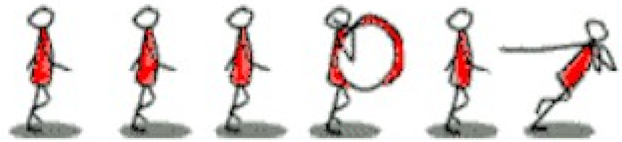
What is Drum Buffer Rope?

Drum Buffer Rope (DBR) is a planning and scheduling solution derived from the Theory of Constraints (ToC).

The fundamental assumption of DBR is that within any plant there is one or a limited number of scarce resources which control the overall output of that plant. This is the “drum”, which sets the pace for all other resources.



In order to maximize the output of the system, planning and execution behaviors are focused on exploiting the drum, protecting it against disruption through the use of “time buffers”, and synchronizing or subordinating all other resources and decisions to the activity of the drum through a mechanism that is akin to a “rope”.

Theory of Constraints

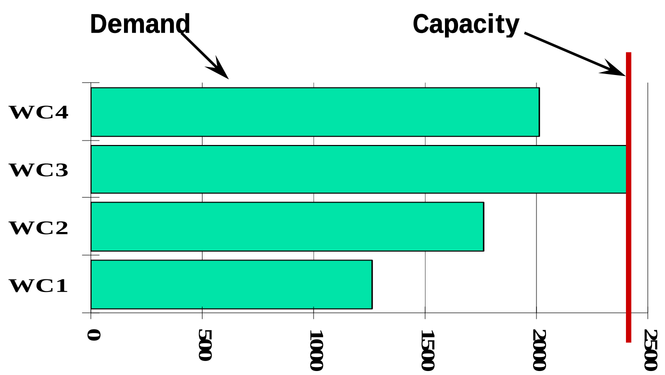
ToC (Theory of Constraints), also called Constraint Management, is a philosophy and set of techniques used to manage an organization. Most widely implemented in manufacturing operations, it teaches management how to identify and direct their focus **on the few critical drivers** that matter to the bottom line performance.

Eliyahu Goldratt originated the idea in his book **The Goal** as a way of managing the business to increase profits. **ToC is a proven method** that can be used by **existing** personnel to increase throughput (sales), reliability, and quality while decreasing inventory, WIP, late deliveries, and overtime. Successful organizations also adopt ToC to help make tactical & strategic decisions for continuous improvement.

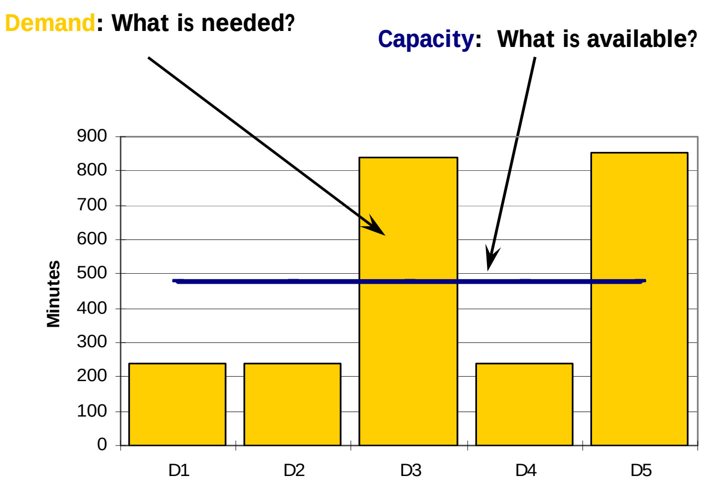
The crucial insight of ToC is that only a few elements (constraints) in a business control the financial results of the entire company. ToC tools identify these constraints, and focus the entire organization on simple, effective solutions to problems that seemed insurmountably complex and unsolvable.

The Scheduling Problem

When one looks at the load versus capacity, one must look at each resource individually. The aggregate view of, for example, 1000 hours available in the factory versus 880 hours of demand doesn’t adequately describe the situation. In figure 1, we see that most work centers have extra capacity, while work center 3 is fully loaded and cannot accept more work. The true state of this plant is that it is full and cannot accept more work that involves WC3.



In addition, we must consider the time frame in which the demand occurs. A monthly or weekly aggregate view of demand may not be sufficient to take action and deliver work on time.



To solve this problem, most systems will offset by some standard fixed lead time, but all that does is move the peak over. Forward scheduling algorithms will not "see" the peak until it's too late

The peak demand must be moved to open capacity.

If you ignore peak demands, you will have expediting, overtime, additional WIP, late deliveries because capacity may not be available when needed. This will have negative effect on system throughput, due date performance, and lead times.

ToC in Production

The Theory of Constraints is an integrated management philosophy and set of techniques which serve to manage & optimize the activity of the business.

ToC begins with one underlying assumption; the performance of the system's constraint will determine the performance of the entire system. To help you understand explain, we use a chain as an analogy. The strength of the chain is determined by its weakest link. What determines the strength of the chain? Its weakest link.

The process of delivering a product or service is very much like a chain; each resource and function are linked. It only takes one element in the system to fail, to cause the entire system to fail.

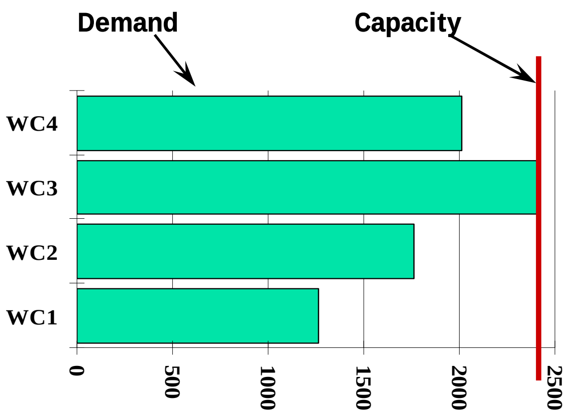
In order to improve the system, we must optimize the weakest link; the constraint or drum. All other resources are subordinated to that. In scheduling terms, we

1. Develop a detailed schedule for the drum resource
2. Add buffers to protect the performance of that resource
3. Synchronize the schedule of all other resources to the drum schedule

The Drum Buffer Rope Solution

Identify the system's constraint

The first step is to identify the drum. The drum is typically the most heavily loaded resource (or workcenter) in the plant.

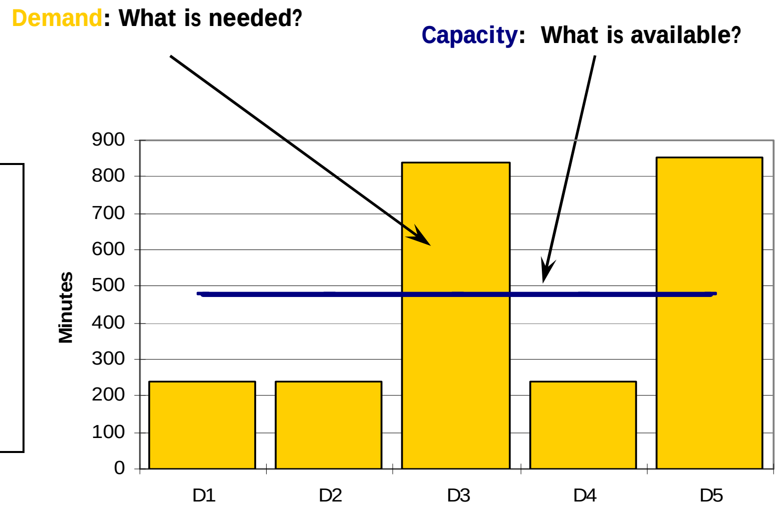


Exploit the constraint

40 hrs / week

P1 demand
51 on day 5
50 on day 3

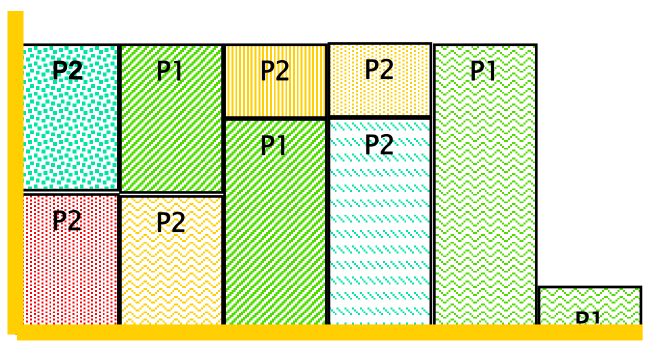
P2 demand
10 on days 1-5



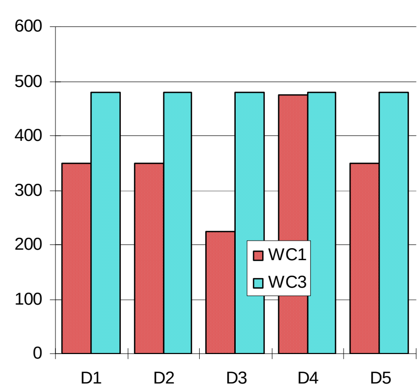
Once the drum has been identified, a detailed schedule is prepared to satisfy the customer requirements, resolving the peak loads.

The Drum Schedule

DAY	PART	QTY	MIN
1	P2	10	240
1	P2	10	240
2	P2	10	240
2	P1	20	240
3	P1	30	360
3	P2	5	120
4	P2	15	360
5	P1	40	480
6	P1	11	132

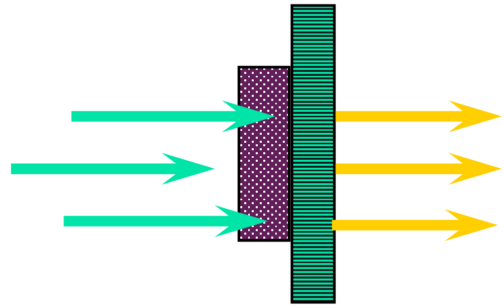


The impact on the non-constraints is to smooth out the load, because their processes are connected to the constraint resource.



The Buffer

The buffer is a period of time to protect the drum resource from problems that occur upstream from the drum operation. Its effect to provide a resynchronization of the work as it flows through the plant.



The buffer compensates for process variation, and makes DBR schedules very stable, immune to most problems. It has the additional effect of eliminating the need for 100% accurate data for scheduling. It allows the user to produce a "good enough" schedule that will generate superior results over almost every other scheduling method.

Since the buffer aggregates variation, it also allows to operate the plant with much lower levels of work in process, producing dramatic reductions in production lead times and generating a lot of cash that was tied up on inventory.

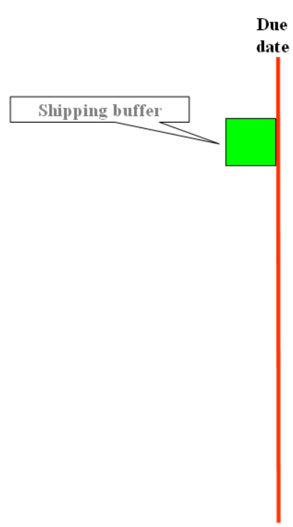
The "extra" capacity at the non-constraints helps, too. Since the plant is not overloaded with work it cannot do, the resources can "catch up" when problems strike, without affecting the drum or global throughput.

Synchronize to the Drum - Subordination

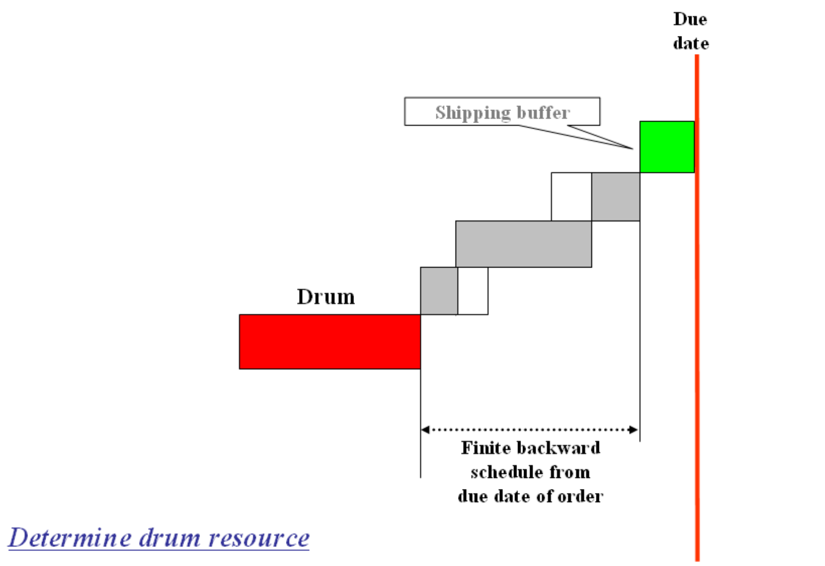
After the drum has been scheduled, material release and shipping are connected to it, using the buffer offset. Material is released at the same rate as the drum can consume it. Orders are shipped at the rate of drum production.

DBR Scheduling Algorithm

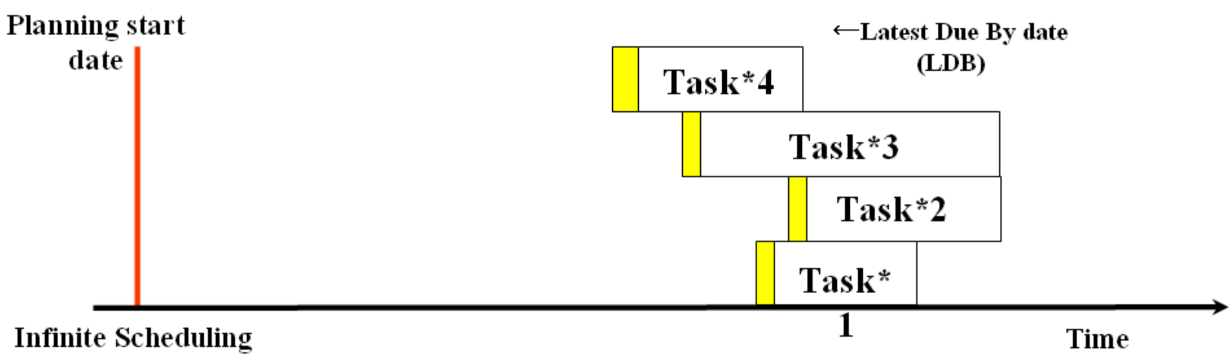
The process of scheduling the factory first focuses on the primary objective of the facility, to ship to committed delivery date. Thus we first find the due date of the order, and add a shipping buffer to create an "ideal" finish date with confidence.



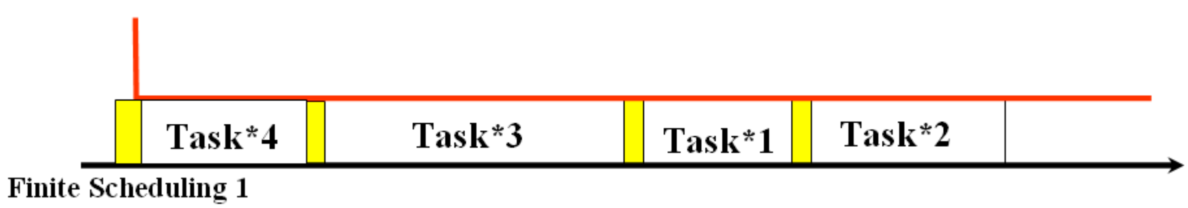
From this planned finish date, the order is backward scheduled to identify an “ideal” time to work on the drum resource, a “latest due by” (LBD) date.



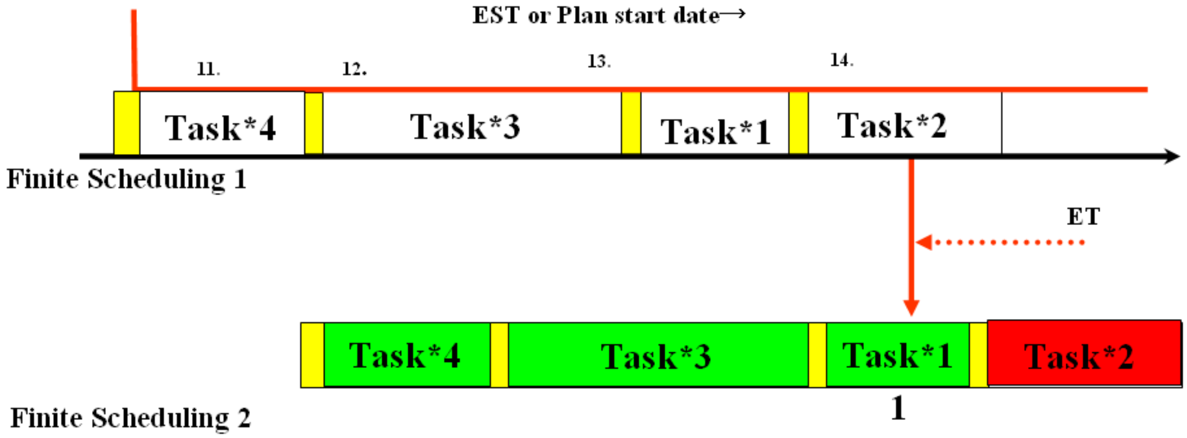
All orders are scheduled to fit on the drum using two passes; first, by assigning all batches an ideal placement on the drum schedule.



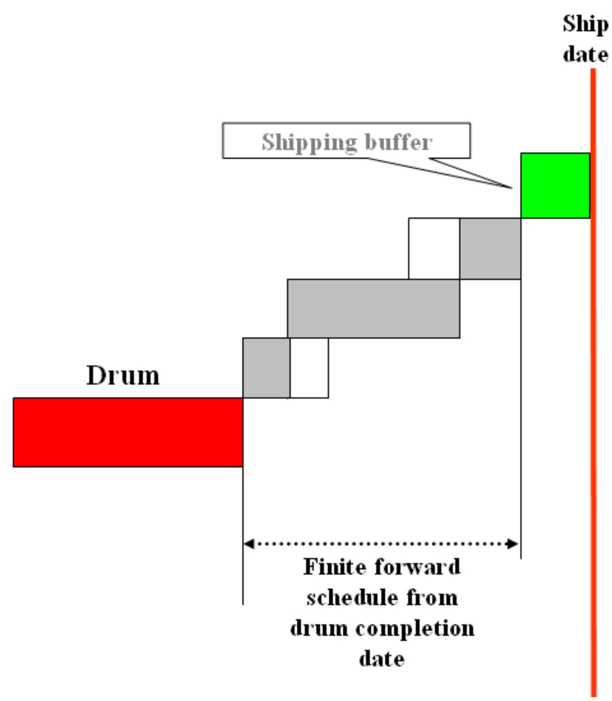
When the batch does not fit, i.e., there is another occupying its space, the batch is scheduled earlier in time so the order due date is not violated. This may result in some jobs starting before today, and not all jobs may be ready to start at the drum resource.



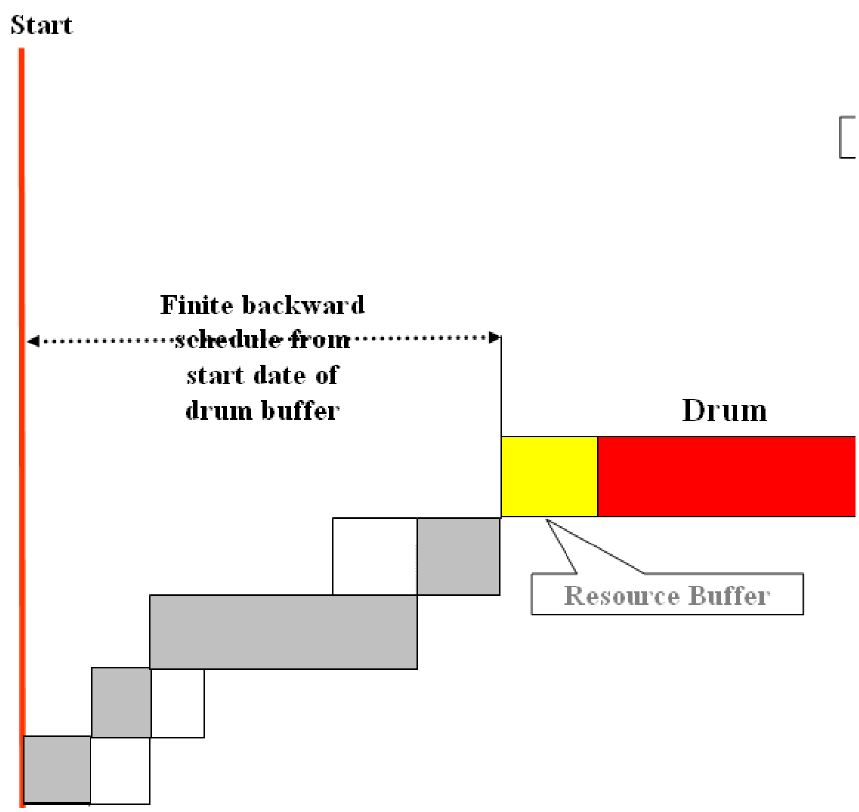
The drum is then forward scheduled to resolve these conflicts, and potentially late jobs are identified (the red batch).



After the drum is schedule, the operations after the drum are scheduled forward in time from the drum completion date.



Then, the jobs feeding the drum are backward scheduled from the start of the resource buffer.


Start
Finite backward schedule from start date of drum buffer
Drum
Resource Buffer