DBR Drum-Buffer-Rope
Operations Planning & Execution

Quit Re-planning. Plan Sensibly then Execute!

Every manufacturing plan has a limited life. A plan is only an attempt to synchronize efforts and resources ahead of time. It is based on a set of assumptions, most of the time very solid and historically based assumptions, but assumptions nonetheless. Every plan and the assumptions it is based on is subject to "Murphy" – variations and unforeseen issues that break down at least one of those assumptions. If you do not believe these "Murphys" exist, stop reading. In most manufacturing scenarios, these deviations begin almost immediately after the release of a plan/schedule. Additionally, they tend to accumulate and/or amplify each other to create major synchronization issues throughout the resource base.

What is most environments response to this phenomenon? "We have to replan!" And when the new plan breaks down? "We have to replan!" The result is a constantly changing schedule and set of priorities that impact the company's ability to meet customer due dates, effectively manage purchasing and materials requirements and limit additional expenses such as overtime and fast freight.

Is this really a planning problem? Yes and no. It is planning problem that quickly moves into an execution problem. It requires a planning AND execution solution.

In most cases, our default response to poor system performance is to have better, MORE PRECISE, planning. We feel we have to get better forecasting data, examine and rebuild routings, adjust standards, schedule concurrently at every resource center, and carefully account for every precious minute of manufacturing time everywhere. If you review the majority of manufacturing planning software on the market and carefully examine the sales and marketing emphasis what you will see is that many of them are highlighting scheduling precision and slightly different "optimization" and forecasting algorithms.

Take the output of these precision based scheduling techniques and what you will find is that most of the time it simply says, "We will hit this date if every thing goes according to plan." At the same time almost everyone in manufacturing readily admits that every thing NEVER goes according to plan. The plan is

PRECISELY not realistic. This plan is then used to communicate and make commitments to customers, suppliers and the resource base. You know the rest of the story from here.

What we have to understand is two things. First, trying to be more precise everywhere is leading us directly into being imprecise as a whole. This is especially true as concepts such as LEAN have proliferated and companies have dramatically dropped inventories making materials availability more of a challenge in the face of an unrealistic plan.

Second, Murphy will not be eliminated. Despite what some manufacturing "gurus" may say, the elimination of random events and variations is completely unrealistic. Yes, major sources of disruption can be systematically attacked and eliminated through a concerted effort, but at what cost in terms of time and money and at which area should we begin? And, What should we do in the meantime – continue to plan and replan?

Step 1: Plan for Murphy.

How can we plan for random disruptions that can and will occur anywhere? We cannot plan for these events at a resource level. If we fall into that trap, lead times will expand as we attempt to insert additional time at each operation in order to account for things that might happen there. Additionally, while we are aware that every thing NEVER goes according to plan, we also accept that never does EVERYTHING go wrong at ALL places. In other words, disruption and variation can occur anywhere but will not occur everywhere. If we cannot plan for them at a resource level, we must plan for them at a higher level. Let's examine how.

The Shipping Buffer

The key is to isolate these disruptions from effecting what is critical for our customer commitments (due date performance) and control (planning and execution). Let's deal with our customer commitments first. This stage is relatively simple from a planning perspective. Essentially, what we have to do isolate the accumulation of variable events in the facility from directly impacting the shipping date. The key is to realize that we should plan an order to be ready a certain period of time BEFORE the actual required shipping time. This is called a Shipping Buffer. How large should the shipping buffer be? It depends on the complexity and variability of that specific manufacturing environment. One thing is clear, however, minimizing this time buffer will require much better planning and control within the manufacturing facility.

The "Drums"

A manufacturing plant is a system often containing a substantial number of interdependent events. Within any system of interdependent events, there is

usually one or, at the least, a limited number of resources/factors, that truly affect the output of the system – a leverage point. Many have called these areas "constraints" or "bottlenecks." In fact, Dr. Eli Goldratt and Jeff Cox, wrote a business novel called, *The Goal*, thoroughly explaining this issue and giving birth to a management methodology called the Theory of Constraints.

These definitions (constraint and bottleneck), however, are much too simplistic and reactive in nature to really explain what these leverage points really represent. They are areas that make the most sense to decouple the accumulated variation of a string of events from the rest of the processes and resources. It could be an integration point in the routing (e.g. assembly), a capacity constrained area (e.g. a bottleneck) or a highly instable process that will only greatly amplify any variation as an input. It is a strategic control point. The proactive question, "Where should it be?" should always be asked and answered.

Drum-Buffer-Rope Planning

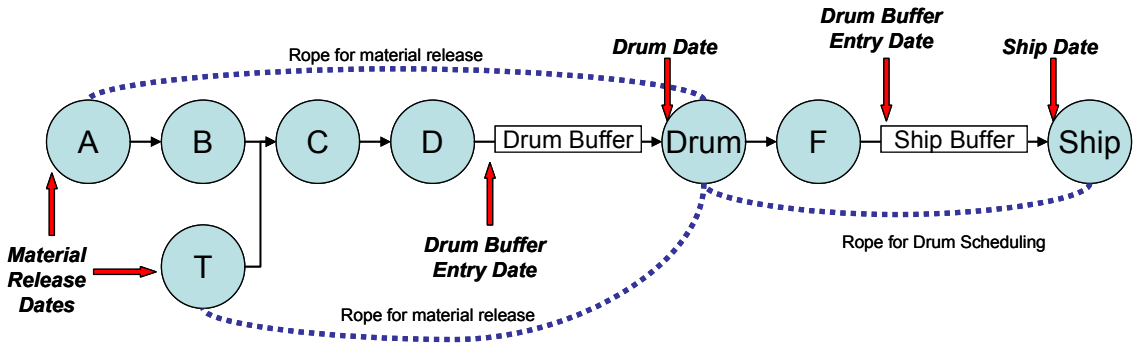
Planning begins at these strategic areas. They become the "Drums" because they provide the cadence that all other resources and areas follow. With a given customer commitment in mind (provided by the due date with a Shipping Buffer), they are scheduled before any other area. Every area has finite capacity and the Drums are no exception. Capacity testing happens here first. If there is no capacity for the given time that corresponds to the due date and allowing for a shipping buffer then the order must be scheduled before or after that time. All subsequent scheduling (e.g. material release) is subordinate in nature to the Drum Schedule.

In order to protect and stabilize this Drum Schedule, a time buffer known as the "Drum Buffer" must be planned and inserted preceding the Drum operation. Just the Shipping Buffer, the Drum Buffer seeks to have work orders ready for the Drums before they are to be worked on by the Drum. The Drum Buffer serves to act as an early warning system in order to alert us to which work orders may impact the Drum Schedule. This allows a manager to intervene BEFORE there is a schedule deviation.

From this Drum Schedule the staggered release of material is back scheduled using the upstream process time (traditional routings and standards) plus the Drum Buffer time. This is called "Tying the Rope."

The result is called Drum-Buffer-Rope. It is a simple plan comprised of a few major waypoints to mange to:

- A clearly defined, timed and sequenced material release
- An expected arrival time for orders into the Drum Buffer
- A Drum Schedule
- An expected arrival time for orders into the Shipping Buffer
- A ship date



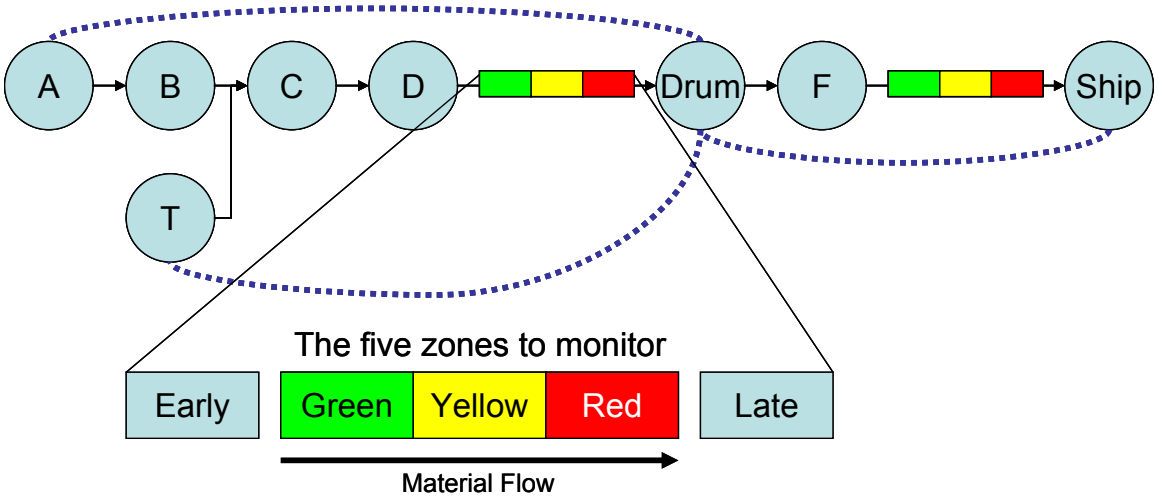
Thus, from a planning perspective, precision is important in only a few places. Ironically, this type of scheduling requires less computing ability and gives a clearer picture of what will actually happen because it is inherently simpler than most traditional schedules and it recognizes and seeks to protect what is critical from Murphy. Finally, we have a schedule that will be hit even if many things DO NOT go according to plan.

Step 2: Manage the Murphy - EXECUTE!!

A Drum-Buffer-Rope schedule is managed through its buffers. The buffers will tell you about the health of the system and any individual operation, the status of a work order and where to focus improvement. The buffers are visible, real-time tools that clearly depict any deviations to plan and set priorities for corrective actions.

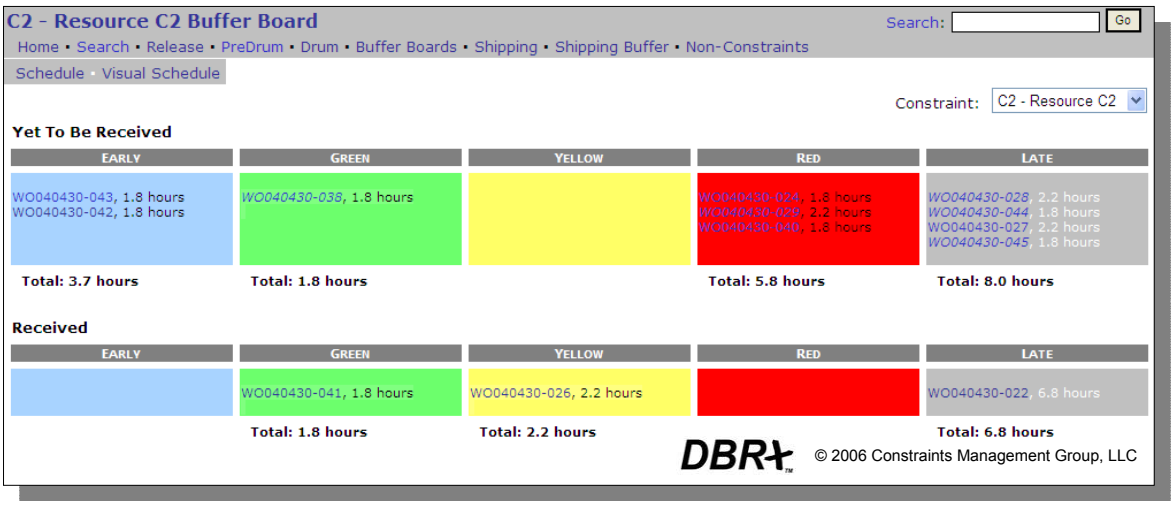
Buffer Management

To manage the buffer we divide it into three time zones: Green, Yellow, and Red. The zones are not necessarily of equal proportions. We should also pay attention to other zones: Early (work order is ready before the total time length of the buffer) and Late (work order arrives after the entire length of the buffer has been consumed).



We will have to reconcile the work orders actual presence in the buffer by recording when it entered the buffer and judge that against planned entry to create a view about what, if any, corrective actions need to taken. When a work order is not ready and in the buffer at the start of the Green zone (planned buffer entry), a "hole" is created in the buffer. The severity of the hole will ultimately determine when we have to act and which work orders to act on.

This means that we have to think about the above 5 zones from two perspectives, "Yet to Be Received" and "Received." When something has been "Received," the hole has been filled. Below is a real-time buffer board that reconciles released work orders against their buffer status.



Notice that when we account for the same time horizon from the two different perspectives, it actually creates a total of ten status zones. Those zones are:

1. Early – Yet to Be Received. This zone actually represents all released work orders that are on the way to the buffer.
2. Green – Yet to Be Received. This is a hole in the buffer. Not a serious hole, but a hole nonetheless.
3. Yellow – Yet to Be Received. This is a deeper hole in the buffer that should now be getting the attention of the personnel responsible for managing the buffer.
4. Red – Yet to Be Received. This is the deepest hole that we can dig without impacting the Drum schedule. This zone alerts the appropriate personnel that if corrective actions are not taken the Drum schedule will be disrupted.

Did You Know?

Constraints Management Group makes an elegant piece of DBR software that is not only user friendly, but is extremely robust and affordable. Combined with the proper implementation strategy and services, ***DBR+*** can make the common sense seen in **The Goal** real AND sustainable.

DBR Plus™
Drum-Buffer-Rope Scheduler & Buffer Manager

5. Late – Yet to Be Received. The Drum schedule has already been disrupted by this work order and it is still not present.
6. Early – Received. The work order is physically present at the buffer and ready to be worked on by the Drum ahead of the time horizon we planned for. This usually means that the standards we are using to generate the plan may be over-estimated (very commonly most companies standards are highly inflated to try to combat Murphy and disruptions everywhere) or the work order was released ahead of schedule.
7. Green – Received. The work order was received within the planned time horizon with a, relatively, lot of time to spare.
8. Yellow – Received. The work order was received within the planned time horizon with moderate time to spare.
9. Red – Received. The work order was received within the planned time horizon with little time to spare.
10. Late – Received. The work order was received after the time it was scheduled on the Drum. By definition, it has caused a disruption to the Drum schedule, but, it is at least present.

Step 3: Improve

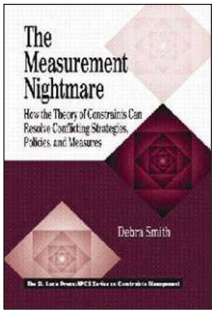
Continuous improvement in a Drum-Buffer-Rope system is about focusing capital and time in order to improve the system's performance from three main perspectives; lead-time, inventory and volume.

Quite simply, lead-time gains will help a company retain and/or grow market share and/or get more money for it. Reducing the amount of inventory means that there is less captured money in the system to service the market. Growing volume will allow a company to do more business with the same or relative small amounts of additional overhead.

What about Cost?

A basic principle of Management Accounting states that, "company will profit maximize when it makes and sells the product with a highest contribution margin per unit of its scarcest resource."

DBR allows a company to squeeze more cash from a given resource base. That's a good thing, no matter how you choose to allocate costs.



For more on the accounting implications of DBR read The Measurement Nightmare, by Debra Smith

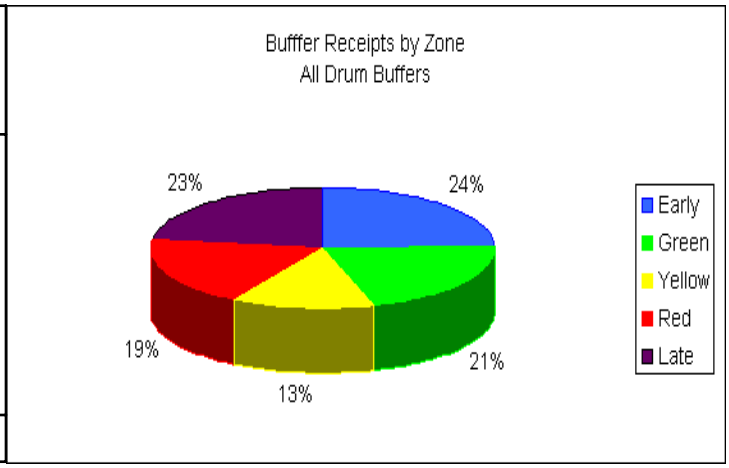
Initially balancing the above three categories and, eventually sending them all in the right direction is the objective of a DBR system.

Reason Code Analysis

The required transactional data from Buffer Management can be used to direct improvement. By forcing reason codes when transactions (receipts) are made in certain key zones (Late, Red and Early) of the buffer and comparing them over time we can get an amazingly clear picture of how to direct improvement efforts.

Reason Code Analysis (Red Zone)

Reason	Occur	%
Equipment	50	41%
Late Release	24	20%
Material	19	15%
Labor Shortage	14	11%
Expedite	12	10%
Other	4	3%
Total	123	100%



Below are some typical types of zone receipts and reason codes and what some potential recommended actions might be.

Zone Receipt	*Number of Occurrences*	*Reason*	*Recommended Actions*
Late	23	Set-up delay at work center "CNC-Lathe7"	Set-up reduction program at CNC-Lathe7
Red	27	CNC-Mill18 down	Preventative mtnc program (off-hours) at CNC-Mill18.
Early	52	Released on-time, beat standards	Clean standards up of listed product families.