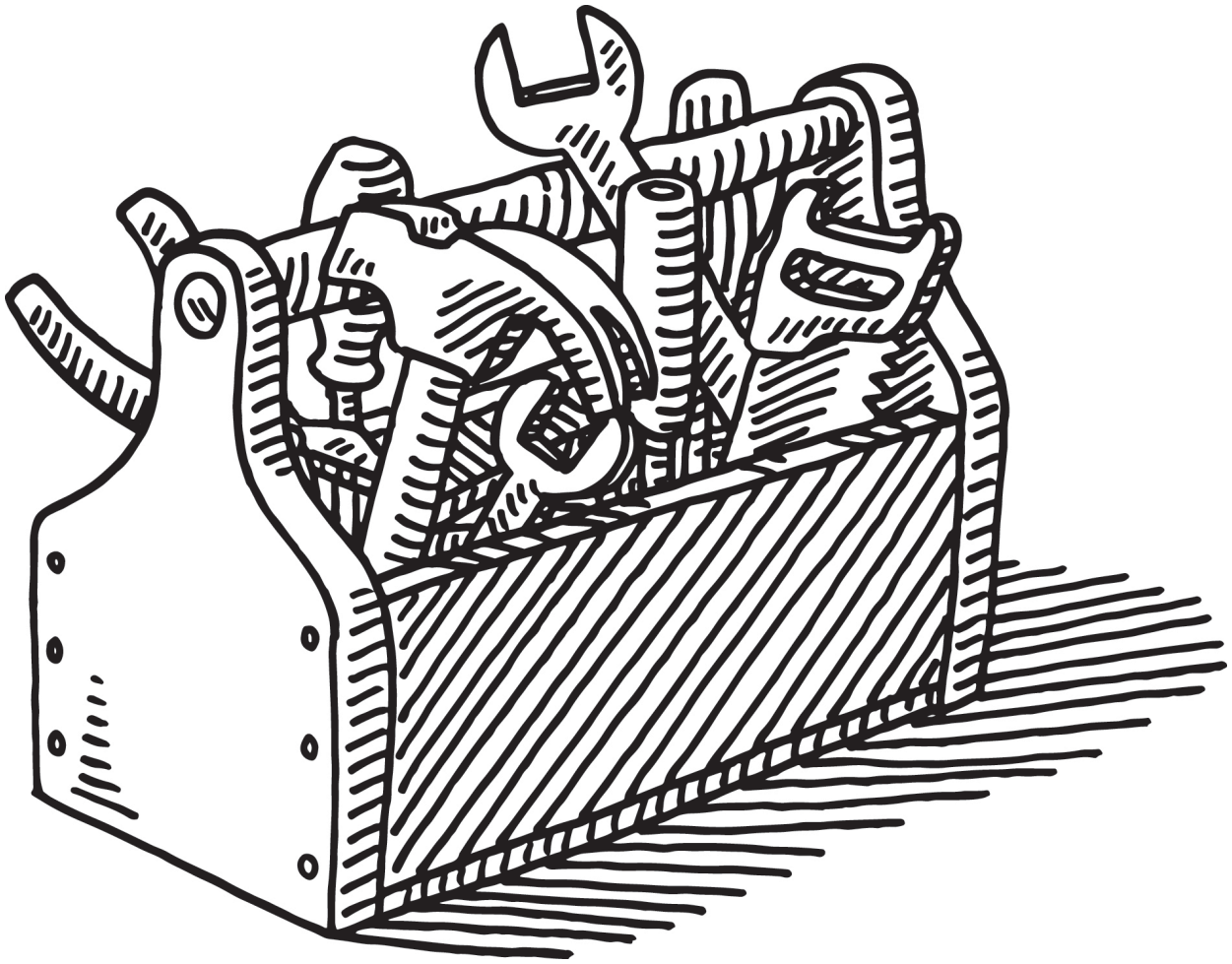
OLIVER WIGHT PAPER series

Master Scheduling

How to Optimize the Production Scheduling Toolbox



Imagine the **possibilities**,
realize the **potential**.®

Introduction

Eric and I have been teaching together for ten years. We have noticed cycles. At one point we watched our semi-annual public course on Master Scheduling dwindle to a class size of six, then we saw it swell to bursting – with over forty participants per class.

We are a couple of Supply Chain guys, so what do we know about why class size has such swings? Well, not a lot. Trends like class size dynamics and variables are not our forté, but we do know quite a bit about trends in Class A companies. Here are some trends we've seen around Master Scheduling and some common challenges that drive people to related classes.

Watch

There are three main trends that drive professional schedulers to our growing Master Scheduling classes.

Here are two of those trends:

1. Entropy: Companies see a need to take control of the supply chain. Entropy has taken over and it's time to take back the reins.

2. Revolt: Customers are not just frustrated by poor delivery, they also want everything on-demand and are increasingly intolerant of long lead times (and they shop like it!)

A Surprising Trend

There's one more reason we are experiencing a surge in interest in Master Scheduling: Companies we've seen recently are leaner and, as a result, running out of capacity. Most of these companies are engaging in IBP or Integrated Business Planning – a great start, but let's look deeper.

As we know, Integrated Business Planning creates systems to allow for better capacity utilization and alignment to company growth plans – but IBP occurs at a much higher level (e.g. resource requirements planning) than the nuts and bolts of rough cut capacity planning and its effects.

IBP Definition

Integrated Business Planning is a decision-making process to align demand, supply, strategy, portfolio, and resulting financials over a 24+-month rolling horizon.

Master Scheduling should be addressing that gap, by optimizing utilization and ensuring that resources are directed to the right areas.

What Does a Master Scheduler Do?

Imagine that IBP plans your trips for the next two years and every month looks at your progress and realigns or updates the places you would like to visit next. That's a great "big picture tool." Master Scheduling then puts the specific directions to your destinations into a step-by-step plan for the next three months. It is these specific plans that enable travelers to say, "At a high level that's where I want to go, but now I know if I am flying, driving or walking – and where to have a boat ready just in case!"

In other words, master scheduling is how you're going to get there.

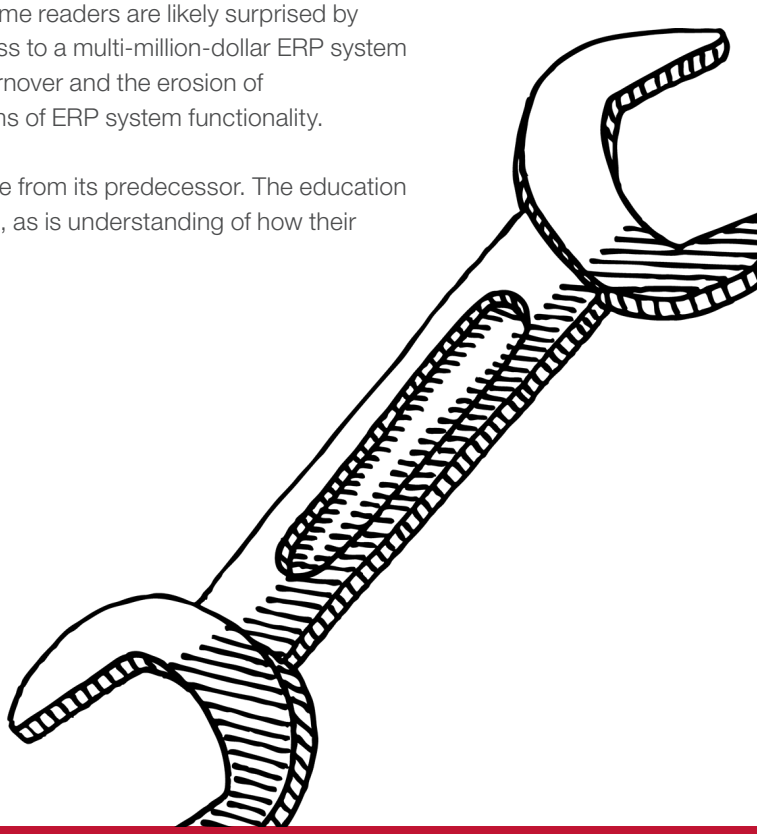
The process has been around since the 1970s – it is not new or unproven. So why don't more companies master schedule?

Whatever Happened to...?

We find that most companies had a Master Scheduling process at one time. It was fashionable to implement Master Scheduling in the heyday of Material Requirements Planning (MRP) and MRPII…It was just the way to do things. Through turnover, time, and the influence of technology, the process atrophied to a role of the Master Scheduler whose job is to release Work Orders for the shop floor. Typically, this person does more expediting than actual planning. Where any planning is done usually turns out to be in a spreadsheet held (and often sporadically updated) on someone's hard drive, unshared.

Another common reason we hear from companies for not master scheduling is, of all things, the Enterprise Resource Planning (ERP) system. We often hear feedback saying, "Our system doesn't do this or that…" While this may or may not be true for some antiquated or homegrown systems, it is generally not the case for the big ERP software players. The basic functionality in support of Master Scheduling likely exists, but it hasn't been turned on or configured properly. Some readers are likely surprised by this. Why would someone use a spreadsheet when they have access to a multi-million-dollar ERP system provided by their employer? Once again, the reason is related to turnover and the erosion of understanding – in this case, there is often a knowledge gap in terms of ERP system functionality.

The knowledge gap goes beyond the training that one might receive from its predecessor. The education required to understand best-practice planning processes is lacking, as is understanding of how their particular ERP system supports those processes.



How Do We Pivot?

Regardless of the reasons for not having a Master Schedule, a company needs a plan if it is going to survive. Even if everyone knows things are going to change, there needs to be a clear, well-defined starting point.

Let's start by making the fundamentals of Master Scheduling clear. We will use three common manufacturing environments and briefly examine how Master Scheduling fits:

1. Make to Stock (MTS)
2. Make to Order (MTO)
3. Engineer to Order (ETO)

**Even if everyone knows things will change,
there needs to be a clear, well-defined starting point.**

Make to Stock (MTS) Environments

In the Make to Stock environment, customers expect that their orders are satisfied immediately from inventory on the shelf.

In this case, multiple sources of demand typically exist:

1. Independent demand plan (a.k.a. forecast) anticipates and communicates what customers will likely purchase.
2. Dependent demand calculates (through bills of material) and communicates (through the ERP system) the requirements needed for producing other products. Finished goods are often used in producing other products.
3. Actual orders are demand that has been placed by customers as an order, often consuming the forecast in the process so as not to double count demand.
4. Planning system parameters, such as safety stock, are also a form of demands that drive requirements to achieve planned stocking levels that anticipate customer orders that diverge from planned volumes. (There are multiple reasons why one might carry inventory.)

An ERP system will compare total projected demand to current inventory levels and calculate a projected available inventory balance over time. When the projected available inventory balance is anticipated to fall below pre-determined levels (typically safety stock or zero), the computer will suggest planned supply orders to rectify the issue.

A Master Scheduler will review the ERP system's suggested supply orders (a.k.a. Computer Planned Orders) over a certain time horizon and create Firm Planned Orders to firm up the schedule and take control of the plan. This activity creates the beginnings of a Master Schedule.

Establishing a Firm Planned Order

The Firm Planned Orders may line up with an ERP system's suggestions or may differ. For example, differences may exist when the Master Scheduler knows something unique about the plan that needs to be considered.

Let's use a simple example: Say the ERP system has suggested two supply orders within the same month or week. The Master Scheduler may decide to combine the suggested orders into one long run of like product – to minimize disruption to the shop floor and maximize utilization of the manufacturing line once set up.

"A "Firm Planned Order" represents the planner's recommended plan of action (e.g. buy, make) in terms of quantity and timing."

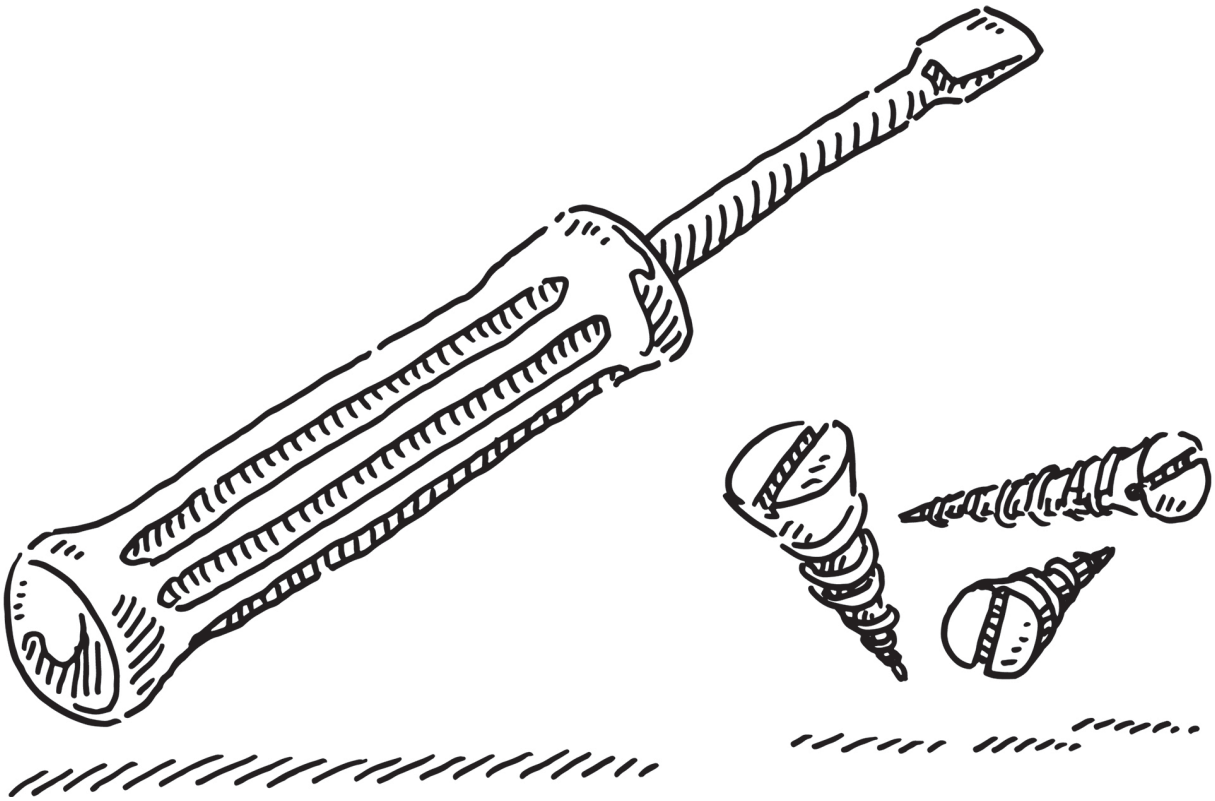
The foundational concepts of Master Scheduling outlined above and can be summarized as:

1. Review recommendations from the ERP system based upon its analysis of demand and supply balancing

2. Based on product, process, and environmental knowledge, with the overall objective of meeting total demand and other targets (e.g. inventory), either accept or modify the ERP system's recommendations

3. Create a Firm Planned Order to take control of the plan from the computer

A *Computer Planned Order* is a suggested order from your ERP system. Once the suggested order is reviewed by the Master Scheduler, it is accepted as is or modified (including deleting) and *firmed* up by the scheduler. Firm Planned Orders are unique in that the computer cannot change them.



Planning Time Fences

Before we define what a Planning Time Fence is and what it does, let's explore what happens in an ERP system when customers order more than expected. It's good news! Our Sales team is ecstatic! But on the supply side, things get a little more complicated, as our Firm Planned Orders are suddenly called into question.

In our example above, our Master Scheduler adjusted the ERP system's suggested orders and combined them into a single Firm Planned Order. This modification was to streamline operations by combining one order with another order in a clever bid to optimize output.

But now, customer orders have exceeded expectations.

Here's what happens, step-by-step:

1. The Master Scheduler combined two planned orders to utilize capacity.
2. He or she firmed up a plan.
3. The ERP system sees larger than expected customer demand earlier than anticipated.
4. The ERP system must now suggest more supply in order to bring the world back into proper projected available inventory balance.
5. Because we *firmed* the combined work order, the ERP system cannot move that order to an earlier date to achieve balance.
6. The ERP system will add an additional computer planned order earlier than our firm order to achieve balance.

While the ERP system's addition of a Computer Planned Order in step 6 follows the basic logic of planning supply when inventory quantities go below desired levels, the result of the combination of Computer Planned Orders and Firm Planned Orders may result in:

1. Higher-than-desired inventory (if the Firm Planned Order isn't adjusted), as well as

2. Nervousness that might trickle-down into plans cascading throughout the Bills of Material (BOMs)

To control the Bill of Material "trickle-down" impact of short-term changes in demand, we utilize a Planning Time Fence. The Planning Time Fence defines a horizon where the ERP system can no longer automatically make changes. In our example, we make it so the ERP system can no longer add Computer Planned Orders inside of a certain date range.

When in doubt, a Planning Time Fence should cover the cumulative lead time of the end item (manufacturing and purchase lead time summed along the longest critical path) to control the complete supply chain underneath the end item. To simplify the concept, see the figure below. If the Master Scheduled end item is the large red ball on the right, the smaller dots to the left of it are the purchased materials and/or manufactured subassemblies that make up the red ball, and the arrows in between represent the lead times, the longest critical path is represented on the very bottom in red, which is the cumulative lead time of that large red ball.

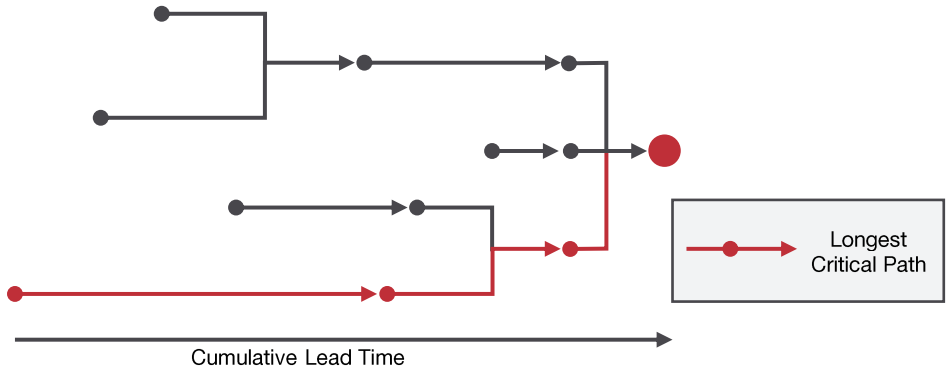


Figure 1: Logic for Calculating Cumulative Lead Time

With a Planning Time Fence set at the cumulative lead time, one can see that the planner has effectively controlled the entire supply chain below the master scheduled item. The ERP system will only create new orders (Computer Planned Orders) outside of this fenced area. Inside of the Planning Time Fence, only Firm Planned Orders exist; and the ERP system will simply make recommendations when it sees an imbalance. This means the Master Scheduler must firm up Computer Planned Orders for them to be moved inside the Planning Time Fence and drive lower-level dependent demand within the ERP system that will be acted upon in the near term.

To be clear, lower-level demand is indeed driven outside of the Planning Time Fence from Computer Planned Orders. But the demands will be outside of the ordering windows for these parts and, therefore, will not drive action from a material planner or production scheduler. (The requirements are generally useful for longer-term procurement planning/negotiating across a longer horizon.)

Valid Master Schedules

Valid (i.e. achievable) schedules are the cornerstone of any planning environment. To say a schedule is valid, one must be able to say that:

1. The material is actually needed by internal or external customers

2. The material due dates for production or procurement meet the need dates for said internal or external customers

3. That one will indeed have the capacity to support the material plan.

Rough Cut Capacity Planning (RCCP) is the process by which the master schedule is tested against available capacity on critical resources to support a valid master schedule. The material side of a valid master schedule is supported by taking control of the environment over the cumulative lead time and keeping material dates current. Not every resource is evaluated using RCCP, but only those that are considered bottlenecks or in any way are deemed "critical" to assess. (Rough Cut Capacity Planning need not be confined to equipment. It could also be purchasing capacity, for example.) This topic is covered extensively in the Oliver Wight book, *Master Scheduling: A Practical Guide to Competitive Manufacturing*, soon to be in its 4th edition. For the sake of this white paper, it's important to emphasize that the Master Schedule must be tested using RCCP to ensure validity.

Lead Time Parameters Are Key

A firm planning horizon, over the entire cumulative lead time, does two wonderful things in the supply chain world. It ensures:

1. Clear, robust communication of intended build plans that authorize capacity reservations and raw material purchases

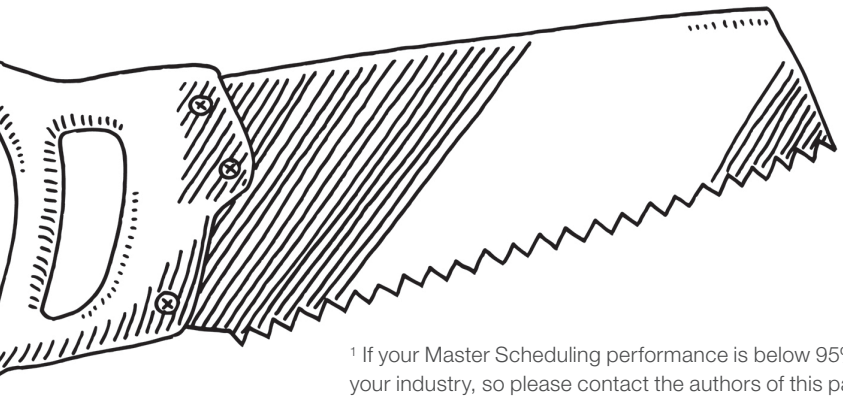
2. That Available-To-Promise functionality is using realistic supply plans

ATP or Available-To-Promise Functionality

Available-to-Promise functionality provides the amount of uncommitted supply that customer service can promise to customers in any given time frame.

How is ATP calculated? The ERP system begins with Inventory-on-Hand and deducts all of the actual demand (e.g., firm customer orders) from today until the next available incoming supply is scheduled for that item. By doing so, the system calculates how much more current inventory is available to promise to the next customer that calls. The assumption is that any customer orders that are placed on, or after, the next scheduled supply, can be promised from that incoming supply and not from the current inventory. In this way, a customer service representative can know exactly how much he or she can promise any customer in any time frame.

Using ATP calculations for customer promising affects the company's bottom line by improving customer satisfaction. These improvements include, for example, not promising more than the company is planning on making and effectively allocating existing inventory across customer orders. We recommend that a company does not use ATP functionality until it has gained control of the master schedule and is effectively delivering a master schedule adherence of 95+ percent. Without those two things, ATP will be quickly discredited, not trusted, and emails and phone calls will continue [1].



[1] If your Master Scheduling performance is below 95%, please let us know. We'd like to hear about the challenges in your industry, so please contact the authors of this paper. info@oliverwight.com

The Master Schedule and Degrees of Freedom

When the Master Schedule is developed, it takes into account all demand from internal and external customers, new product activities (pilot runs) on critical production assets, and preventative maintenance on key resources to name a few. It is truly the *master of all schedules*. All manufacturing processes align in support of achieving the Master Schedule. Though it is the Master, it is not a dictator. Typically expressed in weekly increments, supporting processes have the flexibility to optimize as long as the final result is what was expected from the schedule. For example, if a paint booth has to paint red, black, and yellow components in the same week, the shop scheduler has the freedom to choose the color order that minimizes changeover/ cleanout within that given week.

Make to Order (MTO) Environments

The Make to Order and Assemble to Order Master Scheduling process relies on the foundations of Master Scheduling in a Make to Stock environment, but with a bit more complexity.

MTO and ATO companies do not have inventory finished and on the shelf like MTS companies do. Rather, MTO companies recognize that there are so many possible configurations for orders that it is almost impossible to guess what to put on the shelf. Therefore, they do not forecast customer demand at each individual configuration. They do forecast at a family level and use other techniques to plan the possible options.

Different Environments

MTO: Make to Order

ATO: Assemble to Order

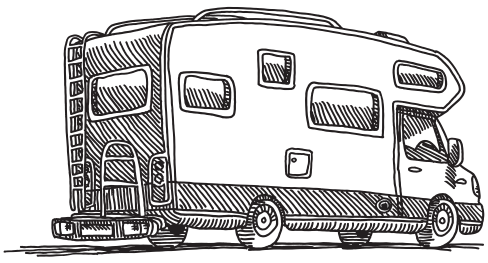
MTS: Make to Stock

ETO: Engineer to Order

In the case of the MTO, production must be prepared to assemble or make a uniquely configured product. The Master Scheduler needs to plan for required components of any configuration because the procurement lead times of those components often would extend beyond what any customer would be willing to wait for the end item. In short, they have to buy the right amount of parts and have them on hand when the orders come in to assemble the product in the right configuration.

As an example, let's take a product that has lots of options, such as a recreational vehicle (RV).

There are many configurable options in an RV. We will also pick just one option type, such as the engine or motors. The engine could be, for example, either gasoline or diesel or one could choose an EV option that includes electric motors, batteries, and a home charging station.



When a customer places an order, the first specification might be the size of the RV. Let's say the customer wants a 22-foot RV. Sales could look at the Master Schedule and see a 22-foot RV Available-To-Promise on a given date. This given date is just as we described above – where the planned supply did not have a customer commitment against the 22-foot RV – it was, in fact, available to promise.

Now, what about the engine option? Just like we had a demand plan for the 22-foot RV, we would have a demand plan for the engines.

Often a Planning Bill of Material is used for options like engines. In our case, the planning bill would have three engines on it, with percentages according to the probability that a customer might order that particular engine (see below). The Planning BOM would be tied to the RV plan, and thus have a corresponding Master Schedule and ATP at two levels, as shown in the figure below.

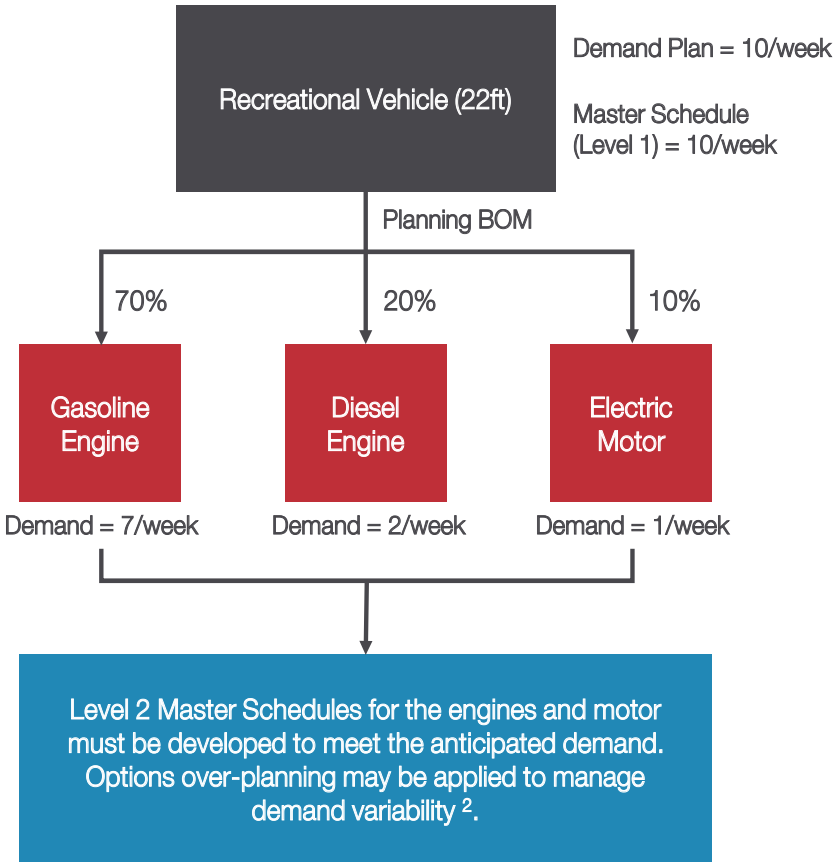


Figure 2: Example of Level 2 Master Schedule

It is possible that Sales can offer a 22-foot RV available for the customer, but the top engine choice is not available until a later date. The customer could change their mind and choose a different engine that is available sooner or simply wait. If the customer chooses to wait, a new order for the RV with the specific engine choice will be created.

[2] The nuances of multi-level master scheduling in MTO and ATO environments and using tactics like option over-planning are explained in more detail in our Oliver Wight public Master Scheduling course and in the aforementioned book *Master Scheduling: A Practical Guide to Competitive Manufacturing.*

ETO - Engineer to Order Environments

Engineer to Order environments complicates things further. Schedulers not only need to plan for materials and capacity, but also for the amount of engineering capacity required.

All of the above techniques described earlier are in play as ETO items are:

1. Never on the shelf, and

2. May not have a commonality to anything ever made before

Well, the second part of the above is not completely true, as even the most esoteric ETO companies find some commonality among what they make and sell.

For example, for the leading builder of submarines, it is pretty unlikely that the company would get an order for a recreational vehicle. So, they may have an understanding of unique technologies or materials that should be on hand – or capacity planned for – when the order comes, as opposed to starting from scratch.

ETO myths: "But you cannot schedule the engineering time when the design requires never-before-seen products." Not true! It is critical to start with a schedule and modify as you go.

And yet, planning for that third component – engineering capacity – adds a new dimension for Master Scheduling.

It Is a Long Way Down the Road

Leading ETO companies learn to understand that the cumulative lead time formula includes the engineering time. Lead time starts with engineering design time, then adds material procurement and manufacture time to complete a customer's unique order.

Sometimes in ETO product planning meetings, you hear resistance such as, "You cannot schedule the engineering time when the design requires never-before-seen products."
That is not true.

In line with the premise of this paper, we underscore again that you have to start with a plan even if you know it's going to change.

The Solution

Master Schedulers need to know that the best ETO planning requires alignment with Sales teams to establish BOMs and routers that enable the ERP system to estimate all aspects of the ETO environment.

Engineering time can be put into a BOM like a needed component, and into routing for capability planning (engineering skills and the number of engineers).

For example, the part number that could be created would align with large, medium, and small new projects with place holders for unique items that need to be designed. Alongside the unique items are *similar to* items that require little extra engineering content. Scheduling lead time would vary based on the amount of known and unknown content.

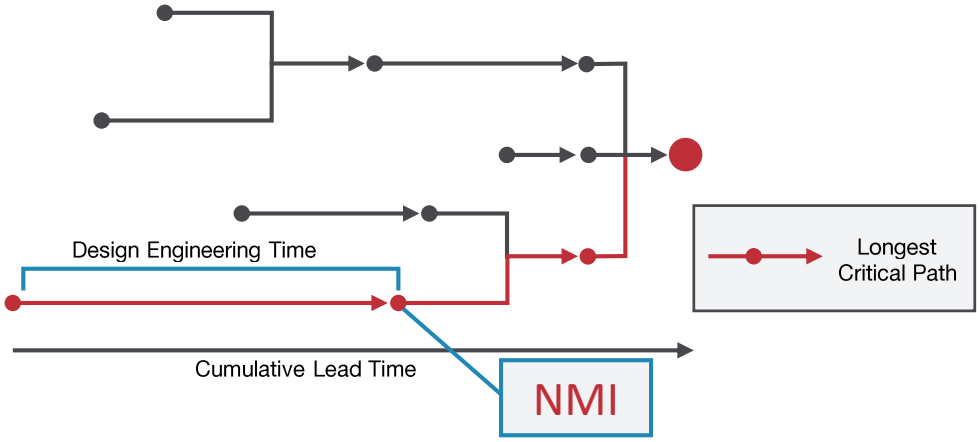


Figure 3: Logic for Calculating Cumulative Lead Time in an ETO Environment

Taking the above example of cumulative lead time, we can see that the cumulative example now includes a New Medium Item (NMI) (see Figure 3). This part number NMI has a lead time and would have an associated routing to call out the design skill or skills to create the new item. Just like any other part in the BOM, Material Requirements Planning (MRP) would recommend to the engineering planner that it was time to start the design process in order to be prepared to make the NMI with its planned lead time.

The amounts of engineering time, the planned lead time to design, and the skills required are often best guesses at first. Over time planners learn to tune these estimates based on customer requests. Though the plan may be a bit sketchy, having a plan is far better than not.

Summary

Master Scheduling is usually linked to forecasts of when and how much of a product will be demanded or custom engineered. The idea is to quantify significant processes, parts, and other resources in order to optimize production, predict bottlenecks, and anticipate volumes of completed goods. Master Scheduling should drive factory activity – doing it right dramatically affects profitability.

For those trends we see in our Master Scheduling classes, wanting to optimize the supply chain and tighten delivery times are two common pain points that can be addressed by learning a few tricks and best practices.

The third trend, running out of capacity, is avoidable altogether by honing the skills of Master Schedulers. Literally, the buck starts and stops there.

Authors

David Goddard
Oliver Wight
Principal

Eric Deutsch
Oliver Wight
Principal

For support or a curriculum to help get Scheduling performance back on track, please contact Oliver Wight Americas for information about programs.

E: info@oliverwight.com

www.oliverwight-americas.com

About Oliver Wight

Oliver Wight has a 50-year track record of delivering business improvement to some of the world's best-known organizations. We believe that sustainable improvement can only be made through your own people. Unlike other consultancy firms, we transfer our knowledge to you, which means you can achieve performance levels and financial results that last. Our principals are seasoned professionals who have real-world manufacturing experience. They are thought leaders in the fields of supply chain management, integrated business planning, demand management, and product management. The largest worldwide consultancy of its type, Oliver Wight has offices throughout Europe, North and South America, and the Asia/Pacific Region.

OLIVER WIGHT

Oliver Wight Americas
P.O. Box 368, 292 Main Street
New London, NH 03257, US

T: +(800) 258-3862
E: info@oliverwight-americas.com

https://www.oliverwight-americas.com/

Oliver Wight Asia/Pacific
118/3 Male Street, Brighton
Victoria 3186, Australia

Oliver Wight EAME LLP
The Willows, The Steadings Business Centre
Maisemore, Gloucester, GL2 8EY

Imagine the **possibilities**,
realize the **potential**.®