not productive output.

The capacity of a system is critical to the planning and production phases of products and services. Capacity is not just a production or storage concept. If you think of your favorite restaurant as a service, the capacity of restaurant is not the maximum capacity as determined by the fire department inspection; it is the maximum amount of customers that the restaurant can serve in an acceptable time. This is may explain why you may visit a restaurant and there are vacant tables but there is still a wait time—the capacity is dictated by the number of servers and cooks not the number of tables.

In the manufacturing sector, the first stage in capacity planning is to determine the maximum capacity of the plant or shop floor. The most discussed concept for this phase is known as Rough Cut Capacity Planning (RCCP). RCCP is defined by APICS as: "the process of

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[36] "Capacity." *Merriam-Webster.com*. Merriam-Webster, n.d. Accessed July 17, 2020. <http://www.merriam-webster.com/dictionary/capacity>.

[37] Blackstone, John H., Jr., APICS Dictionary, Fourteenth Edition, APICS, Chicago, IL, 2020, p. 21.

converting the master production schedule into requirements for key resources, often including labor; machinery; warehouse space; suppliers' capabilities; and in some cases, money."[38] RCCP is a preliminary stage to determine, if all resources are available, if the company can meet the needs for the Master Production Schedule. The Master Production Schedule is the anticipated build schedule based on adjusted forecasts and firm orders from customers. Often enough cut capacity planning will indicate that a set production level is doable for the company, but when constrained by available resources the company may find that actual capacity is exceeded.

RCCP leads to capacity planning which is simply determining how much capacity the company needs to meet the production schedule. Capacity planning includes Capacity Requirements Planning. During this phase of the planning process, the company looks at constrained capacity to determine the actual capacity available and how to use that capacity to meet the Master Production Schedule requirements. Constrained capacity takes into consideration worker absences (vacation, sick time, appointments), machine maintenance time, and known material shortages or delays.

Capacity Requirements Planning is the process of establishing the overall level of productive resources needed in the facility or system to meet the demands of the Master Production Schedule (MPS). One of the outputs of this process may be the determination that additional capacity is needed and when it is needed. Failure to properly conduct this phase of the planning process may impact the responsiveness of the company to the customers which in turn could impact the competitiveness of the company and maybe even the life of the company.

Capacity Planning includes a series of decisions for the company as shown in Figure 6.1. The goal is to try to maintain as level a production process as possible. Designing a facility that can be used for manufacturing more than one product is helpful in this goal – this will be discussed in greater detail in Chapter 7.

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[38] Ibid., p. 153.

1. **When do we need to add capacity?**
2. **How much capacity do we need to add?**
3. **Where is the new capacity needed?**
4. **What type of capacity is needed? (labor, materials, machines, etc.)**
5. **When do we reduce capacity? (This is not a good thing but may be necessary if demand for a product or service decreases.)**

Figure 6.1 Capacity Decisions

Do we need to add capacity? When do we need to add capacity? If the demand for the product or the forecasted demand for the product exceeds the company's capacity, the options are to expand the operations or outsource the additional capacity needs. If the demand increase is a short-term increase, it may be better to outsource. If it is a long-term increase in product/service demand, then the answer may be to add capacity to the firm. If the increase is short-term, the decision may be to outsource temporarily.

This leads to the decision of how much capacity to add. The follow-on question to this is does the company add a little capacity at a time on a regular basis or one large increase in capacity and then grow into the new capacity? One distribution center in Southern California after trying the little capacity additions realized that they were constrained in their location and could not expand any more. Their decision was to move about five miles down the road, buy more than enough land for future expansion, and build a facility that was about one and one-half the size of what their immediate needs were and then grow into the facility.

The answer to the question of "where is the capacity needed?" can only be discovered by walking the process. The first place to look is at the system constraint. Every system has a constraint, and the system capacity is the capacity at the constraint. Walking the process will identify the constraint. This leads to deciding what type of capacity increase is needed. It may be as simple as adding a machine or adding another shift or it could be as complex as designing and building a brand new facility. Temporary workers may be the answer. Department stores do this every Christmas season and Parks and Recreation Departments do the same thing every summer. The stores know the sales will be increased from the increase in customer traffic buying for the

holiday season and add seasonal help. Lawn and garden centers and services do the same thing with summer hires to account for the seasonal increase in demand.

The least favorable option for the company when demand exceeds capacity is to backorder the product to the customer. Backordering is not a good option as it forces the company to violate the concepts of perfect order fulfillment and means the customer will have to wait longer for the product. Since most companies do not have a monopoly on products, this may mean losing a customer or an order to a competitor.

When capacity exceeds demand for the product there are a few options to consider. The first and most drastic is to reduce capacity. This may be in the form of plant closures, forced vacations, furloughs or employee layoffs. The second remedy may be to reduce operational hours. Many companies have adopted this option during the pandemic to keep workers employed while meeting the needs of the customers.

Aggregate Planning

Aggregate capacity planning is a long-term look at capacity needs and requirements. Usually aggregate planning looks 18 months or eighteen to twenty-four months into the future. Why should we be concerned that far out? The forecasted demand for the product is going to drive long-term planning for resources. The need to look far into to the future is based on the lead times necessary to increase capacity. This does not happen overnight. An increase in capacity may require a new facility or new equipment. New facilities take time to design and build and time to hire and train the employees to staff the facility. Aggregate planning allows the company to start the process of creating new capacity without waiting until the last minute.

Master Production Schedule

Short-term capacity planning is driven by the Master Production Schedule. This anticipated build schedule helps to formalize the production plan and helps the company translate specific parts/components/finished products requirements into a work schedule and capacity plan. The near-term capacity plan has to extend out at least as long as the longest lead time (lead time is the time from you order a product or component until the time you receive it) for the components or materials for the product (this ties to the inventory concept that we will discuss in Chapter 16 and the Bill of Materials concept that we will discuss in Chapter 13).

System Capacity versus Department Capacity

When calculating a capacity for a system or facility it is important to look at the total system as well as the capacities of individual operations. The Theory of Constraints (as discussed in Chapter 18 in more detail) states that the throughput capacity of a system is the capacity at the constraint or bottleneck. Therefore, it is important to look at the total system by walking the process starting with the capacities of the component operations. The Theory of Constraints states the adding capacity anywhere but at the constraint will not increase the capacity of the system – it must be increased at the constraint.

For example: the US Army has a system known as the Fuel System Supply Point. Each individual system contains up to six 50,000 gallon fuel containers. However, the capacity of the system is not the total of the storage containers (up to 300,000 gallons) but the capacity of the fuel hoses, the filters and the pumps that deliver the fuel from the containers to the customers' fuel trucks. The system uses a series of hoses and pumps to distribute the fuel. The primary constraint is the capacity of the filter separator which is only 150 gallons per minute.

Capacity Utilization versus Capacity Efficiency

What is Utilization? Utilization is a manufacturing measurement of how much of a company's available capacity is being used. Many textbooks will make you believe that the closer a company is to 100% utilization the better the company is managed. Figure 6.2 shows calculations for utilization.

Utilization Rate =

(Actual output rate/available capacity) x 100

Or

(Hours worked/hours available) x 100

Figure 6.2: Utilization Calculation

Then, why is 100% or as close to 100% not always a good number? The utilization rate should match the consumption rate or sales rate. Consider the following scenarios:

- What if producing 100% utilization at one workstation in the system creates a buildup of work in process inventory at the next workstation because the line is not balanced (we will look at line balancing in Chapter7) or due to a constraint? This will result in excess work in process inventory – products that are between raw materials and finished goods.
- What if producing at 100% results in producing more product than the customers are buying? This would result in excess inventory.

The push for 100% utilization usually comes from the finance offices that use the justification "you wanted a new machine; we found the money and now you are not using it to peak utilization." The same personnel will come back next month and ask why there is so much excess inventory on the shelves.

Another consideration for not producing at 100% utilization may be the actual hours worked compared to the hours available for work. This calculation must take into consideration the warm-up time for machines and cool-down times for machines before and after production runs. Some machines may need to warm up to a certain operating temperature before efficient production occurs. And some machines may need to cool down before completely shutting down at the end of the workday. If this is not taken into consideration, their utilization rate calculation may be impacted.

What is efficiency? Efficiency is the measure of how well a worker, workstation, or machine produces compared to a standard output as shown in Figure 6.3. Examples of measuring efficiency include pieces produced per hour compared to the set standard for outputs.

Efficiency = output (pieces per hour)/ standard pieces per hour

Figure 6.3: Efficiency

Demand Planning and Balancing as Part of Capacity Planning

One of the goals of facility planning (more on this in Chapter 7) is to provide for the future and provide flexibility in operations. One of the goals of capacity planning is to have a smooth level production rate. A methodology for accomplishing both goals is to try to manage

the demand rate for products. This can be accomplished in a variety of ways. Demand planning, production planning, product design and capacity planning must be balanced.

Shift demand into slow periods. This may be the result of sales promotions or advertising campaigns to convince the customer to buy the products or services in an off period. Disney used to do this with their Florida Resident Salute Pass. This pass allowed unlimited visits during the periods that Disney had identified as off-peak periods. This provided a win-win. Disney had guests in the park and Florida residents got to enjoy the park in less-crowded times.

Offer the product or manufacturing in off cycle or counter-cyclic times. Burlington Coat Factory made an entire market this way. They started off by offering winter clothes in the summer and summer clothes in the winter. Toro attempts to balance the workload in the manufacturing. They make lawn mowers in the winter and snow blowers in the summer on the same assembly line. Another variation of this model is to work with customers to offer them incentives to commit to the purchase of seasonal items in the off season with guaranteed delivery in time for the seasonal sales.

Requiring Reservations. From a services perspective, demand planning and capacity planning can be seen in restaurants that require reservations. The use of reservations allows the restaurant to control the capacity of guest coming into the restaurant. It can also be seen at Disney World with the use of the queues for rides. Disney is a master of this concept by continuing to move the guests through a series of rooms as part of the queue to keep the wait from seeming as long as it is. This can be seen in Figure 6.4.

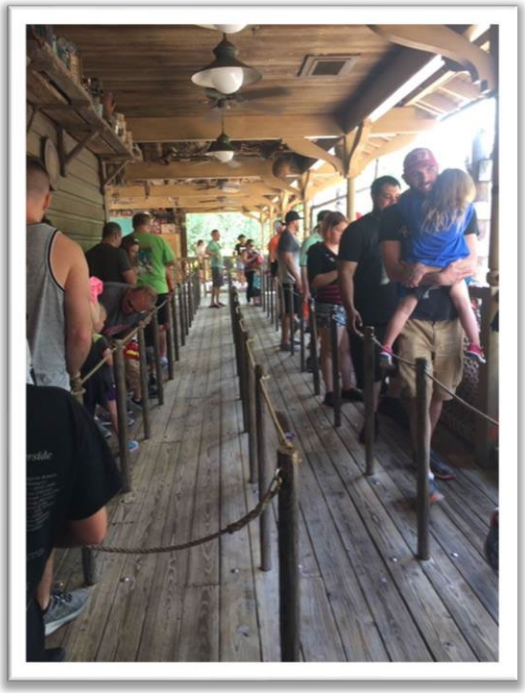

Figure 6.4: Queueing System at Disney World

Scheduling

Scheduling may be the most difficult part of the planning process. Scheduling operations must consider capacity. But it also must consider personnel and personnel skills, materials availability, machine availability, and customer priorities. This makes scheduling difficult.

In the absence of any other guidance, the best method of scheduling operations is first in and first out. This means that the first order received is the first order worked on and completed.

Summary

Capacity planning is critical to the success of the operation whether it is a service industry or a manufacturing industry. The Theory of Constraints states the throughput capacity of the system is the capacity at the bottleneck. It is important before embarking on a capacity planning activity to walk the process and identify any bottlenecks or constraints. The entire capacity planning process is driven by the Master Production Schedule and if there is an

imbalance between capacity and the schedule, the planner has to make some critical decisions on how to balance the scheduled production with the necessary capacity.

Discussion Questions/Thinking Questions on Capacity

1. Why or why not is 100% utilization important?
2. What are some of the reasons for not working at 100% utilization?
3. Why is it important to have a plan for when there is more capacity than demand?
4. What is the difference between utilization and efficiency?
5. From your perspective, what is one example of the Theory of Constraints?
6. What is the purpose of the Master Production Plan?