HOW TO BUILD A RELIABLE DELIVERY PROCESS

Building a System That Delivers Orders on Time, in Less Time

The order fulfillment process is often treated as an afterthought by managers, resulting in poor delivery performance and chaos on the shop floor. This paper presents a method for creating a reliable order fulfillment process, which when applied properly results in every order delivered on time, in less time, with minimal management intervention.

PINNACLE STRATEGIES

How to Build a Reliable Delivery Process

Introduction

Despite the advances in information technology and systems, most plants manage the process of prioritizing and managing the production of customer orders as if it were an art, approaching the task as a craftsman would, rather than treating order fulfillment systemically, using a robust process to manage and control production.

Rarely is the order fulfillment process treated as a process unto itself, with sequential steps and appropriate controls. Instead, order fulfillment is treated as an independent group of production steps, delegated to the resource owners (the plant) who do the work. Typically, they have little incentive to deliver on time, but rather, their incentive is to be "efficient". As a result, the important task of improving on time delivery is an afterthought in process improvement efforts. In the end, orders are thrown over the "wall" from the sales function to the production function, like hand grenades that might explode into a product that satisfies the customer. The result is chaotic efforts, late deliveries and unhappy customers.

Delivering On Time

This paper introduces a process, which results in every order delivered on time, in less time, with minimal management intervention.

The process is a set of tools and processes to schedule and manage your order fulfillment efforts that involve planning, management, and ongoing improvement. It results in:

- 20% increase in throughput
- 25% shorter lead times
- 15% more sales
- 20% more cash flow every month
- Improved labor productivity of 15% or more

> *The Beauty of the changes we have made has been that it was accomplished with a low tech common sense approach that yielded nearly immediate results of a magnitude I would not have thought possible. Two year increases in billings of 28% and 40%, with increases in our bottom line of five fold, and three fold. In short, the process has totally changed the look and feel of our business, and made it a better place to work."*
>
> Bob Page, President, Graphics Systems

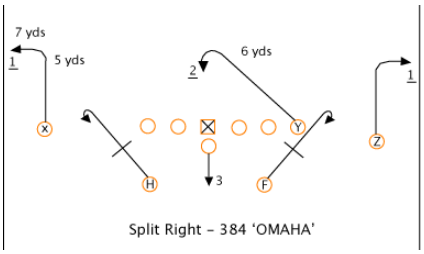
The process people to synchronize their day to day efforts towards the delivery requirements of the customer, which results on time delivery of the customer's order, with less effort and management intervention.

The system has six parts:

- Planning
- Synchronized Execution
- Teamwork
- Order Promising
- Buffer Diagnostics
- Sales & Operations Planning

PLANNING

INSTALL A MASTER SCHEDULER



A single, master plan drives the process and the planning process is the responsibility of the master scheduler; he/she owns the process. While that may seem like an obvious statement, to many, it's not. Those organizations do not employ a master scheduler or even have a formal planning and scheduling process – at least a process in the sense of a rigorous series of steps with checks and balances. A master scheduler manages and controls your organization's capacity in the same way your controller manages your bank account. He or she writes "checks" against the capacity "balance" and ensures the customer needs can be met without overdrawing the account. Your capacity is as valuable to the business as your cash. Someone must be responsible for monitoring and managing this resource.

MAKE THE SCHEDULES REAL

The master scheduler must create a realistic schedule, one that can be accomplished, not a wish list or a club to beat up the plant. While that also seems obvious, in many companies and organizations the schedule is used as a club to point out the shortcomings of production, saying in effect, "If production would follow the schedule, everything would be fine!" Equally ineffective is the schedule presented as a wish list, "Here is everything we have promised, try to get everything out." Having a clear plan that has credibility is critical to driving execution behavior.

The schedule is a statement of the strategy; a "best" basis from which to execute; the strategy to win.

Drum-Buffer-Rope (DBR)[1] gives you an edge in maximizing flow and productivity. Furthermore, DBR schedules are very reliable. The reliability of DBR schedules are what make them useful for creating a realistic model for execution and a reliable tool for decision making.

> *The key to the reliability of DBR schedules is their focus on the main bottleneck resources of the system.*

The key to the reliability of a schedule built using DBR is its focus on the main bottleneck resource of the system and its built-in protection against common-cause variation (buffers). It doesn't try to plan every resource interaction in the system, so the plans it produces are much more reliable.

The planning process itself is also simplified. Since the bottleneck determines overall system capacity, planning is centered on that resource only, providing a simple plan that models the entire process.

PROTECT DELIVERIES WITH BUFFERS

Time buffers protect the delivery dates; they are the shock absorbers that protect the plan from process variation. Just as shocks on the heels of running shoes absorb the variations in the running surface, time buffers absorb the normal variation that exists in every process.

Some people don't like the idea of adding time buffers to the plan — they perceive it as waste. However, time buffers are a necessary safeguard against late deliveries. Don't skimp on them by trying to be "Lean"; the goal of your order fulfillment process is to make the customer happy not efficient. Demonstrate that your order fulfillment process is under control by maintaining high delivery performance, *then* work on improving the process.

[1] See appendix for explanation of Drum Buffer Rope

Time buffers aren't just added randomly to any resource or area; they must be added to strategic locations in the process. First, buffers protect the drum resource and thus, the output of the entire process. Second, a buffer protects the due dates of the orders. This assures that all orders are protected from variation.

Synchronized Execution

The Production Manager Owns Execution

Often, the responsibility for execution is split up among functions or it's not clear who is responsible for the entire process. There can be no question of who is responsible for execution. Having a single person accountable for the entire order fulfillment process provides leadership for the entire execution team. The production manager is responsible for executing the plan. In effect, he is the "Race Boss" of the order fulfillment process. The scheduler creates a plan that *can* be done; the production manager *gets* it done.

Focus During Execution

Since the planning is centered on the constraint resource (the drum), the main focus of production is ensuring this resource actually accomplishes the plan. Flawless execution of the schedule at the constraint resource (the drum) sets up the flow for the rest of the team, creating a synchronous current of work. If that resource executes its schedule properly, the other resources can achieve their schedule with little management intervention.

Even with a carefully thought out plan, people don't always follow directions precisely — you have to watch for compliance. A critical part of controlling execution and early identification of problems is accomplished by monitoring schedule conformance.

Act Early

We know that even the best plans don't always survive reality. When things don't work, you have to do something! It's amazing how many people watch the numbers, notice that performance is not satisfactory, but never act to correct it! Measurement is not enough. You have to respond to the measurement.

We talked earlier about inserting buffers into your schedules. Managing these buffers assures that exceptions do not become emergencies. By tracking the buffer remaining, you can get a fix on the remaining time in the system to compensate for variation, giving you an opportunity to create early action. The buffer management process shows you the almost-late orders, providing you with an early warning so you can act early.

Release on Time, Deliver on Time

Many people think that early release means early finish. To the contrary, early release means *late* finish! Work released into the system too early creates confusion & chaos by causing people to do work that is not needed now, delaying what is really needed. While your resources are happily "getting ahead" on some work, the capacity that's needed for more urgent work is consumed forever, creating overloads on downstream resources and the scramble to finish on time — not to mention the confusion of trying to figure out which order out of 30 is supposed be worked on now, deciding wrong, and then finding that vital order when it's inevitably too late.

Orders released too late are — well, late!

TEAMWORK

The entire team must participate to make delivery reliable. It isn't just the operations or production departments. Perfect execution is a commitment for the whole organization.

Involving people begins with measuring the right things; setting the right expectations for performance. Management decides what the measurements are; what gets measured gets done.

There seems to be so many different things that are measured, that it's hard to pick *one* single measure that expresses progress towards the mission of the organization. This is analogous to a sports team that is unaware of the goal of the game. We agree that the main objective is to score more points than the other team. If we do, we win. The offense scores, the defense prevent scoring. Each sub-group has its own measurements, but the objective of the game is always foremost in player's minds.

Reliable delivery — not efficiency — is the goal of production. The purpose of production is to make products for sale, not to spend as little money as possible. But, looking at the way some managers behave, you would think that the opposite is true! Think about a restaurant. Why should we have a kitchen in the restaurant? It makes the food customers eat. It's the same in manufacturing. Why does a factory exist? It makes things to sell! The number one goal for the system is customer satisfaction.

Management must establish on time delivery (to commitment)[2] as THE key performance indicator. Research demonstrates that this component of your service is the most important gauge of customer satisfaction. If you're doing well here, you can be confident your customer satisfaction score will be high. It's also an indicator of the stability of your order fulfillment system. Good on time delivery performance indicates a stable system, one that is under control. If you can't keep your promises, your system is out control; it's unstable.

The point of the measurement is to create a unity of purpose. What you measure tells the organization what is important. Without a common purpose, your team can never be unified.

PROMISE TO BE ON TIME

Being on time begins with setting the expectation with the customer, promising delivery when it can actually be completed. Order delivery promising must reflect available capacity. Just as you manage cash, you must carefully manage the capacity of your business. There should be a process to commit the capacity, just as there is a process to write checks. Incoming orders are demands on your capacity account. Who is accountable for ensuring that the account doesn't become overdrawn?

Sometimes, there will be demands that exceed your capacity. A rush order. An important deadline. An escalation and reconciliation process makes certain that both the customer and the business are satisfied. The order promising process is a *negotiation* to find the real needs of the customer and determine how to meet them profitably.

QUICK RESPONSE

A necessary part of the promising process is the requirement for a quick response process. This process ensures that emergency orders are handled properly, and if possible accommodated. Customers have emergencies. They sometimes

[2] OTD is measured as the number of orders (whatever you consider an order to be, e.g., line items, complete orders, or part numbers) that shipped on or before the promised delivery date divided by the total number of orders shipped. So if you shipped 70 orders on or before the commitment date out of 100 orders shipped, your OTD is 70/100, 70%.

want a product faster than you normally produce it. How do you handle this? You want to find as many ways as possible to say "yes," but not every emergency is one to which you should necessarily respond. Is the rush order for someone who has never ordered from you before? Will this order be the beginning of a relationship or is it merely a one time request? Or, is the order needed by a regular customer who buys a significant amount? Should there be a difference in how you respond? Does the customer service representative decide or is it up to the account manager? What if overtime is required? Who can authorize the expenditure? The scheduler? The plant manager? The responsibilities for answering these questions and the process for making the decisions must be spelled out and agreed on before you get the call. Otherwise, you may have one person making promises, but another is accountable for the results.

An escalation process keeps everyone honest; preventing you from saying "no" when you should say "yes." Sometimes, the customer wants to have the product but plant capacity is already booked. What then? How is the customer's voice going to be heard? The reconciliation process escalates the request to the next level of management.

Buffer Diagnostics Reveal your Opportunities for Improvement

Buffer diagnosis is the process of reviewing your "almost late" order events and finding the resources that are causing these events.

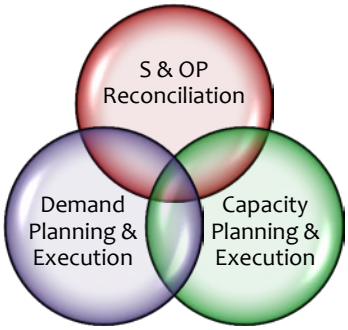
Regularly gather snapshots of the state of your plant; your buffer status. Which parts are almost late? What resource is causing it? Compile these snapshots into your database. They become a documentary of your plant's performance.

At least once month, formally look at your film. Which resources are causing the most disruption? These are the ones that will become your next bottleneck — the one that affects your customer.

These resources are the ones eligible for improvement efforts. Without a targeting mechanism like buffer diagnostics, you are shooting in the dark.

Sales & Operations Planning

The glue that holds this all together is the reconciliation processes. At the top level, the sales and operations planning (S&OP) process integrates the demand and capacity planning for the business. The schedule approval process is the key to getting buy-in, ensuring timely decisions are made and early action is taken to satisfy the customer.



The processes are owned by the process owners – production for the execution schedules and the general manager for the sales and operations plan. The master scheduler manages the processes, being accountable to the process owners.

The essence of the process is to have management reconcile the demand forecast to the planned capacity, making adjustments as the business requires, BEFORE the customer is adversely affected.

Demand Forecasting

Producing a demand forecast allows you build a model of your business. Producing a forecast of capacity requirements allows you to see what types and approximately how much capacity you'll need. Once you have a demand forecast, you can identify what types of equipment and skills you'll need to satisfy the market.

Having a forecast is not the same as having a plan. The forecast and your ability to respond to it have to be reconciled. Some tradeoffs are inevitable. You can't build a new plant in a day; you can't open a new market in a month. Therefore, a process must be implemented to rationally reconcile the demands of the market with the availability of the capacity.

Implementation

The process has been proven in plants all over the world. However, it is a radical change in how the process is managed. Not everyone gets the results.

There are two prerequisites for a successful implementation:

Management maturity: management must be prepared to make the commitment to change and see it through. They must be able to *lead* the implementation through word and deed.

Mature sales organization: the organization must be ready to capitalize on the improvement in operations. The sales organization must be ready to be aggressive in capturing the additional orders based on shorter lead times and improved reliability.

Results

Traditionally, managers devote little attention to how the order fulfillment process is managed. As a result, the process is chaotic, inefficient and simply doesn't do its main job of delivering product to customers on time.

> *"Gross profits from operations increased 174%"*
>
> *Joe Merritt, President, Dixie Iron Works*

The process causes people to synchronize their day to day efforts towards the delivery requirements of the customer, which results in on time delivery of the customer's order, with less effort and management intervention.

In addition, the system delivers significant financial benefits.

Increased Throughput

The process increases throughput by:

1. Improving the productivity of the bottleneck resource.

   Since overall capacity is governed by the bottleneck resource, focusing at this resource results in more capacity. More products are produced at the bottleneck, so more comes out at the end of the process.

2. Elimination of wasted effort.

   Through improved synchronization, resources don't waste capacity producing items that will not be sold.

Reduction of Lead Times

Process lead times are reduced by eliminating excess work in process and improved focus in execution to pull work through the system. Every order is delivered in less time.

Improved labor productivity

Less waste and shorter lead times mean higher output per day, week and month, with fewer resources. A stable process means fewer emergencies, leading to a significant reduction in overtime charges.

More Sales

By reducing lead time and improving on time deliveries, the organization can capitalize on sales opportunities that were previously lost. In addition, the reduction in lead time creates a higher *rate* of output, boosting revenue.

Improved Cash Flow

Shorter lead times mean less work in process inventory invested in your system, yielding a one-time boost to cash, converting essentially dead inventory to cash. It also means a shorter cash to cash cycle. Your business can run on less investment.

Higher Throughput, plus more sales, plus better productivity equals more profit! More cash to keep.

Introduction to Drum Buffer Rope (DBR)

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 controls the rate of throughput for the system. This is the "drum", which sets the pace for all other resources.

Buffers are strategically placed blocks of time in the plan. Their job is to absorb variation and protect the output and performance of the system.

The rope is a pull mechanism that synchronizes the activity of the entire system to the drum.

Planning and execution behaviors are focused on maximizing the output of the drum, protecting it against disruption through the use of buffers, and synchronizing or subordinating all other resources and decisions to the activity of the drum using the rope mechanism.

The Performance of the System is Limited by Very Few Variables

Using DBR begins with one underlying assumption; the performance of the system's constraint will determine the performance of the entire system. Think of a chain as an analogy for your system; a group of resources and operations linked together in a sequence of steps that must be performed in a certain sequence. No single "link" can achieve the purpose of the system without the collaboration of the other links. So what determines the strength of the chain? Everyone knows the strength of the chain is determined by its weakest link. What determines the performance of your system? 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. Truly, there are very few independent resources, the system is governed by dependency relationships and its performance is determined by the "worst" performing link. This insight is what gives the DBR system its effectiveness. We don't need to focus everywhere to improve the performance of the system, only a few variables affect the process. Let's work on those.

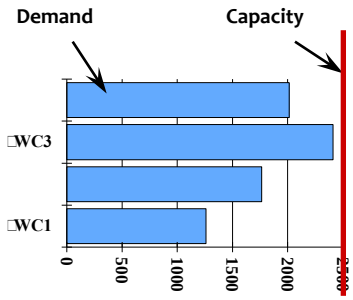
In order to improve the system performance, we optimize the weakest link; the constraint or drum. All other resources are subordinated to that. In scheduling terms, we

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 Scheduling Problem

Loading Occurs By Resource, Not In Aggregate

Not all capacity is created equal. Resource capabilities are not universally interchangeable. Therefore, this limited flexibility must be taken into account in planning & execution. Only a few resources determine system capacity.



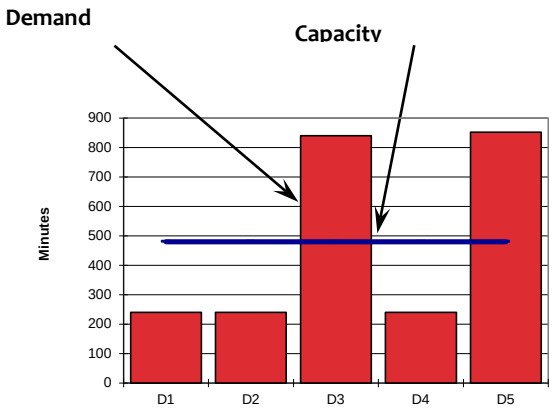
If you look at the aggregated demand on a department or organization, you could miss the true state of the system, mistaking an under-load in the aggregate as an under-loaded state, allowing for overselling the capacity or adjusting capacity downward and affecting delivery performance. The aggregate view of, for example, 1000 hours available in the factory versus 880 hours of demand doesn't adequately describe the situation.

In the chart to the right, notice that most work centers have extra capacity, while work center 3 is fully loaded and cannot accept more work. The true state of this system is that it is full and cannot accept more work that involves WC3.

Loading Occurs By Time; Peak Demands

Demand on resources occurs at a specific time. Even though you may have enough capacity during a specific time period, variation in processing or product mix can cause shifts in demand that prevent you from achieving on time delivery. A monthly or weekly aggregate view of demand may not be sufficient to take action and deliver work on time.

For example, you may have enough capacity during a given week to produce all the demand, but Monday and Tuesday are under-loaded, while Wednesday is overloaded. You can't go back an recapture that capacity. Suddenly, you'll find yourself in an over-load situation that demands you work overtime or have late deliveries.



To solve this problem, most managers will offset release by a fixed lead time. However, this doesn't really address the problem; it just moves the peaks of load to a different. Forward scheduling approaches will not "see" the peak until it's too late, so it's necessary to find the peaks before they occur in reality so they can 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.

The Drum Buffer Rope Solution

Identify the System's Constraint

The first step is to identify the constraint resource that will be the drum. The drum is typically the most heavily loaded resource (or work center) in the system. It can also be easily identified by the two characteristics of a bottleneck: blockage and starvation. Those resources upstream from the constraint will have plenty of work and the constraint resource is likely to have the most. Those resources downstream from the constraint are likely to have little work or suffer from frequent shortages.

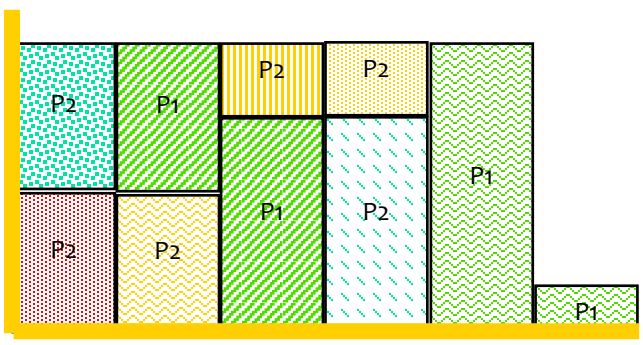
If you can't find a single resource that stands out as your weakest link, pick a likely candidate for the drum and move on. The real constraint will appear soon. If you've made an error in picking the drum, it's easy to correct.

Maximize the Constraint

Once the drum has been identified, a detailed schedule is prepared for the drum resource 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

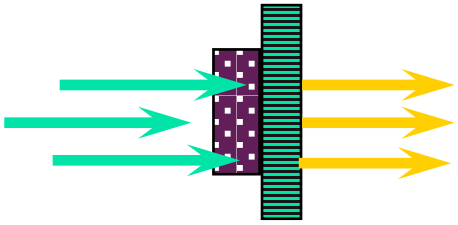


Introduction to Drum Buffer Rope (DBR)

The Buffer

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

The buffer compensates for process variation and makes the schedule stable. 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.



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

The Rope

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.

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