
Back to Basics – part 2

by Martin Powell

In Back to Basics - Part 1 we showed that given that the Goal of a manufacturing organization is to make money, we can operationally achieve it if we increase THROUGHPUT whilst simultaneously decreasing INVENTORY and decreasing OPERATING EXPENSE. Although we will continue to talk about manufacturing plants much of the logic is also applicable for other business systems, including Service where Inventory is not physical materials but is incomplete work (often paper) or in health systems where Inventory is the patients.

We also maintained that we should not balance the capacity of our plants. We said that balancing the capacity of our plants will have a negative effect on the operational parameters – that is THROUGHPUT will go down; INVENTORY will go up; as for OPERATING EXPENSE the result is unclear – cutting capacity will reduce it; increased INVENTORY will increase carrying cost which is an increase in OPERATING EXPENSE.

Attempting to balance the capacity of the plant is a short way to bankruptcy. This is the reason why we cannot find a balanced plant in reality. Survival precludes the possibility of balancing the capacity of a plant.

When we use the term capacity, we mean the capacity of each and every resource in the plant and “resource” is everything that participates in turning Inventory into Throughput – a machine, tool, fixture and worker. Today the general policy is to trim excess capacity – the general belief is that we can balance the capacity of the plant.

So how come that we don't see balanced plants in reality? Well there are a lot of reasons people are using to explain it.

- Some will say that demand changes too rapidly
- Some will say that our workforce is not reliable enough
- Some will say that the process is not reliable enough or there is too much unpredictable scrap
- [The most popular excuse] Our vendors are so unreliable they prevent us from balancing the plant

All of these are minor reasons. The major reasons are intrinsic. Two phenomena exist in every manufacturing organization and many systems, and these two phenomena combined together are the one that prevent us from balancing the capacity of our plants. These two phenomena are Dependent Events and Statistical Fluctuations.

What do we mean by Dependent Events? When we are manufacturing, we are not manufacturing parts in isolation – we are manufacturing through a set of Dependent Events. For example, before we assemble we have to provide all parts for assembly; before we finish a part we have to start it; before we can work on a part we had to purchase the raw materials. One thing has to occur before a second thing can take place. This is the meaning of Dependent Events.

Do you have Dependent Events in your system? Are you processing through a set of Dependent Events? Yes. So the first phenomenon exists in your system.

What about the second phenomenon - Statistical Fluctuations?

What do we mean by Statistical Fluctuations? There are kinds of information where we can predict just an average and not a precise result. Some kinds of information we can predict precisely. For example, if we say that a particular table is designed to have four legs, we can predict that this type of table, when produced, will have four legs precisely – but when we say to process a certain stage on a certain part will take 5 minutes – what do we mean by the 5 minutes? We don't mean that every time this will be done it will take exactly 5 minutes. We really say it will take about 5 minutes – sometimes a little bit more and sometimes a little bit less. This is the meaning of Statistical Fluctuations.

By the way, Statistical Fluctuations exist not only in processing time; they exist also in the previous example – the table with the four legs. How many legs will you prepare if you have to assemble 10,000 tables? 40,000 exactly? Scrap does not exist in your plant?

Which means that even this type of information contains Statistical Fluctuations. And what about the marketing forecast – is it precise?

So both phenomena exist in your system - Dependent Events plus Statistical Fluctuations. Why should Statistical Fluctuations cause any problems? After all we have learned in school that Statistical Fluctuations are averaging out. True – they are but only when we are regarding non-dependent events. Like, for example, the tossing of a coin. When we toss a coin the result of each toss is totally unrelated to the previous result of the toss. But when we are talking about Dependent Events like the case in a manufacturing organization – then mathematics tells us that Statistical Fluctuations are not averaging out – they are accumulating and in the worst possible way.

In order to demonstrate it let us take an analogy to show how come Dependent Events plus Statistical Fluctuations do not allow us to balance the plant.

Remember, the Goal is to increase THROUGHPUT whilst simultaneously decreasing INVENTORY and OPERATING EXPENSE. What happens to the Goal if we try to balance the capacity of a plant that these two phenomena exist? Let us check it by the simplest analogy that we can think of. Where is a system that is very simple – only one product but still has these two phenomena - Dependent Events plus Statistical Fluctuations?

Let us think of a regiment – a regiment of soldiers going on a march. Why do we claim that this regiment is a system? You see the first line of soldiers, as they march, is consuming road – consuming raw materials. The last line is releasing product – totally walked on road. So we can regard the regiment of soldiers as the system producing totally walked on road, while each line of soldiers are the resources. Of course we still have to examine if the two phenomena exist in this simple system. Let's see.

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What about Dependent Events? It is better to be talking about soldiers and not group of ships – because a line of soldiers cannot bypass the previous line. The second line can process the road only if the first line has processed it before. In this sense we have Dependent Events exactly as you have it in your system. So the first phenomenon exists.

What about the second phenomenon Statistical Fluctuations? It exists as well, because, for example, when we a soldier marches at 4 miles per hour – do we mean that in every second he is going at exactly 4 mph? No – sometimes he is going a little bit faster; sometimes he is going a little bit slower. He is advancing at an AVERAGE speed of 4 mph. So we have Statistical Fluctuations exactly as you have Statistical Fluctuations in processing parts. We see that in our simple example both phenomena Statistical Fluctuations and Dependent Events exist.

Now let us see their impact. Let us ask you a question – where do you prefer to be in a regiment – in the first line or the last line? The soldiers that succeeded to get into the first line will finish the march – maybe not fresh but in reasonable condition; but what about the soldiers, the poor soldiers, that have to march in the last line? Everybody knows that in the last line you have to run – run to close gaps. So they will finish the march exhausted.

Let us remember that whenever we have the two phenomena we have spreading – we have a gap. Let us suppose that we send our regiment on a march. As we follow the troops along the route, we see that as time and road go by gaps begin to form between the ranks of soldiers. By the end of the march, the column is spread out a great deal.

What is the distance between the first line and the last line? The first line consumes raw materials and the last line releases product which means that the distance between the first line and the last line is simply inventory – and if we have spreading it means that the same regiment is covering much more road. The road between the first and last line is inventory – and spreading means that inventory goes up. What about Throughput? Throughput is not the rate at which the first line is advancing; Throughput is the rate at which the last line is advancing – the line that releases the finished product. If we have spreading it means that the last line is advancing at a lesser rate than the first line – which means that spreading causes Throughput to go down.

The two phenomena Dependent Events and Statistical Fluctuations cause Inventory to go up and Throughput to go down. Now let us see what will happen if we will balance our regiment – if we will balance our plant. Balancing the plant means that we have to match capacity versus demand - how do we do it in our regiment?

Suppose that we take the regiment and we tell them to go on a march from town A to town B, where the distance between them is 20 miles and we demand that they will do it in 5 hours. 20 miles in 5 hours – this is the equivalent of the marketing demand on our plant. What about capacity? We will select very carefully only flat footed soldiers who have a maximum average capacity of 4 mph – they cannot maintain reasonably, for any considerable period, more than 4 mph. Now we have a balanced plant. The capacity of our flat footed soldiers is exactly in line with our demands – we have a balanced plant.

What will happen to this balanced plant? Remember we cannot tell the soldiers to close gaps anymore – we cannot tell them to run because they cannot possibly do it. They cannot maintain a capacity – a rate – of over 4 mph. If the regiment has been spread before, try to imagine what will happen to this regiment once we have crippled severely its ability to close gaps. It will be spread all over the countryside.

So what will happen to Inventory? Inventory will go through the roof. What will happen to Throughput? Throughput will go down – and what about Operating Expense? We have balanced the capacity of the plant trying to save some Operating Expense – OK but because of that we have lost Throughput; Inventory went up dramatically; carrying cost of Inventory went up and the carrying cost of Inventory is Operating Expense – so now we don't even know what happened to Operating Expense – it might go up as well.

What happens to a plant where Inventory goes up, Throughput goes down and Operating Expense maybe went up? It's bankruptcy! Our plants are unbalanced not because of external effects – our plants are unbalanced not because we don't know how to balance them – our plants are unbalanced not because they shouldn't be balanced. Every time that we come even close to a balanced plant Throughput starts to drop, Inventory starts to go through the roof and we very quickly unbalance them.

Survival dictates that the capacity of plants/systems should not be balanced.

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Implementing TOC for operations in a "I type" plant

by Dr. Eliyahu M. Goldratt



It is well known that implementing the TOC solution for operations brings significant benefits, being one of them the release of additional capacity without any investment in equipment. In the case of production lines or production environments with well implemented Kanban systems the release of additional capacity can be even more significant. Even though TOC has shown that an additional 30% increase in capacity is possible, it turns out that a closer look into these environments (called "I plants" due to its configuration) can bring up to 60% more capacity. Goldratt explains why and how this is possible.

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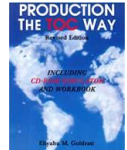
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