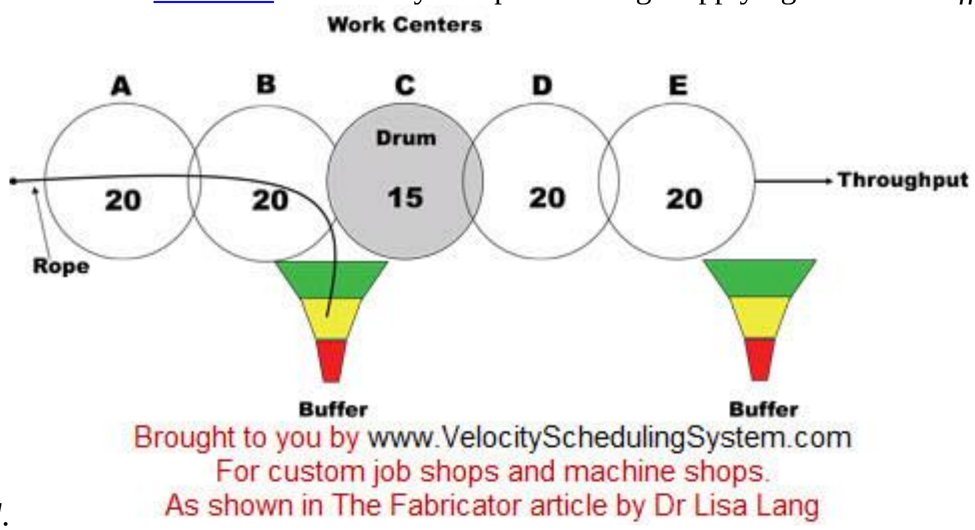
Drum Buffer Rope (DBR)
Summary & Introduction

What is Drum Buffer Rope?

Drum Buffer Rope (DBR) is the Theory of Constraints scheduling process focused on increasing flow by identifying and leveraging the system constraint. DBR was developed by Eliyahu M. Goldratt (Eli Goldratt), the father of Theory of Constraints.

This article explains what is Drum Buffer Rope and how it works. This is drum buffer rope explained and drum buffer rope for dummies!

Dr Goldratt's book [The Goal] tells a story of a plant manager applying the *drum buffer rope*



method.

Traditional Drum Buffer Rope and TOC Production

The [drum] is the constraint.

The resource that is limiting your output. Also called the Capacity Constrained Resource (CCR). Most shops typically only have one constraint at any point in time, but the issue is that for many custom job shops and machine shops the constraint can move as the mix changes. And in custom job shops and machine shops the mix can change dramatically and often.

A constraint is any resources that has demand greater than it's available capacity. Any time lost on the constraint is output lost by the entire system. Increasing output at the constraint, increases overall output. If you increase the output of the constraint to the point that another resources has become constrained, the constraint/drum has moved.

The constraint is called a drum because it sets the pace for the operation like a drum sets the pace for solders marching. The rate of output is equal to the output of the constraint. This concept was illustrated in [The Goal] with boy scouts going on a hike. The slowest hiker, Herby, set the pace. In The Race (also by Goldratt), it was illustrated with solders marching to the beat of the drum.

Improving non-constraints has no effect on overall output. This is why measuring utilization everywhere makes no sense. Trying to 100% utilize non-constraints just results in too much Work in Process (WIP) and the many issues associated with that.

We see a moving constraint most often in situations where shops have balanced capacity, meaning that the amount of capacity needed at each resource is close to exactly what is needed. The capacity everywhere is balanced to the demand. The Theory of Constraints diagram above would show balanced capacity if all circles had the capacity at 20. In job shops and machine shops that have changing mix, this balancing of capacity has the detrimental effect of lowering output. The exact opposite of what it was supposed to do.

It is a common misconception that you should constantly be eliminating your constraint. This would be an unending, ever changing process. For example, the Drum Buffer Rope policies procedures and measure would need to adjust each time your constraint moved. How do you leverage or maximize the output of an ever moving and changing target? It would be difficult. It would be far better to be strategic about the placement of your drum. And for it to be a business decision if the drum moved. After all, the drum dictates the output of your entire organization.

Where should the constraints be?

Where should you strategically place your constraint? Where do you want it to be? Before we answer that question, let's talk about where you don't want your constraint to be. Non-constraints by definition have excess capacity. The rule of thumb is that you'll need 25-30% excess capacity at non-constraints. But I prefer to call this PROTECTIVE capacity. Excess implies that it should be eliminated.

Which resources are easier to hire, less expensive to buy? The answer to those questions will give you an idea of which resources you want to be non-constraints. Since some of this capacity may not be used or used as much, you don't want protective capacity for expensive, hard to hire resources.

So that means that you would want to strategically place your constraint at the resource that is hardest or most expensive to get more of. Often this resource is the essence of what you do.

Now, if you could put your constraint anywhere because all your resources were equal in terms of adding more, then I'd put the constraints at the beginning of your process. More on that below.

The buffer is measured in time.

Drum Buffer Rope (DBR) Summary & Introduction

It's the amount of work expressed in time (like days worth) prior to the constraint. We control this amount of work with the rope.

By having a buffer of work in front of the constraint, we can ensure the constraint does not run out of work. The constraint is the only place where 100% utilization is a good thing!

The buffer's job is to absorb variability. In traditional Drum Buffer Rope there are 2 buffers - one for the constraint and a shipping buffer. The one before the constraints is there to protect the constraint and the shipping buffer protects the due date.

Simplified Drum Buffer Rope just has a shipping buffer. The market is considered to be the constraint and the drum is set to meet all the due dates, so the shipping buffer is buffering the due dates. When you have a market constraint, you need to exploit that constraint by making sure you're on time to all customers.

Sizing the Buffers

Any buffers are divided into 3 zones - red, yellow, green. The buffer is sized so that it turns red about 5% of the time. The 25-30% protective capacity mentioned above is just a starting rule of thumb. To determine if you need more or less, you would look at your buffer statistics. If you're going into the red more than 5% of the time, then you may need more protective capacity at one or more non-constraint resources. If you never go into the red, you have more protective capacity than you need.

In the picture above the first buffer is buffering the Drum or constraint from resources A and B. So that buffer will help you with sizing resources A and B. The "why" reason for buffer penetration into red will help you to determine which resource may need more capacity.

The second buffer is buffering the Due Date. The reason we do that is because job estimates are just that, estimates. They are usually wrong. For example if you estimate that a milling step will take 62 minutes to setup and 37 minutes to run, then the only thing I know for sure is that it's not going to take exactly that amount of time. Those are estimates. As discussed in the 9 Challenges to Scheduling Your Job Shop and Why Your Schedule is Dead on Arrival special report (drum buffer rope pdf), variability is at each and every step of your process. Sometimes more, sometimes less, but always variable!

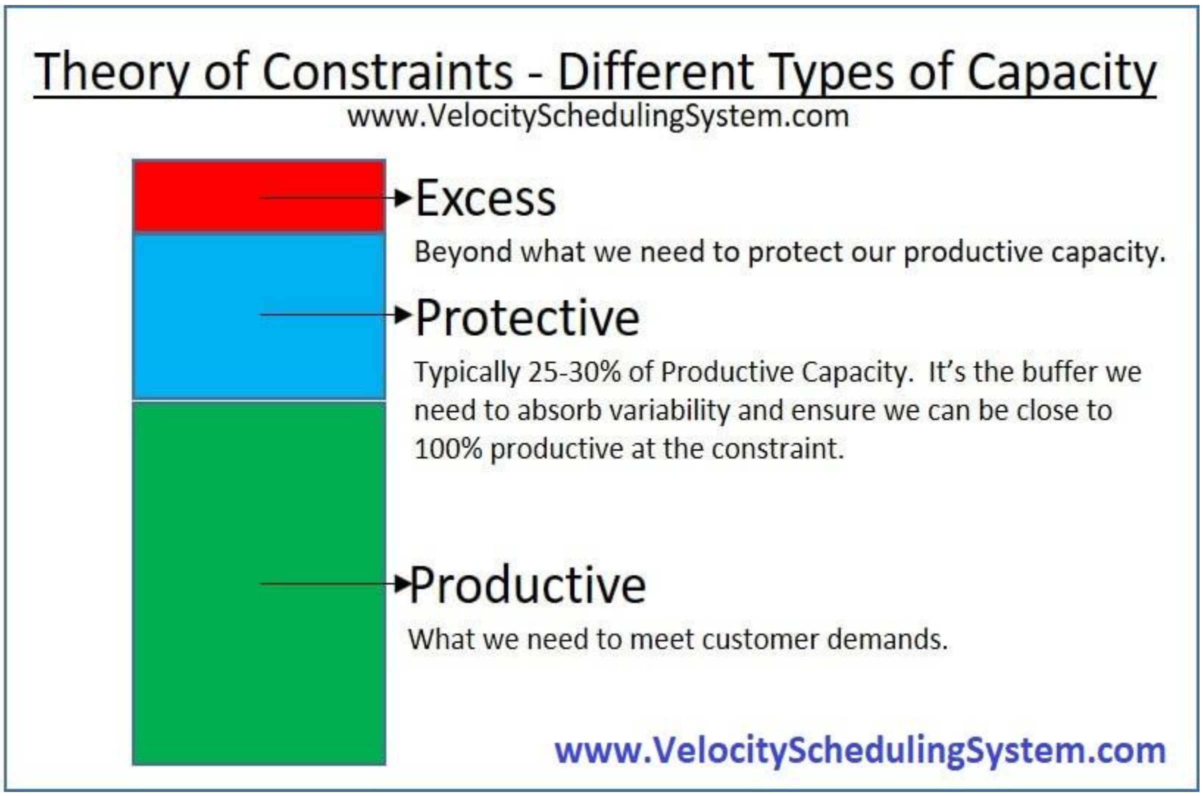
But we use these approximately right (but precisely wrong) estimates to determine the release order of jobs. Jobs that we expect to take longer are released before jobs that we expect to be quicker with the same due date. The second buffer is absorbing the variability of the drum along with resources D and E. So it's the second buffer that will help you to determine the capacity needed for resources D and E.

The shipping buffer is NOT protecting the constraint, so why do we need protective capacity at the non-constraints after the drum?

Drum Buffer Rope (DBR)
Summary & Introduction

1. Because once you finally get through the constraint, the last thing you want to do is take too long to complete, ship and get paid.
2. Because you want to ship on-time, when promised, to customers. And to do that consistently, you need to absorb the variability.
3. Because if you don't have enough protective capacity, these non-constraint resources could become a constraint from time to time. And dealing with an interactive constraint is much more difficult and can lower your Throughput.

Additional protective capacity, if needed, could be gained by using what you have more effectively by reducing setups, reducing variability, staggering breaks, cross training under utilized resources or by adding more capacity. But obviously if you want to maximize Throughput, gaining capacity without increasing operational expenses would be preferred.



And a word on cross training. Cross training is a great thing. Just be careful to watch your buffer to determine if the resources that are moving to the work are causing what they left behind to become a constraint.

TOC, Lean and Six Sigma (TLS)

If the buffer enters red we find out why. For continuous improvement we track the whys for going into the red so that we can reduce or eliminate our biggest disruptions to flow. We are only going into the red zone about 5% of the time, but every time we do there will be one or more assignable causes. We track those, then monthly we do a Pareto analysis to determine our biggest disruption to flow. Then we can use Lean or Six Sigma tools to reduce or eliminate those disruptions to flow. And if the causes for going into the red zone are reduced or eliminated, then we have successfully improved our flow. These improvements to flow lead to less variability and needing less buffer!

The less buffer you need, the faster you will be able to get jobs done!

Lean tells us to reduce waste everywhere. Six Sigma tells us to reduce variability everywhere. The Theory of Constraints methodology, Drum Buffer Rope buffer statistics shows us WHERE to improve to have the biggest impact on our output and Throughput.

The rope is how we control the release of new work.

The idea is that if the constraint sets the pace, the drum beat, for the entire operation, then we should only release work at the rate that the constraint can consume it. Rope buffers drum.

If we release work faster than the constraint can consume it, then WIP (work in process) piles up and bad things begin to happen. (See Little's Law <- click for an explanation of why too much WIP is a bad thing.) A common theme among job shops and machine shops is too much WIP. And this increase in WIP happens in an attempt to keep all resources busy in an environment where mix changes, cross training is limited, certain jobs have to run on certain machines, emergency orders, customer changes and ISO or other tracking requirements.

Combine the complexity often found in job shops and machine shops with the desire to run an efficient operation and the result is too much WIP. The **drum buffer rope video** below explains further.

In Drum Buffer Rope what provides the schedule?

In Drum Buffer Rope the schedule is created for the constraint resource, the drum. Since all other resources have more capacity relative to the constraint, the only resource that you need to schedule is the constraint. If you know what the constraint's capacity is per day, you can schedule or sequence which jobs will be on the constraint each day. This is much easier than trying to schedule every job at every resource.

Simplified Drum Buffer Rope (sDBR)

Simplified Drum Buffer Rope (sDBR) is Traditional DBR without the constraint buffer. Simplified Drum Buffer Rope just has a shipping buffer. The market is considered to be the constraint and the drum is set to meet all the due dates, so the shipping buffer is buffering the due dates. When you have a market constraint, you need to exploit that constraint by making sure you're on time to all customers.

In the case of sDBR the drum is the due date. Therefore there is no need to sequence jobs at the constraint or the "would be" capacity constrained resource (CCR) since the constraint is the market. Raw materials are released on the job due date minus the shipping buffer. Releasing the right jobs in the right order is critical. If priorities are out of sequence due date performance is put in jeopardy.

sDBR is easier to implement since there is only one buffer. But the challenge can be in exploiting capacity to ensure Throughput is maximized.

Drum Buffer Rope vs Kanban

DBR is a pull system. When the constraint finishes one, one is released into the system. Whereas, Kanban is a don't push system. If the kanban is full don't push (release) more in. In DBR the buffer is time. In Kanban the buffer is space.

Drum Buffer Rope Game Simulation

There are several games / simulations you can run to better understand DBR and the benefits:

- The Job Shop Game
- Game from The Goal by Eliyahu Goldratt

Drum Buffer Rope Software

You can find information on DBR software on this page: https://www.velocityschedulingsystem.com/blog/drum-buffer-rope-software/

Drum Buffer Rope Case Study

You can find tons of case studies on this page: https://www.velocityschedulingsystem.com/blog/velocity-scheduling-system-case-studies/

Theory of Constraints Goldratt

That's a brief Theory of Constraints summary of Drum Buffer Rope. The real challenge is figuring out how to make it work in YOUR shop. And that's what we do in the Velocity Scheduling System Coaching Program.

The plant in The Goal is a machine shop. It's not the most complex of cases, but it is a machine shop. Velocity Scheduling System is Drum Buffer Rope modified for custom job shops and machine shops who are more complicated and have moving constraints. In addition, VSS makes Drum Buffer Rope visual.

Drum Buffer Rope for Complex Job Shops and Machine Shops = Velocity Scheduling System

Velocity Scheduling System was developed for the tough cases (this is a partial list, here is the full list of job shop scheduling problems VSS solves):

- For the custom job shops and machine shops that run high mix and low volume work or prototypes.
- For the shops where the constraint or bottleneck moves based on the mix of work.
- For the shops that may not run many jobs twice but can also have a production job to fit in with everything else.
- For the shops that do repairs (in house or on-site) or emergency work.
- For the shops that don't have perfect employee or vendor performance.
- For the shops who don't have perfectly cross trained employees, but have jobs that require a particular machine.
- For the shops that produce a wide range of custom parts or products that have a wide range of lead-times, set-up times and outside processes.
- For the shops that may not have 100% quality performance and or yields that are less than 100%.
- And, for the shops who have customers call and change quantities, dates or both.

If your shop is a custom job shop or machine shop, check out the Scheduling Reports (you can download the drum buffer rope ppt) and Scheduling Webinar tabs. After you watch the webinar, we should talk to determine if your shop is a good fit for Theory of Constraints Drum Buffer Rope / Velocity Scheduling System.

By Dr Lisa Lang