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What is new in Simplified Drum-Buffer-Rope (S-DBR)?

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The good old Drum-Buffer-Rope (DBR)

- DBR was developed in the mid 80s as a relatively simple, yet effective, production planning methodology.
- DBR centers on detailed finite capacity scheduling of the capacity resource constraint (CCR).
 - The rest of the resources were not scheduled and their activation was based on the schedule for the CCR and/or the due-date.
- DBR was developed under the assumption of getting orders from the sales, without truly impacting the committed dates, and coming up with the best planning possible under the circumstances.



Reminder on Drum, Buffer and Rope

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- Drum is the exploitation scheme for the constraint.
 - What to produce and the schedule for the CCR.
- Buffer is the protection scheme on the Drum.
- Rope is a schedule for the material release. Its objective is to keep the buffers intact and not allow earlier release of material than required by the buffer.



The distinction between planning and execution

- One of the tools to deal with uncertainty is to focus the planning on the truly critical areas.
- Leaving enough flexibility in the execution phase to deal with local disruptions without messing the whole planning and the expected objectives.
- This generic approach lies behind the DBR and the S-DBR planning methodologies.
 - The Drum is the main essence of the production planning.
 - Buffers belong to the planning as the mean to keep the planning intact.
 - Rope is critical to fully maintain both the drum and the buffers.
- Buffer Management sets the rules for the execution.



The main benefits of scheduling the CCR that we do not want to lose

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1. Being able to tie the Rope so that the CCR will not starve and will not waste its capacity.
 - Exploiting the CCR capacity.
2. Being able to know whether the delivery dates, given by Sales, are safe.
 - Proper subordination to the market.
3. Smooth the load on the whole shop to prevent too large temporary peaks of load.
 - Enabling the full subordination of the non-constraints.



Finite capacity scheduling of the CCR Is the focus absolutely right?

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- The focus of Operations is on the exploitation of the capacity of the CCR.
 - Many times it leads to problematic subordination to the market.
 - The identity of the client and the impact on the reputation are not always taken into consideration.
 - There is a huge difficulty to deal with urgent orders.
 - A policy of “adherence to the CCR schedule” makes it difficult to enter changes caused by customers who have new priorities.
 - **The result is that the response to the market demand lacks flexibility.**



Finite capacity scheduling of the CCR

Is it right for make-to-stock?

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- The need for better flexibility is especially noted in orders that are **made to stock**.
 - Because the true priority of a stock order is not known at the time of the scheduling.
 - The priority of stock orders depends on the finished goods stock versus the demand. This could change in a day.
- The current practice is to assign a date to the stock order and then base the CCR schedule on that date, like any make-to-order.
 - **The date is based on forecast.**
 - Many times the derived priorities of the schedule are wrong.



Finite capacity scheduling of the CCR

Three buffers to maintain

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- The CCR detailed schedule forces **three different buffers** to be implemented, without good priority mechanism between them.
 - The Shipping Buffer protects the due-dates.
 - The CCR Buffer protects the detailed schedule.
 - The Assembly Buffer – controls the material release of non-CCR parts.
 - What does it really protect? Isn't it just an extension of the shipping buffer?



Finite capacity scheduling of the CCR not always simple

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- In many cases the finite capacity scheduling of the CCR is especially complex.
 - dependent setups and other technical limitations that forbid certain sequences.
 - Time-per-batch operations, like ovens, that work on several orders together provided certain conditions apply to all orders.
 - Many machines, which are NOT identical, are the CCR.
 - CCR operations that feed other CCR operations.
- **Very few, if at all, existing DBR programs can schedule the CCR considering those complexities!**
And, is it really needed?



When one is used to focus on the one CCR

- When the market fluctuates, even a real CCR should have periods of low load.
 - Thus, at those times, the constraint is just the market demand.
 - Should we still **focus** on the CCR at those times?
- Sometimes the CCR shifts from one resource to another.
 - It could be because Sales took T/CU too seriously.
 - **The equilibrium is jeopardized** – all the subordination processes change
 - **A lot of data has to be checked, maintained and fed into the DBR software**
 - Note especially that **all the buffers have to be changed!**



Some Key Observations

- The **market demand is a major constraint** even when a capacity constraint resource is active.
 - Failing to subordinate to the market could lead to a significant dive down of the market demand.
 - Elevating the internal constraint won't improve anything unless the market demand is elevated as well.
 - In such a case how do we exploit both constraints?
 - Not disappointing the market.
 - Not losing too much precious capacity of the CCR.



The direction of the planning solution: the basic SDBR

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- As the market is the major constraint, let's protect the market with **just the shipping buffer**.
 - All materials are released based on due-date minus the shipping buffer.
 - The sequence at the CCR is **not** planned.
- The less detailed is the planning the more critical are the decisions taken at the execution.
- The role of the execution control is now focused on dictating the **right priorities on the floor**.



The direction of the solution: More focus on buffer management

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- Generally speaking every single order is given enough time to flow through the shop floor.
- The Rope ensures that only orders to be delivered within the shipping buffer time are released to the floor.
- At each work center, including the CCR, the sensible decision, which order to do next, depends on the state of the buffers of the relevant orders.
- Definition: **the buffer status of the order is the percentage of the buffer consumed.**
- The higher the buffer status is the higher the priority of the order. Buffer status above 66% is considered **“red”**.



The benefits of the SDBR direction

- Simpler to implement.
- Having just one buffer makes the priority list clear at all times.
- Maintaining much more flexibility to meet the changing requirements of the clients.
- Signals clearly that the major constraint is the market demand, thus even the CCR should subordinate to it.



Concerns / negative branches of using SDBR instead of DBR

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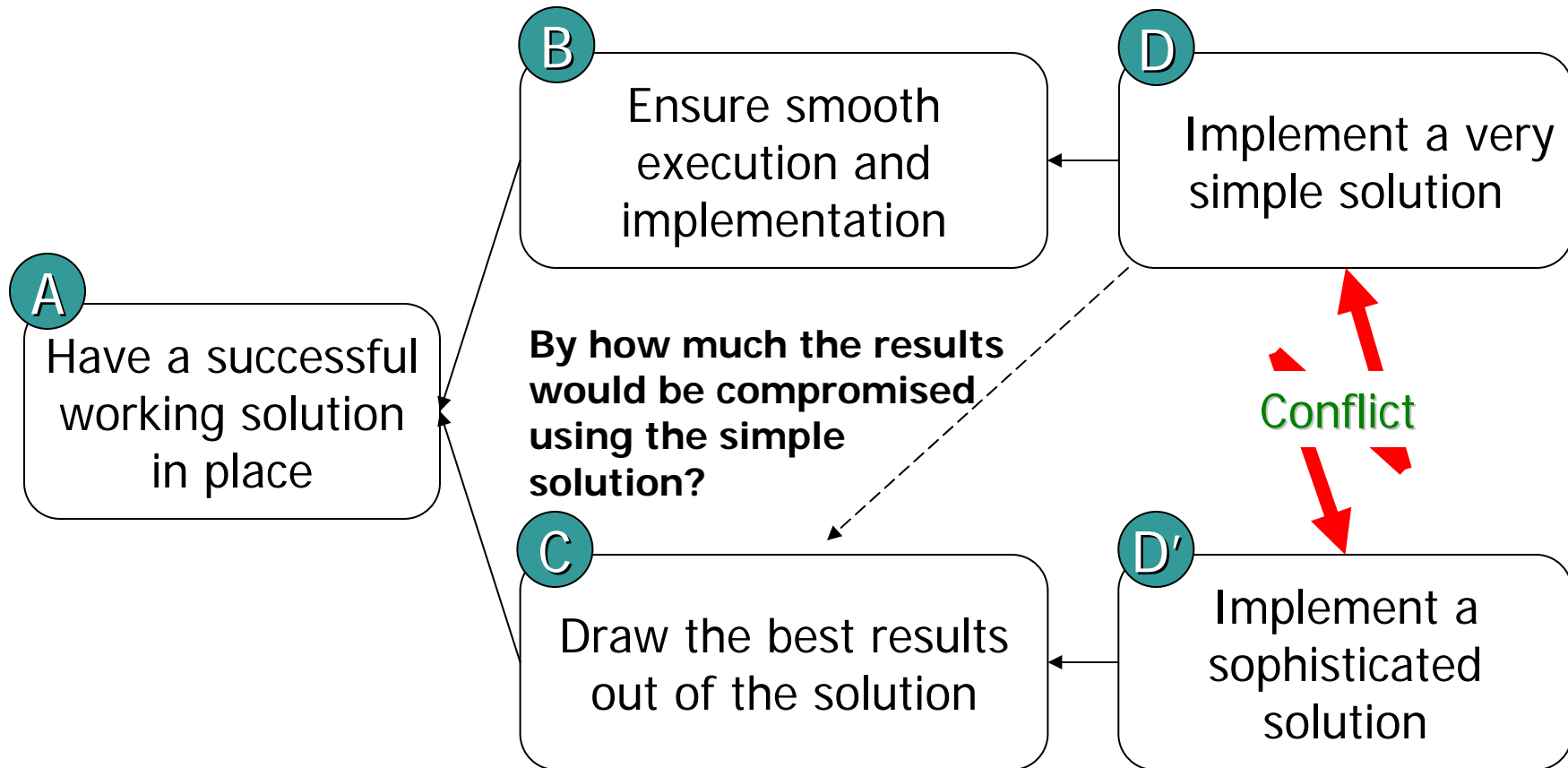
- 1. Failing to exploit the capacity of the CCR**
- 2. Overloading the CCR, thus causing disruption of the due-date performance**
- 3. Maintaining too large buffers, causing some materials to be released too soon**
 - This is the least concerning NBR and we won't discuss it

Do we agree so far?

Are the above your main concerns?



A common basic conflict to consider



Failing to exploit the CCR capacity

- Three types of failures to exploit the CCR.
 1. **Starvation**, there is enough planned work for the CCR to do, but none of it is ready at the CCR at this time.
 2. The sequence at which the work arrives to the CCR forces **waste of capacity** of the CCR.
 3. The CCR works on things that are not truly needed.
- The third type is controlled by the master production schedule, not by the CCR schedule.
- The second type is relevant only when **dependent setups** have a major impact.
 - In that case we need to make some changes to the SDBR.

Let's concentrate on how to prevent starvation in SDBR.



Preventing starvation in SDBR

- When the **market demand** is recognized as **the major constraint**, we expect that even the CCR be able to subordinate to the market.
 - Ensure excellent due-date performance, even when Murphy hits the CCR itself.
 - Be able to respond within the tolerance of the market.
 - All the above make it necessary to **maintain some protective capacity of the CCR itself**.
 - Hence, some very limited starvation does not impact the profit.
- The shipping buffer is usually long enough to provide enough WIP at the weakest link (the CCR).
 - Assuming the RoadRunner ethic is in place.
- The work at the CCR should be monitored daily.



Facing the second concern: overloading the CCR

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- Definition: The **Planned load** is the accumulation of the derived load on the CCR (the weakest link) of all the firm orders that have to be delivered within a certain horizon of time.
- The planned load is expressed as a number of hours/days.
 - it is **NOT** a description of the spread of the load over time.
 - Suppose we have only three orders in the backlog, estimated CCR time are: 50, 125 and 55 hours.
 - The planned load is 230 hours.
 - The sequence is not determined.



What does the planned load tell us?

- The planned load is a rough estimation of the **time when the specific resource would be able to work on a new order.**
 - Assuming the resource is able to work all the time without starvation.
 - Assuming the new order has no special priority relative to the other orders.
- When we monitor the planned load of the CCR we get a pretty good idea of the lead time.
 - The planned load plus enough safety for the downstream operations.



An example: what do we know on the environment just from what we see?



- The red bar shows the planned load of 192 hours of CCR work.
- The green bar shows the orders already reside at the CCR site.
 - This information is harder to get.
- We can easily assume the minimum safe lead time for a new order is around 240 working hours from now.
 - Assuming 40 plus hours are more than enough from the CCR to completion.
 - Assuming the new order could easily reach the CCR in 192 hours.

The difference between a finite-capacity schedule and the planned load

- On the face of it the planned load is a schedule.
 - It is similar to “forward loading” process.
 - But, there is no sophistication in the sequence of orders.
 - No efforts are done to validate the material would really arrive to the CCR on the time predicted by the planned load.
 - **The planned load should not be treated as a schedule** – it should not dictate any sequence the operator has to follow.
- The most important asset of the planned load is the **rough determination of the time a new order has to wait for the CCR.**



Dealing with the overloading concern

- The **planned load of the CCR**, at any given time, should be compared to the **standard lead time** required by the market.
 - Certainly we expect the planned load to be LESS than the standard lead-time.
- There is, yet, no guaranty that the load on the CCR would be smooth.
 - A cluster of orders to be shipped at the same date could be problematic.
- We need to take another step and **control the promised dates of deliveries** according to the CCR's planned load.



Promising delivery dates based on the planned load

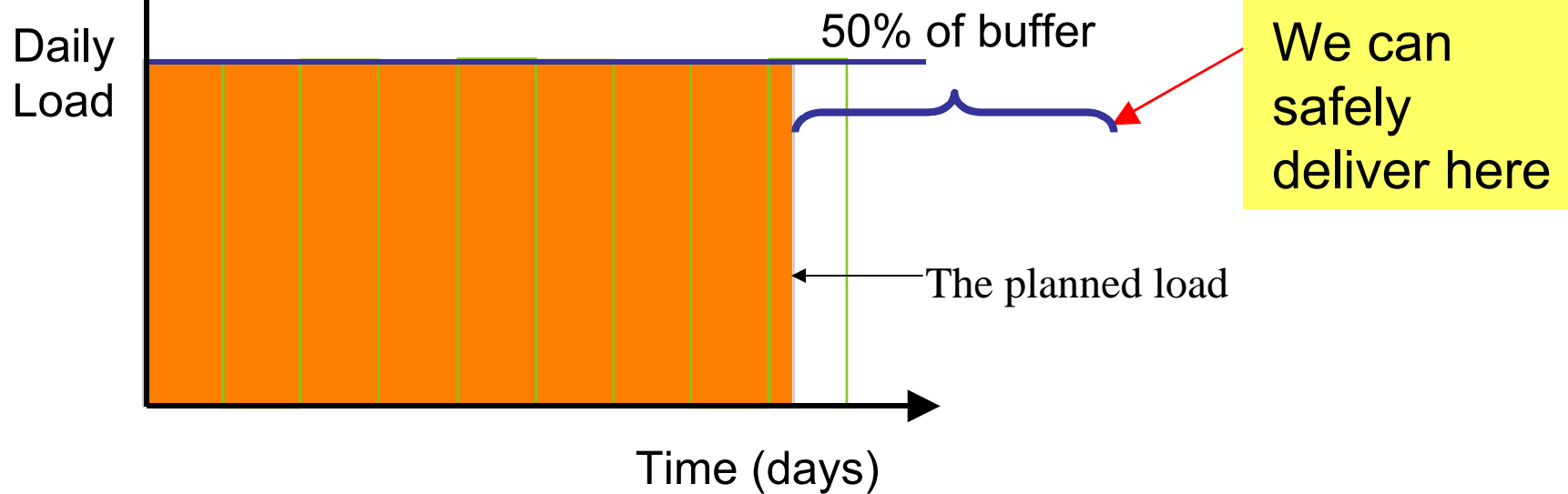
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- In order to achieve reliable delivery dates **Sales and Operations must synchronize their actions!**
- Instead of Sales promising delivery dates and then Operations trying to meet as many of the dates as possible, let's build a **mechanism to determine the dates that Operation can commit to deliver.**
- As the planned load is a rough estimation of the time a new order would be processed by the CCR, we should add a time buffer to the planned load and get a “safe delivery date” for the order.
 - Let's decide to add $\frac{1}{2}$ of the total shipping buffer.



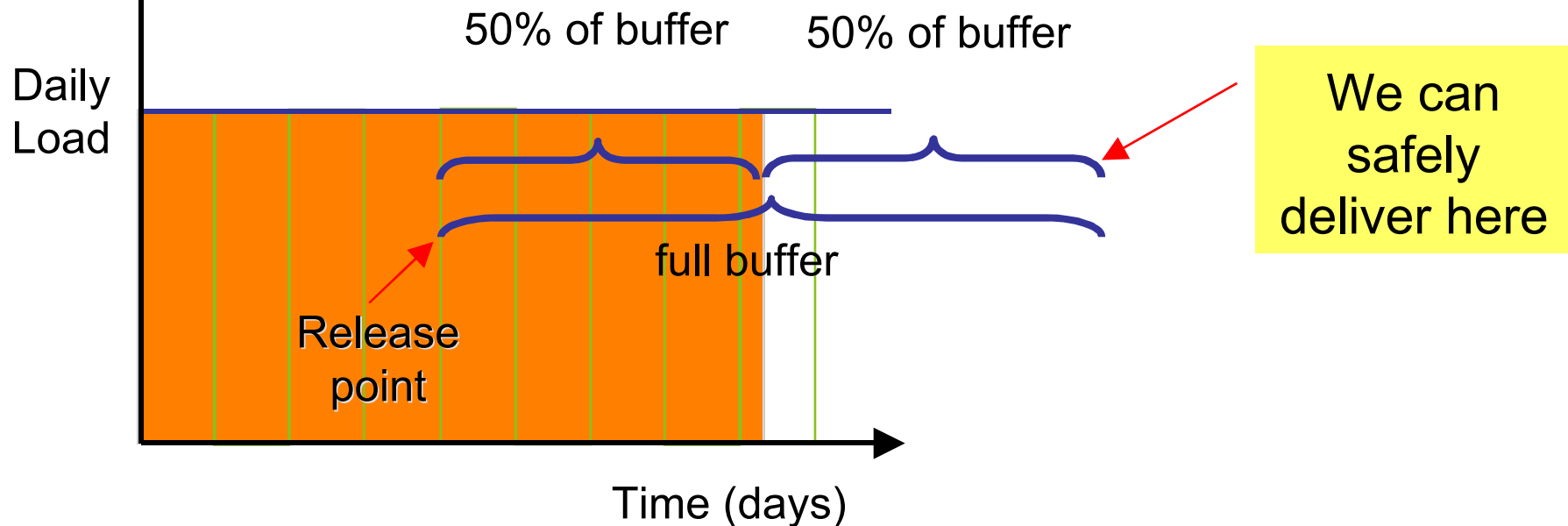
This is how it looks like

All the required CCR load for the orders that have a committed delivery date have been accumulated here.



And this is how we tie the Rope to the Planned Load

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The same approach, assuming the new order would be processed roughly at the current planned load time, leads us also to release the raw materials at half of the total shipping buffer before that time. All in all we have a full buffer between the release and delivery.



The dilemma of quoting short lead-times

- When the planned load is close to the standard lead-time or longer, the safe-date is later than the standard lead-time.
- But, what happens when the safe-date is much earlier than the standard quoted lead-time?

Should we quote short delivery times whenever possible?

- On one hand we could attract more clients now.
- On the other hand, **the clients would expect those short deliveries as the regular service also in the future and for the same price.**



The dilemma of quoting short lead-times

- The solution is offering a special service for very fast deliveries for a considerable markup, while keeping the regular price for standard times that are fully reliable.
- Then we have to deal with orders with very short lead-time, while the regular orders have much longer lead-times.



Dealing with more than one standard lead time

- Defining the problem:

When a company has different commitments to lead times, then promising reliable due-dates is problematic because not all the orders are known at the time.

- This problem includes different categories:
 1. The Rapid Response viable vision template.
 2. Commitment to a strategic client to fast response.
 3. Maintaining product mix with highly variable standard lead times in the industry.
 4. Items that are made to stock.





Managing the reserved capacity

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- **How much reserved capacity we need?**

- Like in the determination of buffer size a good initial guess is all we can hope for.
- Then, we need to look for a way to assess whether the current reservation level is about right.



What do we lose from determining a too high reservation level?

- **Do we lose precious CCR capacity** when we have reserved too much capacity for the “special” items?
 - We do not really mean that every day the CCR will work X% on the special orders and (100-x)% on regular orders.
 - The CCR should work on **whatever is available**, taking into account the buffer statuses.
 - Thus, when there is not much work for the special orders, then most regular orders would be processed **earlier than predicted**.
 - We are not going to move the due-dates backwards.
 - It is easy to move the release of materials backwards when it becomes evident the CCR would be able to process them earlier.



What do we lose from determining a too high reservation level?

- When we plan with high reservation of capacity the **safe-dates are too conservative.**
- So, when the safe-dates lie beyond the standard lead-time, we might lose market demand.
- Then we lose something substantial, which makes it worth to re-check the amount of reservation.



What happens when the reservation level is too low?

- The high number of special orders would push the completion of regular orders later in time.
 - As long as the calculated safe dates for regular orders are earlier than the standard lead times, the situation is under control.
 - When the safe dates are very close to the standard time, and too many special orders arrive, then regular orders are pushed into the red, and the reliability reputation is compromised.
 - Then there is a need to increase the reservation level, causing the safe dates to be later in time, possibly beyond the standard time and causing losing some sales.



Tools for managing the reservation level

- Monitoring the two parts of the planned load
 - The first part is the regular planned load, consisting of all the regular commitments, and how the front of the planned load stands relative to the standard lead time.
 - The second part contains the special orders assuming only the reserved capacity is available for them and how close they are to the short lead-times references.



Tools for managing the reservation level

- Eventually we need to control the overall capacity and how it is used for both regular and special orders.
- For that we need **full planned load** for the shortest lead-time (like super-fast).
 - **All the orders that need to be worked on within the short lead time.**
 - The planned load needs to show some excess capacity within the short time frame.



The complication of dependent setups

- Dependent setups means **significant** dependency of the setup time on the **previous** product processed at the specific resource
- The first question to raise: if the machine would process according to an arbitrary sequence, **would it become a true bottleneck?**
 - If the answer is NO, then there is **no problem whatsoever** to implement SDBR/BM without distortion.
 - Many times it is worthwhile to invest in adding capacity, or coming up with engineering innovation, to get rid of the negative impact of dependent setups.
 - Otherwise we have to yield to **a preferred sequence** imposed by the dependent setups.



Regarding dependent setups

- A dependent setups environment is pushed to use a preferred sequence encompassing all the products.
- The preferred sequence is not necessarily a well-defined unique sequence, but **a general sequence between families of items** that within the family the setup is relatively short.
- The assumption is that violating the sequence would turn the resource into a **bottleneck**.
- The problem is to be able to quote a reliable due-date that would not be too long.



Dealing with dependent setups

- The approach is to respect the preferred sequence for the categories of products, monitor the planned load per category, and maintain an overall time buffer to enable late introduction of urgent orders.
 - The details for the proposed procedure appears in a paper by Eli Schragenheim and can be obtained by sending an email to:

eli.schragenheim@goldrattgroup.com



Summary

- S-DBR is appropriate for the vast majority of the manufacturing environments.
- We have focused here on S-DBR in make-to-order environments, but the approach also covers make-to-stock and hybrid environments.
- The market demand is the major constraint to subordinate to.
- Capacity monitoring of the CCR is critical and can be easily done through the planned load.



Summary

- Buffer management is a necessary condition for successfully implementation of S-DBR.
- Another condition, which is necessary for maintaining full reliability of delivery, is to have Sales fully integrated with Operations
 - Operations provides realistic safe-dates, which are followed by Sales.
 - Managing reliability for urgent orders is also possible, but requires some capacity reservation.
 - Without truly losing precious capacity from the CCR.



