A DYNAMIC APPROACH TO MANAGE THE PRODUCTION CAPACITY

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ABSTRACT

The purpose of the article "A Dynamic Approach to Manage the Production Capacity" is to identify the main elements that are "overlooked" by the classic literature in this field. After a short inclusion into the definition and methods of capacity planning, we complete this article with our own research. We accentuate the importance of defining bottlenecks, in order to define the relationship between possible production and actual production capacity. The entire article underlines the importance of the governing link, suggesting the necessity for the dynamic approach of the production capacity. In order to face our time challenges we must compare the links within the capacity planning with what is requested of them and not just between themselves. This article provides a classic solution but also opens new ways for future developments.

KEYWORDS: *capacity planning; bottleneck; governing link; interphase inventory*

1. Introduction

The capacity of a production unit (e.g. machine, factory) is its ability to produce or do that which the customer requires. In production and operations management, three types of capacity are often referred to:

- Potential Capacity: The capacity that can be made available to influence the planning of senior management (e.g. in helping them to make decisions about overall business growth, investment etc.). This is essentially a long-term decision that does not influence day-to-day production management.
- Immediate Capacity: The amount of production capacity that can be made available in the short-term. This is the maximum potential capacity - assuming that it is used productively.
- Effective Capacity: An important concept. Not all productive capacity is actually used or usable. It is important for production managers to understand what capacity is actually achievable.

The main task of the capacity planning decision is to determine an optimal schedule to replace older machines, equipments or activity centers by newer ones. Traditionally, uncertain factors are seldom considered in capacity expansion because of an approximation view in medium and long-term decision-making.

2. Methods of capacity planning

One popular method of capacity planning is aggregate planning. Aggregate planning basically ties facility planning in with scheduling decisions, and it does so in a way that is quantitative, meaning it produces numbers to back up an operations plan. Plans generally either "chase" demand, adjusting its workforce accordingly or are "level" plans, meaning that labor is relatively constant with fluctuations in demand being met by inventories and back orders. Plans may also be "hybrid," meaning that they combine these two approaches.

Another popular method of capacity planning is the use of the Theory of Constraints (TOC). TOC serves to answer the question of what to change by using cause-and-effect modeling. It operates on the basic premise that a system can never be better than the weakest part thereof and that solving the problem of what holds the system back depends upon the identification of that constraint and the mitigation thereof. This process is frequently likened to that of a physician diagnosing a patient, designing a treatment plan and executing that plan. TOC is a useful tool in project management because of its ability to look at a system specifically and postulate as to how strong it could be. This methodology is quite useful in creating a starting point toward a solution to various business problems from marketing to supplier relationships to project management.

Forward incremental planning (FIP) is a dynamic planning method. FIP is implemented from the initial receipt of an order. The actions required to fulfill that order are prioritized. The essential goal of FIP is to reduce lag time. While it can be quite effective, the primary limitation of FIP is that it assumes that no other action is in progress, as in no machines are tied up and the workforce was essentially idle until the order was received. This may seem like a huge limitation, and it is for some industries, but for companies that produce products with high levels of customization, FIP can be a powerful tool.

Backward incremental planning (BIP) is the other side of the FIP coin. BIP looks at the requirements from the due date backward and organizes the process accordingly. A good example of this is a bakery. The cake must be fresh for its pickup date, so the baker would look at the steps required to produce the cake and the estimated time required to bake and decorate it. BIP works well in cases where a deadline is more of a requested completion date and completing the order sooner produces no benefit.

Break-even analysis is one of the methods used to evaluate alternative capacities. It determines how costs and profit are influenced by production volume changes. It helps evaluated changes in profit caused by changes in variable costs, fixed costs, selling prices, volumes and the mix of products sold. Studying the relationship between costs, sales and profit helps the management evaluate capacity alternatives (Shim and Siegel, 1999, p. 142).

The decision tree approach is another method of evaluating alternative capacities. It is particularly useful for weighing capacity expansion alternatives when demand is uncertain and sequential decisions are required (Shim and Siegel, 1999, p. 143).

Capital budgeting is another way to determine capacity. Operations managers have discretionary power over some capital budget expenditures. Facilities investment decision making, often referred to as capital budgeting, is the process of planning and evaluating long-term capital expenditures. Capital budgeting can be used in situations such as selecting a product line, deciding whether to sell or keep a business concern, and evaluating alternative asset investment options (Shim and Siegel, 1999, p. 343).

3. Research

From an international perspective there are theories that assume that, when balancing the production capacity on average, it is not possible to obtain an output at the level of this balanced capacity. This is the result of the fact that in this case there are two

phenomena that act objectively: the dependent events and the statistical fluctuations. (Goldratt and Cox, 2004, p.95) The statistical fluctuations mean that the same operation must have exactly the same duration every time, but greater or smaller variations are occuring. The idea of "exact duration" is an abstraction, the production processes are always confronted with variation, their dimension being variable.

If there is variation and dependence, and there are no interphase inventories, then in a balanced production process on average we cannot speak about a constant flow. Why is that the case? If the previous operation has delivered 10 items per hour, on average it takes 6 minutes to pass the item to the next operation. If instead of working 6 minutes, it managed to finish the production in only 4, there is positive deviation. But since the next operation in the production flow is still working on the item in its normal timing, it cannot process what has been delivered from the previous phase. If instead of finishing in 6 minutes, it takes 10 minutes to complete the process, the next operation must wait in order to continue the production flow. In other words, the positive fluctuations are lost and the negative fluctuations are adding up, meaning that the total output resulting from the process will systematically decrease, as we have a large number of links forming the production line and the fluctuations are greater.

A possible answer to this dilemma would be inventories. But how do we compute them and how do we manage them? Would it be possible to design another system to manage the production capacity and ensure a constant production flow without having to deal with interphase inventories? The answer is yes, but under these circumstances we have to balance the flow and not the average capacity of each of the links forming the production system.

Therefore the phenomena mentioned earlier exist even if we have the tendency to ignore them and in this situation the only way to do deal with this issue is to have a greater capacity that can take over the negative fluctuations. In this respect we have to provide spare capacity for protection. Only what is over the level of capacity required by the subsequent processes represents a surplus capacity or excess capacity. This is a dynamic sequence of flows that are variable in nature, hence the process can be very difficult to manage.

The trend that has been passed on to current state is to compare the links between them, and not to compare the phasic capacity with the demand.

The current literature no longer defines the idea of "bottleneck". On the other hand, in the international literature it is the first aspect to be clarified: the bottleneck is the resource whose capacity is equal to or less than the demand placed upon it. The classical thinking supports the idea the bottleneck is something temporary that can be quickly removed through the means of organizational and technological measures, while the new thinking in this field argues for the existence of two categories of resources having different purposes in the first place: the critical and the non-critical resources. The bottleneck is the resource that dictates the system's capacity.

An interesting observation is to notice that until the eventual removal of such a resource from our system, the bottleneck constitutes the most important issue production managers have to deal with. The whole decision process is influenced by this reasoning. The decisions regarding the acquisition of new equipment, the decisions of cooperation, the decisions of establishing the priorities concerning maintenance, the issues referring to the size of the production batches, the investment decisions, they are all affected by the way in which the bottleneck is managed. *Do we have to ignore this thinking and focus on the classical way, or should we take it into consideration*?

In this new theory that emerged after 1985, although there is no direct reference to the governing link, it is accepted and it is even recommended to identify the place where the entire production flow is managed, that means managing the bottleneck because it represents a constraint for the system in discussion. The significance of bottleneck should be seen in a much larger perspective than in the classical theory, in the sense that the

bottleneck could be found in the company or outside the company, either in a physical form, as a piece of equipment, a machinery, or under the form of organizational policy or measure. According to this view the size of the production batch should be different at the bottleneck from that at the non-bottleneck.

Identifying the bottleneck is a complex process. In case we speak of a physical constraint, there is an inventory accumulation in front of the bottleneck and this is very easy to be observed. In more general terms the bottleneck is also known under the name of constraint. If we refer to aggregate organizational levels we talk about the capacity at system level, we talk about performance at system level, where only for reasons of simplification we sometimes accept the idea that the capacity of the system is equal to the sum of the individual capacities of its component parts.

If we take into account the phenomena we discussed previously, it is obvious that this argument is no longer valid. If we admit that the capacity of the system is not the sum of the local capacities, according to the phenomena mentioned earlier in this article, this means that it is not desirable to use each of the links in the system at its maximum capacity. On the other hand we cannot rely on utilizing the resources at a minimum and conclude that it is enough. We need to build a mechanism that could tell us how much of the capacity of the other links should be put to work.

4. Solution

The resolution provided for this situation is the drum-buffer-rope concept. (Goldratt) These realities have been managed intuitively for many years and have been presented under different forms in order to lead to the conclusion that at least from a theoretical point of view the resources were used at their maximum, consequently the results to be obtained were maximum. These phenomena are universal and apply everywhere. They can be managed through some simple means such as the kanban and the pull system. It is generally agreed that it is good to start the production process after estimating the demand existing on the market.

There are two pressure factors acting against the rules of common sense. The first of them is the tendency to make a maximum use of resources, expecting to incur lower costs due to the production of a greater quantity. This situation occurs mainly when the employees are remunerated based on an hourly wage. The second factor is that it is better to already have a stock of products when the demand is expressed because in this way the response to the clients' needs is very prompt. The production managers should know how much to produce in order to subordinate everything to the bottleneck. In order for the employees to act according to this request it is necessary to evaluate them in conformance to other indicators than the traditional ones, that is the degree of resource utilization. The more a resource is used, the greater the output to be obtained is. It is the case at the local level. When we speak from the global point of view the results can be disastrous. This new system of operational indicators has been proposed by Goldratt and it is accepted by the qualified experts in the field. The just-in-time system uses almost the same principles under a different form, but this aspect is beyond the purpose of the present article.

5. Conclusion

To conclude we can say that we need to debate, in case the arguments presented previously are insufficient, and test these theories in practice either to prove that they are not real or to convince ourselves that they really work and to adopt them in order to

introduce and implement them in the day-to-day procedures. We can ignore these restrictions but this does not mean they will cease to exist. Although it may seem an insignificant issue, in other words we deal with bottlenecks that should be elevated by enforcing technical and organizational measures, the impact of the theoretical but most important, practical consequences is incomparably greater. The effects go as far as the entire classical managerial accounting procedures based on the system of distributing common costs on one or two criteria is to be questioned. Our proposal is to seriously debate on this matter and to decide on its validity.

6. Further debates

The business environment has never been more challenging than it is right now. The speed of change in the marketplace is creating a stress on corporations to respond quickly and effectively. The impact of capacity management is felt throughout the organization, within every element of the supply chain. Production capacity is very important; if the capacity is not great enough to meet peak demand periods and inventory building is not properly planned, customer demand will go unfilled. Distribution capacity, both storage and throughput, ensures delivery of the right product at the right time.

Change has become the rule, not the exception. The need for capacity management is measured not in years or quarters but rather in weeks and months. Changes can be brutally fast and without warning. Industry over the past two years has been hit hard with a steep slowdown of their business. Some were managing their capacity to great detail during the late 90s, with state of the art systems in place; however, these systems failed when business conditions began impacting their extended supply chains, including contract manufacturers and suppliers.

External as well as internal dynamics create the need for constant monitoring and adjustment of capacity levels and policies. Internal dynamics can be equally as disruptive. No matter how well capacity planning is conducted, the decisions must periodically be revisited to make sure they are still aligned with the organization's goals.

In today's dynamic business environment, speed and flexibility are a necessity. From being able to quickly respond to business conditions to reacting to dramatic changes in customer demand, an imbalance of capacity can have devastating results. Too much capacity can result in low return on assets, morale damaging layoffs and expensive facility closures while too little can result in lost sales and eroding customer loyalty.

7. Acknowledgements

This article is a result of the project „Doctoral Program and PhD Students in the education research and innovation triangle". This project is co funded by European Social Fund through The Sectorial Operational Programme for Human Resources Development 2007-2013, coordinated by The Bucharest Academy of Economic Studies.

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