ThermoFab and DBR: Manufacturing At Warp Speed

A White Paper Report

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You probably know ThermoFab as a leading custom thermoforming provider of high-quality plastic enclosures for a wide range of medical, industrial and computer products. ThermoFab continually strives to be the best, to provide the best customer service, and to excel in all areas of manufacturing. This is the key to ThermoFab's continued success.

Manufacturing is what ThermoFab does, and it is the skill and success of the manufacturing activities that delivers value to customers. ThermoFab has faced many of the same challenges most manufacturers face – managing inventory and production schedules, balancing demand against resources to quote realistic shipment dates and produce product on-time, streamline activities to become more responsive to changing demand and more flexible in meeting changing needs.

In its continual quest to improve operations, ThermoFab has adopted an advanced production planning and scheduling methodology called Drum-Buffer-Rope (DBR) that is based on the Theory of Constraints, a philosophy first introduced to the manufacturing world by Dr. Eliyahu Goldratt with the publication of his landmark book *The Goal* in 1984.

ThermoFab's owners and managers would like you to know a little about DBR so you can understand and appreciate how this exciting technology helps make ThermoFab a better supplier and partner, delivering quality products when you want them.

The Theory of Constraints

In 1984, Dr Eliyahu M. Goldratt published a ‘business novel’ titled *The Goal* in which he introduced the Theory of Constraints in an easily readable parable-like form. *The Goal* follows a fictional plant manager through his daily challenges – the same challenges that every manufacturing manager faces: late incoming deliveries, machine breakdowns, late changes to orders, too much of the wrong inventory amid shortages of what you really need, difficulty getting work completed on time, etc. The main character discovers a basic principle, the Theory of Constraints that he applies to his problems with amazing results.

The Theory of Constraints (ToC) revolves around a single basic idea: in every multi-step process (such as in a manufacturing plant), there is one activity that determines how fast work moves through the process. This bottleneck is called the constraining resource or simply the constraint. ToC simply says that you must identify and manage the constraint. In so doing, you can maximize throughput (production) and better manage the entire plant.

Such a simple idea does not come without complications, however. It is not as easy as one might think to change your thinking and manage the factory in such an unconventional manner. Traditional signals and measurements, for example, work against what you are trying to accomplish with ToC. Traditional measures of efficiency and utilization no longer matter and conventional actions to increase these measurements defeat the purpose of ToC.

There is a mechanism for implementing ToC in a plant that is called Drum-Buffer-Rope or DBR. The name derives from the three basic elements of the technique. DBR controls the release of work and the flow of materials through the plant to produce products in accordance with market demand. The result is shorter lead-time, better on-time completion performance, as well as reduced inventory and operating expenses.

The ToC Process

Traditional production scheduling and control, as practiced by the majority of factories throughout the world, is based on traffic control, and having inventory ‘buffers’ throughout the process. Traditional production control is focused on managing the movement of work into and through inventory queues (waiting lines) and scheduling of each resource (work center, machine, worker) for maximum efficiency and utilization. This philosophy tends to drive relatively large lot sizes (batch quantities) to increase efficiency by spreading setup and changeover costs over a larger population of parts or products. This results in larger inventories and longer lead-times.

ToC tells us that we needn’t worry about non-constraining resources since they don’t impact the flow of work through the plant. We should concentrate on the constraint, and just make sure that the other resources don’t get in the way.

DBR is implemented with a five step approach:

Step 1: Identify the Constraint(s). This is usually not very hard to do – just look for the machine or work center with the biggest pile of backlog behind it. Or ask the supervisors which work center is the biggest problem. There are scientific ways to measure production rates and backlog as well. Sometimes there are multiple constraints, but often one is the real limiter of production throughput.

Step 2: Exploit the Constraint(s). Once you know where the problem is (the limiter), do what you can to maximize its production. This might include operator training, more aggressive maintenance and upkeep to make sure the equipment operates at full efficiency, better operator schedule to eliminate down time, and certainly making sure that there is always work available for that operation.

Step 3: Subordinate Everything Else. This simply means that the non-constraint resources must not be allowed to interfere with the smooth operation of the constraint. And less management attention is needed at non-constraints since high efficiency and utilization at these non-constraints does nothing to improve throughput. On the contrary, keeping non-constraints busy just to maximize this kind of measurement will only result in higher costs and higher inventory.

Step 4: Elevate the Constraint(s). Once you have gotten all you can out of the critical resource, if it’s still the constraint, then consider what you can do to increase its capacity. Such actions as adding a second shift or extending operating hours, or adding resources (people and/or machines) increase capacity beyond what was available through maximizing what was there before.

Step 5: Repeat as needed. Successful completion of the first four steps will likely raise the constraint(s) to the point where it or they are no longer the bottleneck. The next step then is to find out where the bottleneck has moved to and go through the same process again. This is a continuous process. Even if an ultimate constraint is identified, one that cannot be elevated, it is necessary to remain vigilant and manage work flow using Drum-Buffer-Rope to insure maximum throughput and success.

Drum-Buffer-Rope

DBR operations are deceptively simple, as you will see from the following description. Consider a simplified plant floor situation in which there are four resources (work centers) each with the pieces-per-hour run rates shown in figure 1.

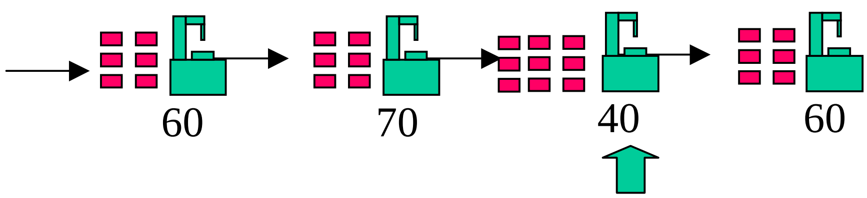

Figure 1; "Normal" production environment

The third work center is obviously the bottleneck since it has the slowest rate of 40 units per hour. In DBR parlance, resource 3 is the **drum** – it sets the pace for the entire 'system' or collection of resources.

In a well-managed plant floor environment, input and output are in balance. As a result, lead-time and work-in-process levels will remain steady. The same logic applies under DBR so the second part of DBR is to control the release of work. That's the **rope** – the release of work at the same rate that it flows through the constraint.

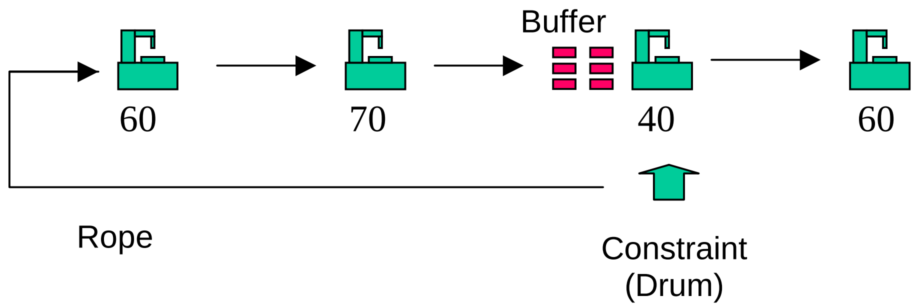

Figure 2; Drum-Buffer-Rope

Whereas in traditional production there is buffer inventory at every step in the process, in DBR we only buffer the constraints. In figure 2, notice that there is considerably less WIP inventory. Since the first two work centers operate at a faster rate than the constraint, it is not necessary to buffer them – let them run out of work from time-to-time, it won't hurt overall throughput. If there is a disruption upstream of the constraint (machine breakdown, maintenance outage, etc), we want enough buffer in front of the constraint to make sure that it can keep producing. When the disruption is resolved, the higher production rates at the upstream resource will rebuild the buffer to its former level. We keep releasing work to the floor at the same (drum) rate.

Downstream at the fourth resource, it is a similar situation. If production is disrupted, inventory will temporarily build up but will be flushed through after production resumes because of this resource's higher rate.

To complete the DBR 'protection', a so-called shipping buffer (finished goods or items completed before schedule) insures that you will make ship date commitments if there is a disruption downstream from the constraint.

This is obviously a greatly simplified explanation of DBR but it captures the essentials. The bottom line is that DBR shortens lead-time, increases throughput, and increases on-time completion of work. ThermoFab's customers enjoy quicker turnaround and more reliable delivery.

Big Changes at the Plant

ThermoFab made the transition to DBR in the middle of 2003. Prior to that time, like most other manufacturers, ThermoFab struggled to complete orders on time, despite its best efforts with expediting, overtime, and extraordinary measures. The plant floor was littered with too much inventory and it was difficult to sort through which orders were most important, most critical, or most in danger of being late.

The most challenging aspects of the conversion to DBR were all psychological. As you might expect, there were some skeptics within the company and winning them over was a critical part of the process. Truthfully, after running the plant in the traditional way for many years, changing over to the DBR way was a challenge even for Tom King, president, and the driving force behind the change.

Tom admits that it was difficult to walk through the plant and see machines (at non-constraint work centers) sitting idle. It was a real 'mental adjustment' to not worry about that, and to not worry about setup time at non-constraints. Traditional performance measurements – efficiency and utilization – are like a lifeline for a hands-on manager but they can kill a DBR project. Tom and his senior staff kept asking for these reports but the implementation team consultants kept saying 'don't worry about that, focus on the constraint'. The consultants proved to be right; efficiency and utilization are no longer a part of the ThermoFab culture. The most important measure is on-time completion. Keeping the customers happy is the ultimate measure of manufacturing success.

The DBR process does have its own measurements, though. The software associated with DBR constantly monitors the flow of work and the adequacy of the buffers to compensate for disruptions. Buffers can be too small, of course, resulting in real production problems. But they can also be too big – providing more protection (at the cost of too much inventory and lengthened lead-times) than is needed.

Line workers are also greatly impacted by this radically different change in the dynamics of the plant floor. Having become used to large quantities of work-in-process (backlog), they became nervous when that backlog began to disappear. Understandably, they feared that business was down, they might be running out of work, and layoffs might be coming. Nothing could be further from the truth. In the first quarter of 2004, sales were up 40% and May 2004 was the biggest sales month in three years. Yet, the plant floor is virtually empty of inventory and backlog.

Ironically, this presents somewhat of a problem for sales. When they bring customers and prospects in for plant tours, which they are encouraged to do, it doesn't look 'normal' to have machines sitting idle and no huge piles of work around the plant floor. The company has resorted to running sales samples on some of the idle machines during plant tours.

On-time shipping percentage now hovers in the 'high nineties' with several consecutive weeks of 100% on-time shipment recently. In addition, things have calmed down considerably at the plant. Before DBR, customers would feel the need to call to check on the status of their order, sometimes finding their way directly to the plant manager, hampering his ability to manage the plant and get the orders done. No more. Customers can count on getting their order on time and there's no longer any need to check.

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The Goal by Dr Eliyahu M Goldratt is available through amazon.com or your local bookseller