The Little Blue Book on Scheduling

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The Basic premise of this book is that off the shelf Enterprise Resource Planning (ERP) systems are not able to handle the planning and scheduling needs of a pure make-to-order manufacturer or a mixed mode manufacturer with some make-to-order requirements. The fact that some ERP vendors have added Advanced Planning and Scheduling (APS) modules to their offerings is considered and discussed in some detail.

The book is essentially divided into two parts:

- Part 1 talks about the generic problems with ERP systems, which will help the reader understand the critical need for good scheduling and planning.

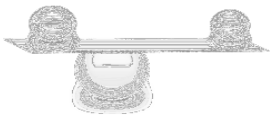
- Part 2 then goes about explaining, in some detail, exactly how companies can get from where they are today to where they need to be.

I have attempted, wherever possible, to explain my ideas as clearly and as simply as possible. Much of the confusion surrounding ERP systems and Advanced Planning and Scheduling (APS) systems has been compounded by those who hide behind ambiguous wording.

The problem with keeping things simple is that the world is not necessarily a simple place, so I would like to make it clear that if your ERP system does not have

the problems that are identified in this book then *you are one of the lucky few and you should be congratulated.*

Also, I invite feedback from anyone who agrees or disagrees with the many opinions outlined in this book. Please send your comments or questions to me at mliddell@stpartners.net. I truly believe that lively debate based on the intelligent use of logic is the best way to make progress and implement change.



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Acknowledgements

There are so many threads woven into the fabric of this book. Some of these threads go back twenty years or more and some of them go back only a few years.

The first and most important person that I want to thank is my wonderful wife who has been with me for over thirty-eight years. Daniele has shared with me all the frustrations through the years. She was often the only person I could talk to during my long struggle to understand this thing called scheduling. Unfortunately for her, the battle didn't end at that point and there were to be many more frustrations as I grappled with ways to explain my ideas. To put it simply I don't think I could have done any of it without her.

The second person I'd like to thank is my partner and president of Suncoast Technology Partners, Dan Hahn. Until I met Dan I struggled to make my ideas work. Too often they got bogged down in a sea of data and that is where Dan stepped in. I remember working with him on our first project and giving him what I knew was a difficult problem. He said, "I can do that easily." I knew of course that he couldn't. History will show that Dan was right and from that moment on, I knew that he was the missing ingredient. The many success stories that followed proved that I had judged him correctly.

One thing that I have noticed in life is that successful people always seem to have great attitudes. Some argue that their attitude is great because they are successful, but I assure you that is the wrong conclusion. I argue that it is almost impossible to be successful unless you first have a great attitude. And so it is with my good friend Denis Picard who has had a major influence on my thinking. It was Denis who took the time to listen to me, support me, and tell me that my point of view wasn't crazy. Denis was the first person to read my book, and although the early drafts of the book were quite rough, he was there to guide me through a number of important improvements.

I would also like to thank some of the others who have taken the time to read my book and give me feedback, including Mihael Krosl of INEA in Slovenia, Mike Novels, the president of Preactor International in the UK, Denis Ouellet of West Monroe Partners in Canada, and Garry Baunach of Simulation Modelling Services in Australia. I was amazed and encouraged to see how many people were able to relate to my message given the differences in their backgrounds.

The last person I'd like to thank is my editor, Terri Hutchison. She has helped me get over the last hurdle, getting the book in shape to send to the publisher. This includes a significant amount of effort and cleaning up the graphics, for which I am very grateful.

Of course I also want to thank *you*, the reader, for taking the time to pick up this book and read it. I don't think you will be disappointed. Even if you don't agree with everything I say, I am sure it will give you a broader perspective on a number of important issues.

Introduction

My name is Mike Liddell, and I am the CEO of Suncoast Technology Partners. Since 1990 I have devoted all my time to helping my clients solve their planning and scheduling problems.

I make no apologies for the passion that I bring to the subject of scheduling. It appears to me that the world is moving faster everyday and that this is the great challenge faced by manufacturers in the new century.

The bulk manufacturing of commodity items to a large extent has moved offshore, so I have come to the conclusion that the future of manufacturing in the U.S. and Europe belongs to those companies that are built to handle change. Manufacturers in the future must consistently process change quicker and smarter than their competitors. I believe that the best way to do this is by building better planning and scheduling systems.

It is fair to say that I have been significantly influenced by the writings of Eli Goldratt as laid out in "The Goal" and "The Theory of Constraints". I feel that Goldratt has done a great job helping people to understand the nature of capacity constraints. Goldratt's ideas have paved the way for new technologies that are capable of delivering very creative and exciting solutions to problems that have plagued manufacturers for years.

I admit that I have spent many years battling the teachings and the far-reaching influence of APICS (now known as the Association for Operations Management). I am convinced that, despite their best intentions, when it comes to production planning and scheduling, APICS has been slow to grasp the real issues. I strongly believe that most of the ERP systems in use today do not have the tools or the technology required to manage finite capacities. The good news is that, in most cases, these capabilities can be easily added to any ERP system so there is usually no need to "throw the baby out with the bathwater."

I think that the APICS approach to managing change has often been too rigid and structured. There is no doubt that ERP systems can turn into monsters that need more and more data. One of the basic premises of this book is that most ERP systems were designed to address the needs of the make-to-stock (MTS) manufacturer but many businesses are now moving to a make-to-order (MTO) model.

I will argue that the needs of the make-to-order manufacturer are very different and that generally there is a growing need to be more agile and lean. This can only happen if production planning and scheduling systems can handle cause and effect. Without this capability a company will never have the information needed to make smart decisions about their capacity.

A repetitive theme of this book is the observation that by stripping away the buffers of excess time and

inventory we start to expose some major limitations of ERP systems. Put simply, make-to-order manufacturers are in the business of managing and selling their capacity, which means that they need a better set of tools than most ERP vendors are providing them today.

By reacting like Pavlov's dog to the squeaky wheel, make-to-order manufacturers can easily clog up their plants with low priority orders so what they need is better ways to help them prioritize their work so that they can concentrate on servicing their key customers.

Everywhere I look I see companies who do not take steps to address this issue starting to lose their key clients. I can guarantee that losing key clients will have a significant impact on their bottom line. This book is all about helping those companies and individuals who recognize the problem and who want to know how to fix it.

Preface

This book is written for those who work in today's manufacturing industry and who struggle every day building better, faster, and more innovative products while trying simultaneously to reduce their costs.

Companies compete because they have no choice and the reality is that ultimately competition produces winners and losers.

Competition is what threatens our jobs and security, but it is also the driving force behind innovation and progress. This book shows companies how they can, and in fact must, compete if they want to win.

In today's shrinking world, competition can come from anywhere. For larger, established manufacturers competition comes from smaller more nimble companies. For all U.S. and European companies competition comes from low cost emerging nations such as Mexico, China, and India.

This book talks about change, not only how it impacts businesses every day, but also how the rate of change will continue to increase as it has done for the last 100 years or more. My intention is that after finishing this book, the reader will understand how to manage change so that it becomes a competitive advantage.

Given enough time anyone can create a great plan, but the reality is that most plans are obsolete before they leave the drawing board. Mike Tyson, surprisingly enough, says it best, "*Everyone has a plan until they get hit!*" A great plan isn't good enough; a better process is also needed, a process that is able to react systematically, intelligently and quickly to the barrage of changes coming from the market, from suppliers, and even from the activities within ones own organization.

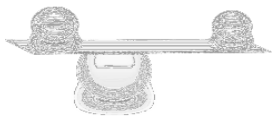
Lean manufacturing has provided a mechanism that can help smart companies become more nimble by reducing non-value added processes. One of the biggest non-value added components can be found in excess inventories of finished goods, sub parts and raw materials.

By manufacturing only what their customers have ordered, companies are suddenly faced with the startling realization that they no longer have any buffers to hide bad decisions. Changes have an immediate and cascading effect and they don't have the data they need to make intelligent decisions about what they can and cannot promise their customers.

I would like to apologize in advance for the incessant use of acronyms such as MRP (Material Requirements Planning), ERP (Enterprise Resource Planning) and CRP (Capacity Requirements Planning). For better or worse these acronyms are used throughout the world and are part of the every day language of manufacturing.

Having said that and at the risk of confusing readers even more, I use the terms scheduling, finite scheduling, and APS interchangeably. APS is an acronym for Advanced Planning and Scheduling, and in most cases it is just a fancy name given to finite scheduling software.

The last point I want to make at this stage is that this is not a book about lean manufacturing; however I must point out that, contrary to what many lean experts think, APS systems are an excellent tool for those who want to reduce waste.



Chapter 1

ERP SYSTEMS

Understanding the limitations of ERP

I would imagine that many readers of this book have been through the acquisition and implementation of one or more ERP systems. ERP vendors will confidently assert that their system will do anything and everything except maybe make the coffee. *I know this first hand because I was one of those making that presentation.* These claims are usually not made with the intention of misleading anyone but with the honest belief that they are accurate.

In my defense I started to ask questions or more accurately my customers started to ask questions that sent me on a path of discovery that was reinforced after I read a book called "The Goal" by Eli Goldratt.

My Eureka moment came back in late 1990 when I finally realized that there was no way on God's Earth that ERP systems could actually do everything managers and executives expected them to do. I immediately resigned from the ERP software company I was working for and started my own business that was dedicated to helping companies overcome the scheduling limitations of their ERP systems.

This Eureka moment presented many challenges. First of all my conclusion was very different from what APICS was saying and some APICS members would get almost violent if anyone had the nerve to disagree with them. In fairness to APICS they have slowly softened their opinions over the last few years.

In the early years a gap existed between understanding the problem and knowing how to fix it. Early solutions were only partially effective and it was hard to convince people to take a chance. Currently this is no longer the case and there are a few powerful software packages that can be customized to fit the needs of companies small and large. This is, however, not an easy task. Saying that finite scheduling is just another software module is like saying Tiger Woods is just another golfer, Michael Phelps is just another swimmer, and that the brain is just another body part.

Implementing a finite scheduling module is similar to going on a blind date and finding that the date is a beautiful woman. So you fall in love with her and after the wedding you discover that she is an heiress worth millions.
What I am saying is that the most powerful long-term benefits of an APS system may not be initially apparent.
For clarification purposes: Manufacturers almost certainly need an ERP system. ERP systems do a fantastic job of creating transactions, storing data and instantly sharing information. Companies who are smart enough to adapt them by building smart

customized processes around them are able to achieve astonishing results.
The temptation for companies to throw out their current ERP system and put in a new one should be the last resort. If they are not careful they will spend large amounts of money only to end up years later with the same problems. This does not even take into consideration the time spent by employees and the frustration and confusion experienced by their customers. Many companies never recover from this. There is often a better alternative. If business problems are related to poor customer service, poor on-time deliveries, the loss of key clients, and the frustrations of long lead times then there is definitely another path that is much simpler, much less expensive, and much more likely to produce results.

Without going into too much detail, this book explains some of the surprising limitations of most ERP systems and what to do about it. The next chapter journeys through the evolution of ERP systems and in very simple terms explains how they work and why they are limited. It will be evident that these limitations are inherently built into most ERP systems on the market today. Although these constraints impact most companies they can be debilitating for the make-to-order manufacturer.

This book provides alternatives to companies who think that they must replace their existing ERP system. Those who recognize the importance of keeping key clients happy and winning new clients will see how to turn change from a problem into a competitive advantage.

A simplified history of ERP systems

Before ERP there was MRP. MRP stands for Material Resource Planning and was popularized in the 1970's by Ollie Wight. MRP was nothing more than a technique for exploding a multi-level Bill of Material (BOM) to determine the materials a company would need to purchase or the sub parts they would need to make in order to manufacture a finished product.

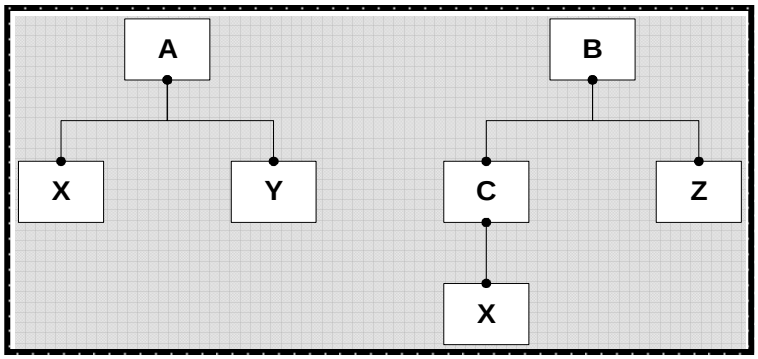
The intent of this chapter is to give readers a thorough but simplified understanding about the basics of Enterprise Resource Planning (ERP), Materials Requirement Planning (MRP), Master Production Scheduling (MPS), Manufacturing Execution Systems (MES), Capacity Resource Planning (CRP), (Bills of Material (BOM), and Routings.

Simply stated, the reason MRP works better for a make-to-stock manufacturer is that it was designed to achieve production efficiencies by grouping demand into long runs wherever possible. It can do this because it keeps inventory buffers of purchased parts and sub parts.

The make-to-order manufacturer, however, has an entirely different set of problems. Every minute he spends making excess inventory consumes the materials and the capacity he needs to deliver customer orders on time.

The make-to-stock manufacturer is selling inventories and the make-to-order manufacturer is selling capacity. In reality of course everyone is limited by capacity at some level, so even make-to-stock manufacturers can improve their profitability by improving their ability to plan and schedule.

The very simple example below shows the sub parts needed to make a finished part A and a finished part B.



If a make-to-stock manufacturer wanted to make 10 A's and 10 B's then Materials Requirement Planning (MRP) would explode the BOM Bill of Material (BOM) and group the demand for each of the sub parts:
20 of part X (because both parts need an X)
10 of part Y
10 of part C
10 of part Z

It would then check the inventory levels of each of these sub parts and determine to either purchase or create work orders for any sub parts that were getting

low on inventory. Usually there would be a minimum order quantity for each sub part.

Because of stock levels, the company would probably have enough of each sub part to manufacture the 10 A's and the 10 B's immediately. If there were a real shortage of any of the sub parts then MRP would create an exception message and a work order would be launched to fill that shortage. This work order would have to be completed before anyone could start the work orders for the A's and the B's.

In the make-to-order world, however, there would probably be no inventories of sub parts. So before the work order for 10 B's could begin, the work order for 20 X's would have to be completed and put back into inventory. Then, the work order for 10 C's and 10 Z's must be completed and put back into inventory. Only then could the work order for the 10 B's begin.

Planning and scheduling all these work orders is much more complex; this is the price a company must pay if they want to reduce inventories.
Does it have to be this way? In this situation I recommend that the make-to-order manufacturer follow one of two options:

Option 1 is to find a scheduling system that can handle the pegging of one work order to another. This is a good idea if the company has a complex, multi-level BOM or if inventories of some sub parts are kept

because MRP takes this into consideration when it suggest work orders.

Option 2 is to flatten the BOM and the routing. Below is an example of what the work orders would look like if the BOM and the Routing are flattened for finished part B.

Op 10	**make sub part X**
Op 20	**make sub part C**
Op 30	**make sub part Y**
Op 40	**assemble finished part B**

Unfortunately this option is only available to those manufacturers who have a relatively simple BOM. For the many companies who fit this bill there are some very attractive benefits:

- It simplifies the process.
  - No pegging multiple work orders together
  - One to one relationship between the sales order and work order
  - Easier to track progress of customer orders
- Group orders together for plant efficiencies -- with a scheduling system that handles sequencing rules
- Simplify and reduce the number of transactions required -- no need to keep moving sub parts into and out of inventory

Early MRP systems were simple, and they provided manufacturers with a powerful tool to manage their inventories and their purchasing. Some software companies recognized an opportunity and by the early 1980's they had created something that they initially called MRPII and eventually called Enterprise Resource Planning (ERP). In order to live up to its billing the ERP vendors added a great deal of functionality such as order entry, inventory management, purchasing, and accounting. In many ways this made a great deal of sense, because it integrated most of the data within a company. This meant that information could be maintained in one place but made available to anyone on the system.

The problem was that the term "Enterprise Resource Planning" was misleading to say the least because ERP systems provided very little functionality for manufacturers who actually needed to plan and schedule resources such as machines, people, and tooling.

During the late 1970's MRPII and then ERP systems started to use the concept of Master Production Scheduling (MPS), which was supposed to give planners a tool to help them time phase and prioritize their work. To this day most ERP systems still use MPS and MRP. MPS groups the actual demand (customer orders) and the forecast demand for finished goods SKU's or major assemblies; it nets this against the available finished goods stock and the scheduled expected receipts from the production plan. This is

done using the concept of time buckets (usually weekly). In its simplest form an MPS report looks like this (See the following table).

SKU: XYZ	Starting	Month 1			
	Balance	Week 1	Week 2	Week 3	Week 4
Projected Gross Requirements		250	250	300	300
Scheduled Receipts		350	200	100	100
Projected Available Balance	100	200	150	-50	-250

Any shortages identified in this process are used to tell the planner when they need to create new work orders. MRP then uses these work orders to explode and group the demand for sub components and purchased parts using BOM's and Routings as explained earlier.

Unfortunately there is a major problem with MPS:

> It assumes that purchase orders and work orders will be completed at the date that they are planned and has no mechanism for adjusting to anything that happens in the real world such as a late shipment from a supplier or a work center that is scheduled to more than 100% of capacity.

In an attempt to address the issue of one or more capacity constraints, ERP vendors introduced another new module that they called the Capacity Requirements Planning (CRP) module. Obviously some sort of reality check was needed to see if there would be enough capacity available to complete all the work orders, and the CRP module was definitely not the answer. Many of the limitations of ERP systems were tied directly to the limitations of the CRP module.

The CRP module is unable to accurately calculate the projected demand and utilization of capacities because it uses a number of techniques that have severe limitations such as:

Infinite capacity
Backward scheduling
Time buckets

Below is further explanation of how these techniques cause inaccuracies:

- Because it uses the concept of infinite capacity there is no way for the CRP module to calculate the projected impact of an overloaded work center on the projected capacity of downstream work centers.
- Because it uses backward scheduling, the CRP module does not provide a mechanism to calculate the cause and effect of any change on either the available capacity or on the scheduled completion dates of orders. The best that CRP can do in this case is to give companies an

exception message, which tells them that they have a problem.

- The Routing data in most ERP systems usually identifies the required resources at the work center level. In reality this is often not enough information because all products may not be able to run on all machines in that work center.
- Routing data usually holds work center run times, but in reality each machine could run at a different speed. This could cause a distortion in the way that capacity is consumed so there may be a constraint at the machine level even if there is no constraint at the work center level.
- The CRP module uses the concept of time buckets to calculate the projected demand for capacity. Time buckets can be a useful way of summarizing and reporting data but, they are hopelessly inadequate when it comes to calculating available capacity or for scheduling orders for the following reasons:
  1. Time buckets don't know or care if an event takes place at the start or the end of the time bucket, so the impact on downstream resources cannot be predicted.
  2. Time buckets have difficulty managing events that span from one time bucket to another.

3. Time buckets do not allow you to schedule more than one operation for an order in the same time bucket.
4. There is no easy way to modify the capacity of a time bucket due to calendar events like overtime, holidays and planned maintenance.
5. Time buckets do not take into consideration the impact that the sequencing of orders can have on capacity (see "*The Power of Sequencing*" section for more explanation).
6. Time buckets cannot accurately calculate the time an order will wait in a queue, so they must use the concept of average queue times. The trouble with average queue times is that even if a person could calculate it accurately, it is a totally useless piece of information.
7. Time buckets cannot calculate sequence dependent setup time so they have no option but to use the concept of average setup times.
8. There is no mechanism to determine the affect on the capacity or on the scheduled completion date of an order when raw materials are shipped late or a machine goes down.

9. If there is a delay in the first step of a work order then there is no way to calculate how that delay would affect the timing of downstream operations and the scheduled completion date of that order or any other order.

As I mentioned earlier, even if the capacity calculation was accurate and it determined that a resource was overloaded what can be done with that information?

The available capacity of that resource could be changed by adding overtime but there is no guarantee that this would solve the problem or just make it worse by increasing costs. Another option is to keep modifying the planned dates of your work orders in an attempt to balance your capacity utilization. This becomes a game of trial and error that could take days at best to resolve.

Manufacturing managers and executives need to understand that the CRP and scheduling tools provided by ERP systems have only a very limited ability to predict downstream consequences of a change of any kind. For example they have no tools to help them intelligently prioritize their workload, they have no ability to accurately estimate the promise date of a new order and they have no way to synchronize material and capacity constraints.

This is analogous to driving a car with your eyes closed. The only time you know you have a problem is when you hit something.

For years nobody seemed to grasp the significance of these limitations. Nobody actually came out and said, "The King has no clothes!" That is until Eli Goldratt started writing books like *The Goal* and *The Theory of Constraints* and even then there were few that really understood the implications of what he was saying.
There is a great quote from Winston Churchill, which I think is very appropriate. "We occasionally stumble over the truth but most of us pick ourselves up and hurry off as if nothing had happened".

So how does anyone survive with such a system? That's a good question but if you have ever worked in a plant like this you actually know the answer.

What usually happens is that a customer calls in a panic to see why his order is late. Someone is then sent to expedite that order. Expediting means that another person has to go into the plant and physically locate the order in question, assuming the order can actually be found (which is sometimes a big assumption). At this point the late order gets a red tag and becomes a high priority order, which sets off a whole chain of unexpected consequences. It's like playing with a Rubik's cube in that a simple change can have many unintended consequences.

One cosmetics manufacturer we worked with and who shall remain nameless had twenty people with the title "Expediter." These expediters were very powerful, and they were put on a pedestal because without them nothing would happen. All they did all day was put out fires because the entire production facility was in react mode. The schedule was put together on a weekly basis, and by the time it was signed off on by all departments it was already useless. On-time deliveries were never measured or discussed.

The good news is that because ERP systems are not able to predict the likely consequences of making a change nobody is aware of the catastrophic cascading consequences until the next poor, confused customer calls in and complains that his order is also late. And so it goes from day to day, chaos to chaos with no hope of ever getting control of the situation.

It is my experience in working with hundreds of manufacturers over the years that very few of them accurately measure their on-time delivery performance. This is somewhat surprising given the critical relationship between delivering on-time and keeping customers happy.

One assessment my company did for a client identified the fact that they had over 4,000 open order line items that were already late. What was really surprising was that nobody actually tracked the number of late orders and even more stunning was that nobody was even remotely surprised.

Within three months of implementing a new scheduling system, the number of late orders was reduced to less than fifty. It seems that human nature discourages us from measuring what we know we can't control.

The next question then is how do companies stay in business operating this way? The only way that most manufacturers can survive in such a world is to build in huge buffers of materials, finished goods and lead times that are designed to counter the fact that you have zero control over what is going on in your plant. These buffers, of course have a massive impact on costs and on the bottom line.

Now along comes a brilliant consultant who says that he can reduce costs and make them more efficient by adopting lean manufacturing techniques. So they start to remove all these non-value added buffers from their process. They actually start to reduce costs but guess deliveries…BOOM!!!...CHAOS!!!

What I am suggesting (actually suggesting is not the right word) is that if a business is moving towards a make-to-order, lean business model then chances are it will need to change the way it plans and schedules.

Back in the mid 1980's it was recognized that ERP systems were not providing manufacturers with the tools they needed to send information to the shop floor and to track what was going on in the shop floor. This

opened the door for software vendors to provide what they called Manufacturing Execution Systems (MES).

This was another recognition that despite having their roots in MRP, ERP companies provided limited functionality for the people who actually did the day-to-day work of manufacturing.
The reality is that although MES systems filled a huge hole for the chemical industry, the pharmaceutical industry and other process industries, in general discrete manufacturers have not adopted them. I think there are two reasons for this.

- Unlike APS systems, this was something that could be added to ERP systems and as a result many ERP vendors did add MES capabilities to their offerings.
- Many discrete manufacturers thought that MES systems were too complex for their needs and either used the ERP module or they opted for simpler, less expensive ways of collecting data from the plant.

The main reason that I mention MES systems is to point out what is not always obvious and that is that they do not do scheduling. Most of the larger MES systems work in partnership with APS companies to provide scheduling.

There is one last point I want to make about today's ERP systems that needs to be clearly understood because it has very serious consequences. In order to

compete, ERP vendors are constantly being pressured by their competitors and by their customers to be all things to all people.

This forces them to constantly expand the number of integrated modules that they offer and support. For example many ERP vendors have recently added a Customer Relations Management (CRM) module.

To make things worse they have additional pressure to create customized versions of their basic modules to address the unique needs of specific industries.
As we all know, complexity has its problems and in my opinion many ERP vendors have lost sight of the basics. Apart from confusing their users, there are other, even more serious consequences to this strategy.

The very thing that makes an integrated ERP system attractive becomes its worst nightmare. What I mean is that because of the tight integration between each of the modules, there are thousands of touch points.

Every time a change is made to one module it can have unintended consequences on several other modules. This makes it progressively more difficult and more expensive to make improvements and fix bugs. Given this reality, it is easy to see that it quickly becomes virtually impossible for one ERP vendor to claim to have the best solution in every area and this opens the door.

Many ERP vendors are being stretched to the limit to meet the ever-changing needs of their clients and the market place.

Smart ERP vendors recognize this reality and take the time to invest in developing partnerships designed to fill in the holes in their offerings. They spend the time needed to provide these partners with tools that help them do the difficult integration work.

Many manufacturers have become frustrated with ERP vendors and this has opened the door for software vendors to step in and create "Best of Breed" solutions. It is obviously much easier to keep a solution on the leading edge if that is the only thing that company does. Best of Breed solutions and the fact that integration tools are getting better is changing the way that manufacturers are looking at their options.

As we mentioned earlier, some ERP vendors have recognized the problem and have added APS modules to their offerings. Most of these companies did so by purchasing APS technology from third party software developers and some of them were able to even integrate it into their manufacturing modules.

I think it is important here to explain why the ERP vendors did not just build their own APS modules. APS systems are difficult to develop because they must manage time constraints without using time buckets. The only way to do this is to create something called a scheduling engine. The power and flexibility of an APS

system is directly related to the effectiveness of its scheduling engine and scheduling engines are very complex. In short they cannot be built quickly or with just database technology.

Unfortunately for the unsuspecting manufacturer, some of the third party software developers were more than happy to sell their APS systems because they were struggling to survive financially on the merits of their technology. This meant that some ERP vendors had integrated technology that was not that good to start with and any time and money invested in trying to implement these systems would more than likely be wasted because they would not be able to grow as their needs changed.
The few ERP vendors who were able to integrate APS modules into their offerings were initially able to gain a competitive advantage by demonstrating this attractive functionality. On the surface it was somewhat puzzling to figure out why this approach did not produce many success stories.

The obvious reasons that these attempts to implement cookie cutter scheduling solutions failed is that most ERP vendors probably did not have the skill set needed to continue developing new functionality and they almost certainly did not have the skill set needed to understand the clients' needs and how to match the software to those needs.

It is my conclusion that there is another far more important reason that these scheduling systems don't

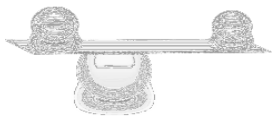
work. I believe that unless a scheduling system has the built in logic to model real world business constraints, it is of no use because it will give faulty information. It is not possible to consistently make good decisions from faulty information. *That means that even if you have an APS system it does not mean that you are getting any of the significant benefits that are outlined in this book.*

Although I will discuss this subject in much more detail, I wanted to finish this chapter by saying that APS systems should have three characteristics that make them very different from other ERP module such as Accounts Payable.

- They must handle the level of detail needed to model real world constraints such as operators and tooling or the ability to calculate sequence dependent setup times based on multiple product attributes that may be unique to each company.
- They must be able to provide advanced functionality, such as custom sequencing rules, for schedulers who want to get additional benefits from their systems.
- They need to be easily customized and modified (think Excel) so that they can meet the changing requirements of a business without being orphaned when new versions are released.

My conclusion is that planning and scheduling systems should reflect the things that make a business unique including strategic objectives.

If a system can't grow and change to meet the changing needs of a company, then it becomes a burden that will have little or no value.
Since change is one of the few things in life a company can count on, it makes a great deal of sense to start with a system that can grow and change also.



Chapter 2

Lean/MTO Manufacturing

A very simplified history of lean manufacturing

Because of the dramatic impact that Lean Thinking has had on the world of manufacturing, it is important to understand the strengths and weaknesses of Lean Scheduling techniques such as Heijunka and Kanban.

As most people know, the Toyota Production System (TPS) was developed by Toyota to eliminate waste from manufacturing processes. Lean Manufacturing is a philosophy built around the best practices of TPS. Since waste is defined as any activity that does not provide value to customers it is steeped in common sense.

Lean Manufacturing focuses on 7 Production Wastes (Muda):

1) Transportation
2) Inventory
3) Motion
4) Waiting
5) Over-processing

6) Over-production
7) Defects

These 7 wastes negatively impact throughput, manufacturing costs, lead-times and on time deliveries.

Toyota analyzed what they defined as Value Streams (all the activities required to produce a specific product) and concluded that the traditional factory floor layout of functional work centers and batch and queue production practices were the major drivers of the 7 manufacturing wastes. Their solution was to develop a number of process improvement methodologies that transform the factory from functionally based work centers to product based work cells and production lines. Toyota then replaced batch and queue practices with continuous flow production.

Continuous flow is also referred to as one-piece flow. The most basic definition of one-piece flow is that parts move through production from step to step with no work-in-process (WIP), one piece at a time. It works best in combination with the Toyota cellular layout in which both assembly operations and equipment are arranged in the logical sequence of production.

Lean employs the TPS visual scheduling techniques of Heijunka and Kanban to schedule continuous flow production. Heijunka level loads production based on actual demand and daily rates, while Kanban uses the depletion of inventory buffers to trigger demand signals.

Early adopters of Lean, seeking to remain competitive and frustrated by their complex ERP System's inability to improve manufacturing performance, were attracted to the underlying simplicity of Lean and its reputation for manufacturing excellence. Usually these companies were manufacturers that had low mix, high volume demand patterns, such as automobile suppliers. These early adopters initially achieved noticeable improvements in their manufacturing performance.

As word spread about the success of Lean implementations, manufacturers who did not fit the Lean template of low mix, high volume demand patterns, began to launch Lean initiatives. More often than not, initial operational benefits gave way to missed deliveries, material shortages, poor machine utilization and a growing sense of confusion throughout the organization.

What is not common knowledge is that many of the companies that did fit the Lean template were experiencing similar problems. Industry studies of Lean implementations confirm that many Lean initiatives did not sustain their initial benefits, especially in the area of customer service. As Lean thinking evolves in response to this reality, Lean initiatives are focusing less on cost reduction and more on improving customer service, specifically improving how to connect variable demand patterns with manufacturing execution. This demand driven focus is an important step in achieving sustainable Lean benefits.

Manual Heijunka and Kanban are fundamentally sound scheduling systems for continuous flow production. The problem is that most companies are not able to achieve continuous flow for their Value Streams because they are still using batch and queue processes to manufacture component parts. The challenge for these companies is to achieve a balanced connected flow, not continuous flow. Our conclusion is that most of the problems are caused by manual Heijunka and Kanban which were not designed to support more complex Value Streams and variable demand. In order to improve customer service and react to demand variability, Lean scheduling needs to be smarter and faster.

APS technology, on the other hand, was designed to handle complex Value Streams and variable demand. It can synchronize the schedules of numerous machine cells and production lines in minutes… not days while offering the ability to evaluate multiple what-if scenarios. APS systems manage complex sequencing rules, sequence dependent setup times and multiple constraints (such as machines, operators, tooling and materials). This functionality is necessary to achieve balanced connected flow and improve production throughput in complex Value Streams. An additional benefit is that APS provides the data needed to support decision making at different levels of the organization… not just on the shop floor.

Demand Driven Lean combines the best of both worlds because APS connects Lean Thinking to

customer demand providing manufacturers with a complete system that;

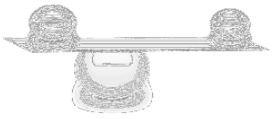
- automates Heijunka scheduling to level load production
- synchronizes multiple constraints such as machines, operators and tooling.
- synchronizes the flow of materials and component parts coming from upstream work cells
- uses sequencing rules to minimize changeover times and wait times at upstream work cells
- eliminates non value added activities needed just to maintain ERP
- extends Visual Control Systems to provide company-wide visibility
- automates complex line sequencing requirements
- improves operational decisions by simulating multiple what-if scenarios

This chapter tells a story about two independent groups of pioneers who were both motivated by the limitations of ERP to find a better way back in the early 1990's. The Lean group was spearheaded by Toyota and over the last 20 years they have had an enormous impact on the performance and profitability of countless manufacturers worldwide.

The Finite Scheduling group which eventually became the APS group concentrated on developing a better technology that was designed to handle real world scheduling problems. The success of APS and the need

to use this technology to improve Lean is becoming obvious.

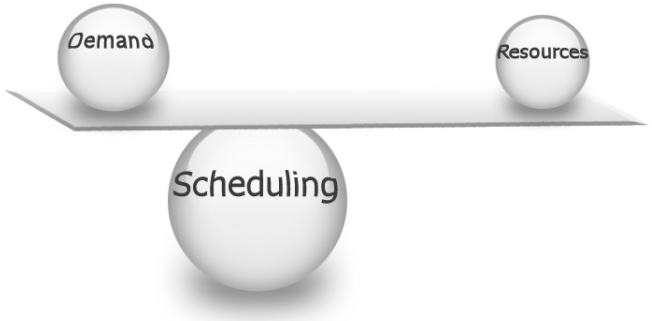
Demand Driven Lean with APS will take Lean thinking to the next level.



Chapter 3

Scheduling - The Missing Link

Why is scheduling so critical?



As the diagram above shows, scheduling is the process of balancing demand for products with a company's available resources for the purpose of creating a valid action plan.

Demand would include customer orders, stock replenishment orders and samples, while *Resources* includes machines, operators, tooling, and inventories of raw materials, sub parts, and finished goods.

As I mentioned earlier in the book, I use the terms scheduling and APS interchangeably. APS is an acronym for Advanced Planning and Scheduling and in most cases it is just a fancy name given to finite scheduling software.

I sincerely believe that scheduling is the brain center that drives the operations side of a manufacturing company. As such the schedule should be able to absorb the constant barrage of changes that impact a business and quickly create a new action plan. This plan should reflect the strategic direction of a business.

I am not saying that this process should be completely automated but you should be able to reschedule your plant in a few seconds or at worst a few minutes. To be useful, your scheduling system must be able to realistically model real world constraints so that it can provide management with the information needed to make important decisions.
This includes the ability to use cause and effect logic to evaluate multiple what-if scenarios before deciding the best course of action

Once a sound schedule has been created a scheduling system needs to be able to synchronize every key activity that needs to be performed from making sure raw materials are available to communicating a precise sequence of events to the shop floor.

One way to look at scheduling is as a way to answer the question, "What should I make next?" This is actually a critical question because every minute a manufacturer spends making the wrong stuff not only increases costs, it takes away from his ability to deliver what the clients actually need.

As I will explain later, planning systems should also have a major impact on how a company answers that question. It is the ability to quickly create a smart schedule, and have that schedule automatically synchronize all the other critical activities that is the big missing link in most off the shelf ERP systems.

Without a coherent scheduling system companies can easily start down a path that gets progressively more self-destructive. Mass confusion and panic set in when decisions about changing priorities are made in a vacuum or by multiple people (including executives). Mass confusion results in low productivity and poor customer service and ultimately the loss of key customers. All of these factors have a massive impact on your bottom line.

Anyone who has ever been down this path knows the hopeless feeling in the pit of their stomach that comes when you realize that the chances of getting out of this mess are quite small.

Don't give up because all is not lost. Adding a smart scheduling system to an existing ERP system may be the answer. Scheduling is where the "rubber meets the road" and implementing a good scheduling system should have an immediate and lasting impact on a company's ability to service its clients and improve the bottom line.

I will devote several pages to how companies can get from where they are to where they want to be. One

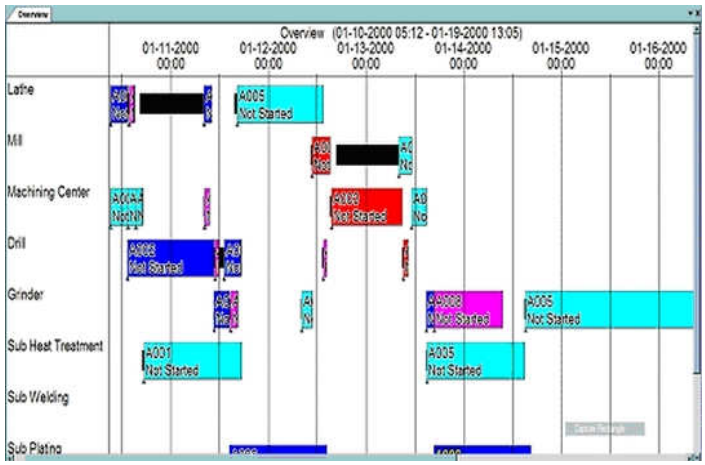
secret is to add new software and new processes to leverage the systems and data that are already in place. At the risk of repeating myself, in the world of scheduling every company is unique and the only way that a scheduling system will work well is if the system can model real world constraints. Adapting the way a company works to fit the limitations of a scheduling system is guaranteed to fail.

Lastly it is important to point out that a good scheduling system not only automates the process of creating smart schedules, it immediately eliminates 80% of the manual effort currently wasted on just keeping the schedule up-to-date. This in turn means that the role of a scheduler must change from being reactive to being proactive. This frees up the scheduler to spend more time solving problems before they actually happen.

I always talk about this in my seminars because in many organizations, the scheduler is very powerful. Without an APS system the scheduler gets and uses his power by putting out fires and they often have absolute control over who gets priority. Managers and executives soon learn that they must bow to this reality or face the consequences. Those schedulers who are unable to give up their power trip must be replaced sooner or later. My strong recommendation is that they be replaced sooner.

Of course the top-notch scheduler, driven by the need to improve, is thrilled to have a new set of tools.

One great way to view a schedule is in the form of a Gantt chart (see below). The Gantt chart shows how each of the resources (machines or subcontractors) is loaded over a selected time-period. Believe it or not, a good scheduling system will create a complex schedule within a few seconds or minutes.



Basic scheduling functionality

A quick review of the limitations of ERP systems as described in the previous chapter gives us a pretty good starting list of the functionality that will be needed in a scheduling system. I say starting point because there is so much more that can be done once a scheduling system has been implemented.

In other words, a good scheduling system should deliver all the functionality missing from an ERP system. Below is a list of the basic functionality that is needed in a scheduling system.

1. The ability to schedule more accurately at the machine level as opposed to the work center level and to assign different shifts and run speeds for each machine.
2. The ability to schedule each machine finitely or infinitely.
3. The ability to schedule using multiple constraints (such as tooling and operators).
4. The ability to calculate sequence dependent setup times.
5. The ability to schedule precisely (minutes or seconds) as opposed to time buckets (usually days or weeks).
6. The ability to integrate easily with other systems like ERP and Shop Floor Data Collection (SFDC).
7. The ability to sequence orders based on due date, priority or some other attribute.

8. The ability to schedule quickly (minutes or seconds) and maintain a real-time view of the schedule.
9. The ability to easily make changes such as adding new orders, changing priorities, adding machine downtimes or completing operations.
10. The ability to synchronize the schedule with material constraints.

Excel, the false Messiah

Schedulers, as a rule, are not stupid. In fact, because of the responsibility they have to keep things running, they are usually quite bright. Once they realize that their ERP system is not going to help them create and maintain a valid schedule, they look for an alternate solution that will prevent their life from becoming unbearable.

Because most people are comfortable with Excel and it usually doesn't cost anything, it often becomes the "drug of choice." Like so many other drugs, however, the side effects can make things much worse and sometimes even fatal.

What I am about to say is so obvious that it will immediately make sense but most people still don't get it. There is no doubt that, given enough time, Excel can create a valid schedule. For that matter a patient person can put together a valid schedule using cards and a wall.

The big problem is the enormous output of time and energy it takes to update that schedule every time something changes because, as we know, things change all day and every day. When a change happens in manufacturing it is not possible to calculate the downstream ripple effect without a system designed to do that. Once a company is able to quickly and intelligently reschedule their plant, they will have an immediate advantage over their slower moving competitors.

To the legion of schedulers out there using Excel, let me just say that I understand, and it doesn't have to be that way. There is no doubt that a valid schedule can be created with Excel, or Access or even with a project management system, but due to the time and effort it takes to keep up-to-date those will never be anymore than Band-aids.

It is important to understand that the ability to react quickly to change is just the starting point. Once a company has this skill, however, it opens up the door to all the other exciting benefits described in this book.

For readers in the position to make a decision, here are two options.

Option 1: Hire a number of people totally dedicated to manually updating your schedule several times a day to reflect all the new orders, shop transactions, machine breakdowns, sick operators, and late suppliers.

Or Option 2: Buy a system that does all of that in just a few seconds, every day.

Let me put the question another way. Wouldn't it be better for a scheduler to spend more time identifying and resolving problems before they actually happen?
Of course this is a trick question. *If you got it wrong, you are not allowed to read the rest of this book, which means you will miss all the other great things you can do with an APS system.*

The power of sequencing

Explaining the wonders of sequencing is one of the fun things I get to do in my seminars. I have described the basics of a good scheduling system. Now I need to prove that there is a whole new world out there to explore. That world is the world of sequencing.

A simple way to understand sequencing is to think of two cars going down a single lane highway. One can go at 120 mph and the other can go at 30 mph. If we assume that they can't overtake each other how long does it take them to drive 30 miles? Of course the answer is easy, the fast car can drive 30 miles in 15 minutes, or can it? If it is behind the slow car then it will take the same time as the slow car, which is 1 hour.

When it comes to sequencing

$$1 + 2 + 3 \neq 3 + 2 + 1$$

This is one of the reasons that scheduling in buckets doesn't work.

The ability to manipulate the way that operations are sequenced at a machine not only impacts setup times, it impacts on-time deliveries and work in progress (WIP).

The following is a simplistic example that highlights how a simple change in the way orders are sequenced can have a significant impact on a manufacturer's ability to deliver those orders on time.

In this example, a manufacturer has three machines -- Machine A, Machine B, and Machine C. Assume that the plant has one Eight-hour shift and that it is open seven days per week.

This company manufactures three products with routings as shown below.

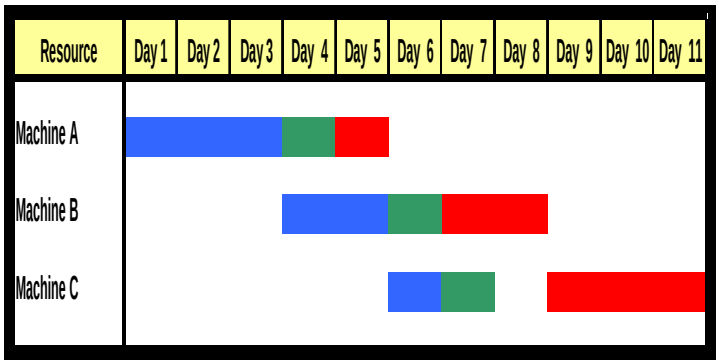
Product X	Operation	Machine	Rate
	10	**Machine A**	**24 hrs**
	20	**Machine B**	**16 hrs**
	30	**Machine C**	**8 hrs**
Product Y	Operation	Machine	Rate
	10	**Machine A**	**8 hrs**
	20	**Machine B**	**8 hrs**
	30	**Machine C**	**8 hrs**
Product Z	Operation	Machine	Rate
	10	**Machine A**	**8 hrs**
	20	**Machine B**	**16 hrs**
	30	**Machine C**	**24 hrs**

For the sake of simplicity, assume that this company has no other orders in the pipeline and that it gets an order for each of these three products.

1) What date can each order be promised?
2) What date can all 3 orders be promised?

Scenario 1:

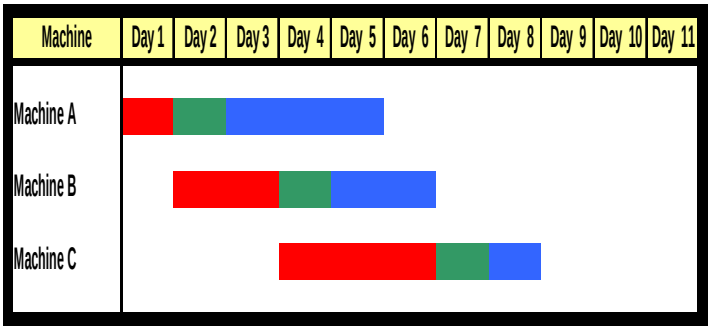
In scenario 1 the orders are sequenced **X** then **Y** then **Z**.



The Gantt chart above shows that **X** can be completed on day 6, **Y** can be completed on day 7 and **Z** can be completed on day 11.

Scenario 2:

In scenario 2 the sequence of the orders is changed to **Z** then **Y** then **X**



Now the Gantt chart shows that this small change has consequences that would be very difficult to anticipate without an APS system. **X** can now be completed on day 8, **Y** can now be completed on day 7 and **Z** can now be completed on day 6.

This example shows effectively that the time it takes to deliver all three orders has been reduced by **three days** or **27%** and simply by changing the sequence of events.

The purpose of this exercise is to demonstrate that the ability to manipulate the sequencing of orders and operations can have a significant impact on the way a plant performs. APS systems should have a number of advanced sequencing rules and the ability to create new rules to address unique requirements.

At this point I think I need to give a warning. Some scheduling systems promise optimized schedules, which means that the system uses advanced algorithms to evaluate billions of possible solutions to determine the optimal sequence (a process that can take hours). Although there are clearly situations where optimization makes sense, generally this kind of system produces results that are too nervous (the schedule shifts around too much) and too confusing for the scheduler and consequently they tend not to work.

Sometimes these systems are referred to as black box solutions because it all seems like magic and the scheduler has very little control. One big problem with a black box solution is that any attempt by the scheduler or the shop floor operator to manually change the schedule could completely ruin the optimization. In fact, any time that an operation takes longer or shorter to complete than scheduled, it can ruin the optimization but a scheduler has no way of knowing this.

Our approach is different because putting all the variables into the mix and calculating the perfect schedule is usually unrealistic. I like to use the 80/20

rule, which says that a schedule should be automated to do all the donkey work (the 80%) but allow the scheduler to use his or her experience to fine tune the schedule (the 20%).

This is done by creating rules and letting the scheduler evaluate how well they work. The ability to create rules is only part of what I am talking about when I refer to a scheduling system that is flexible. Scheduling systems almost always need some level of customization so that they can reflect the reality of the way you run your manufacturing operation. This approach is diametrically opposite from the way that ERP systems are implemented, where companies are expected to change the way they run their business to fit the new system.

Anyone wishing to get more information about rules should contact me at my web site
mliddell@stpartners.net.

Ten myths about finite capacity scheduling

This list has been compiled over the last twenty years by a number of seasoned proponents of Finite Capacity Scheduling systems. It has been based on countless success stories and is as valid today as it has ever been. The purpose of reviewing this list is to counter some of the misinformation that has been published over the years about scheduling. Most of these myths have been spread by those who do not understand the nature of either the problem or the solution.

1. ERP systems can handle my scheduling problems.

   Unless your ERP system comes with an APS system this one is dead wrong. Solving scheduling problems with standard ERP/MRP logic is equivalent to trying to solve a three-dimensional problem with two-dimensional logic. In other words, it simply can't be done in a timely manner.

2. If I buy scheduling software from my ERP vendor I won't have any data integration problems.

   Although this sounds like a good idea it really isn't. This is because very few ERP vendors, if any, had the skill set needed to develop and implement their own

scheduling module, so they went out and bought an APS software company.

A detailed explanation as to why this approach does not work can be found in the chapter that is titled "A Simplified History of ERP systems."

The short answer is that even if they have successfully integrated APS into their ERP offering (and this is not a given), most ERP companies do not have the skill set to continue developing the APS system and they don't have the skill set to implement it properly. ERP companies like to deliver cookie cutter modules with some options. This approach does not work in the APS world where your system needs to work at a level of detail that allows you to model the real world you live in, otherwise your APS system will be of no value to you.

3. Because I have so many changes, my schedule is usually out of date before it is published.

   That is exactly right because anyone can create a schedule once a week. The main benefit of a good scheduling system is that it is able to reflect priorities that are always changing while providing you with real-time information. This is what enables you to systematically make smart and fast decisions. Being able to understand cause and effect at high speed immediately differentiates you from your competition.

4. My schedulers know that our ERP software doesn't help them schedule, so they have

developed their own homegrown solutions using Excel spreadsheets.

Once again this sounds like a good idea, but it usually isn't and there is a chapter, titled "Excel, the False Messiah," that gives a full explanation as to why this is not a good idea.

The short answer however is that the illusion that Excel gives you some control is quickly offset by the exorbitant amount of time it takes to keep the schedule current without any of the built in benefits that come with a good scheduling system such as a visual schedule, easy data integration, and the ability to use sequencing rules. If the schedule does not reflect current reality then it is of no use to you.

5. Because we are implementing lean concepts my consultants tell me that we don't need a computer -based scheduling system.

   Replacing complex ERP logic with Kanban and demand-based manual systems is very tempting, but of course it has its limitations. Toyota themselves recognizes the limitations of these techniques in a demand-driven business model. This is because manual systems do not give you the ability to plan around your capacity constraints. This becomes critical once the buffers of time and inventory have been removed from the equation. Generally an APS system will support your lean initiative.

6. Scheduling systems are too expensive.

   This one of course is true if you have a bad scheduling system that doesn't reflect the reality of your world. Good scheduling systems can pay for themselves almost overnight and are capable of adding millions of dollars to your profit every year. If you are in the business of selling capacity, what other tools do you have to manage this process? If you don't manage this process, you will be tempted to sell your capacity on a first come first served basis, and that is a very good way to lose your key customers.

7. I can implement my own scheduling system.

   Although there are some out there who can do this, it needs someone with a great deal of knowledge about manufacturing and the software that is being implemented. Ultimately the success of the system depends on your ability to match the capabilities of the software to your business needs. Knowing what works and what doesn't can save you thousands of dollars. The pay back can be ten or even one-hundred times better when the implementation is done well and the schedule is tightly coupled with your business processes and constraints, so the risk is great.

8. My business is different than anyone else's.

   Yes this is almost certainly true and although the basics and root problems are always the same, the solutions will vary greatly. One of the strengths of a good

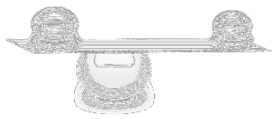
scheduling system is that it can be easily tailored to meet your needs so you don't have to change the way you do business to fit the system. The trick is to find someone who has the experience to guide you through the process.

9. I don't want to keep data in two systems.

   Of course this is a valid concern and a good scheduling system will have the ability to smoothly integrate the data with your ERP system, your shop floor data collection system and any other system that it shares data with your scheduling data such as your purchasing system.

10. What happens when my needs change and I have made major modifications? Will I orphan myself from newer versions of the scheduling software?

    This is really a great question and the answer is that, unlike most ERP systems, the best scheduling systems are designed to be customized just like Excel. This means that upgrades to new versions can be implemented with minimum effort because complex changes can be made without changing the actual core system. If you have selected the right APS system then upgrading to the latest version should be no more difficult than installing a newer version of Excel.



Chapter 4
Understanding the Need for Planning

The need for make to order (MTO) planning?

Now that we have established that MTO manufacturers really do need some form of finite capacity scheduling, why would they need a planning system?

The simple answer to that question is that scheduling systems will do their best to meet the customers promise date, but another tool may be needed to help prioritize orders and create realistic promise dates.

Scheduling orders on a first come first served basis sounds logical, but it is not based on reality because some customers are more important than others. There may be times when tough priority decisions must be made. In other words a scheduling system is like a GPS system, it will help us get where we want to go but it won't tell us where we want to go. The planning process should help companies decide where they want to go.

It is often assumed that planning is a waste of time for the MTO manufacturer but nothing could be further from the truth. Without a planning process the MTO manufacturer may quickly find that there will be times

when his capacity is consumed by low priority orders, which can have a drastic effect on his ability to service key clients.

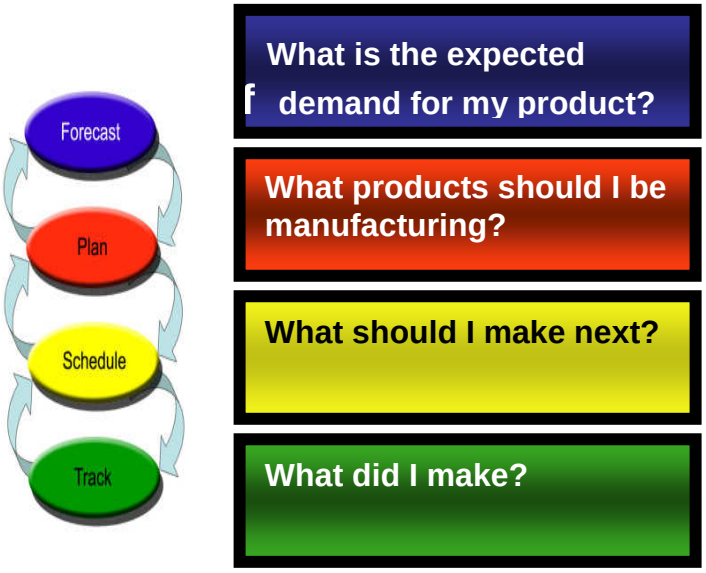
I think it is fair to say that traditional planning is often perceived as a periodic exercise in futility. In many companies planning is more of a budgeting process than a strategic process, but all that has to change for the MTO manufacturer who, as I have said before, is in the business of selling capacity. This means that there is a need to systematically decide which orders are very important and which orders are less important every time a new or change order is entered into the system. Failure to clearly prioritize the workload is the root cause of many of the problems that appear later in the process.

In addition to planning a company's schedule must also be updated with what actually happens in the plant. This is important because the schedule can only be as accurate as its starting point.

The MTO planning cycle is designed to add more power to a scheduling system by helping a scheduler make better decisions at every level.

What is the MTO planning cycle?

As depicted below there are four modules in the MTO Planning Cycle and each module is designed to answer a very specific question and to be tightly synchronized with the module above and below it.



The chart below depicts the relative windows of time for each module in the MTO planning cycle and how they tend to overlap.

These bars do not have time units since some businesses plan in months and weeks and some plan in hours and days.

It starts with the Forecast, which uses historical data to predict the expected demand for products or groups of products. The Forecast however is not the same as a Plan. Although the Plan should use data from the Forecast it should also reflect a company's strategic objectives. For example, the Plan should take into consideration the products needed to sell, and the customers needed to be developed to improve the long-term growth of the business and to meet current contractual commitments.

The main purpose of the Plan should be to guide and prevent the sale of capacity to low priority customers on a first come first served basis unless there is available capacity that has not been committed by a certain date.

I came to understand this problem very clearly a few years ago after implementing a scheduling system for a key client who was competing against commodity pricing from Asia.

Due to the wide variety of products this client manufactured they could only make-to-order. They were struggling because their lead times had been reduced over the last couple of years from six weeks to three or four days. To make it worse they had to

manufacture in batches that were usually bigger than the order size.
My company implemented a scheduling system that was tightly integrated to their ERP order entry module so that when a customer inquiry came in all they had to do was press a button, and the scheduling system checked for available materials, checked for available capacity, and gave an accurate promise date in about fifteen to twenty seconds.

This saved them almost a complete day, which was significant based on their lead times. It worked great except for one big problem. As they promised orders on a FIFO basis, they had no way of making sure they had enough capacity for high premium Quick Turn Around (QTA) orders and long term contractual commitments to key clients.

This was not just inconvenient it was detrimental to their survival, so an additional planning system had to be put on top of the scheduling system to make sure that they reserved capacity based on their strategic objectives and their contractual commitments.

Lets look at each of the modules that make up the MTO Planning Cycle.

The Forecast Module

The Forecast module answers the question "What is the anticipated market demand for each of my products or product groups?"

The Forecast module can use historical data, sales projections, a number of forecast techniques and a business process all designed to estimate the anticipated monthly market demand. This can be done at the individual product level but in the make-to-order world it often makes more sense at the product group level.

It is necessary to emphasize the importance of establishing and following a well-defined business process when forecasting.

Results from the Forecast are fed into the Plan module.

E

The Plan Module

The Plan module answers the question "What products should I be manufacturing to grow the profitability of my company?"

Unlike a traditional plan once it has been created, the MTO Plan becomes an important day-to-day operational tool.

Creating and Maintaining the Plan

The job of the planner is to determine what products a company **should** be making based on actual orders, potential orders, contractual obligations, the Forecast demand and other issues such as:

- anticipated margins for each product or product group
- customer priorities and contractual commitments
- strategic objectives
- capacity constraints

The Plan should also help those who need to place orders for materials that have a long lead-time.

Creating and maintaining the Plan should be a collaborative effort that involves constant feedback from sales, purchasing, senior management and manufacturing.

Using the Plan to make operational decisions:

From a day-to-day operational perspective, the Plan should help to create reservations, track how capacities are allocated on a monthly or weekly basis, and determine the approximate earliest start date of new orders. The earliest start date should reflect both the availability of material and capacity.

The Schedule Module

I have already spent a great deal of time talking about Scheduling but the primary purpose of the Schedule module is to answer the question "What should I make now?"

To answer this question the scheduler must evaluate the current workload and sequence the work at each machine making sure that he meets the company's scheduling objectives such as:

- respecting capacity constraints
- respecting material constraints
- respecting priorities of key clients
- meeting on-time deliveries
- reducing setup times
- reducing WIP

In addition to this, the scheduler is responsible for making realistic promise dates. Using the current schedule and the previously determined earliest start date, the scheduler determines the promise date of each new order.

The Schedule should be able to quickly communicate changes in priority to the shop floor and it must be able to react to changes from the shop floor (such as shop

floor updates and machine downtimes). Information from the Schedule such as the latest scheduled completion date of each order should be instantly visible to customer service.

Please see the chapter on scheduling for more information on Scheduling

The Track Module

The Track module answers the question "What did I actually make?"

Tracking the actual start and end times for each task and collecting machine downtime data provides the vital link between a schedule and the reality of what actually happens on the shop floor. This enables the schedule to immediately show the full effect of changes on the downstream operations. In addition this process provides the key data required for performance reporting and the periodic correcting of routing data, which might also impact pricing.

Shop floor operators should be held accountable for any changes they make to the schedule sequence because it could have an unanticipated and cascading impact on other machines and other orders.

One of my clients recently complained that they were not getting the reduction in setup times that they had expected with their new scheduling system. After verifying that the schedule was in fact optimizing the setup times by combining like items and to reduce setup and changeover times, we started to look at

actual production results. We found that 73% of the operations on the floor were not run in the sequence that the schedule dictated. A daily report was generated, showing the "On Schedule Performance" of each resource group down to the machine level. Within two weeks operators on the floor had dramatically improved their schedule to actual performance, and overall setup/changeover times began to drop.

Chapter 5
The Solution Building Blocks

Overview of the eighty/twenty process

As I mentioned earlier in the book, knowing the problem and knowing how to resolve it are two different issues. Based on years of hard earned experience my company has been able to create a process that we call the Eighty/20 Process.

While there is no doubt that manufacturers can benefit from just installing an APS system, this is missing the point. This would be like buying a new Maserati Quattroporte to drive to the corner store for groceries, while using an old beat up Ford to get somewhere fast, trying to impress a date. The benefits of integrating an APS system with day-to-day operations are so immense that it makes no sense to do it any other way. That is where the skill comes in.

The Eighty/20 Process evolved from our deep held belief in the 80/20 rule, or as it is sometimes called Pareto's Rule. For anyone who has not heard of this rule it can be applied to many things, but in this case it suggests that a company can get 80% of the results from 20% of the effort. Adopting this rule at every level of our process has had a massive impact on the overall success of our customers.

There is a step, however, that needs to be completed before using the 80/20 rule. That is a process that determines exactly what is to be achieved. The process forces us to think through and clearly document the business problem we are trying to fix and to list all the benefits that will be achieved if successful. This is what I call the Assessment phase. Getting this phase right usually enables us to deliver benefits that impact the strategic success of a company in a relatively short timeframe.

Once there is agreement on the problem, it is the job of the assessment phase to create a clear vision of what the ideal, long-term solution looks like from a high level. In most cases this allows us to break that solution down into number phases called building blocks. The first building block should not only deliver 80% of the benefits, it should also lay down the infrastructure upon which a company can build the ideal solution.

The first building block should then deliver 80% of the ideal solution although in reality this could be 70% or even 85%. So, all of the building blocks must be identified before starting along the road to delivering the first building block. When new problems or "opportunities" are encountered the overall view will make it easier to fit these opportunities into the appropriate building block, which keeps everything on track.

The Eighty/20 methodology has a number of distinct phases:

1. The Assessment Phase
2. The Design Phase
3. The Development Prototype Phase
4. The Testing Phase
5. The Implementation Phase
6. The Post Implementation Review

Of course you do not need to follow this process but if you take the time to read the next few chapters I hope I can convince you that each phase has a distinct purpose and that this is a proven way of delivering very successful solutions.

The Assessment Phase

Every penny spent on the assessment phase can pay back a thousand times over. In every new engagement I strongly recommend before doing anything, that each client spend at least two days with us evaluating where they are, what their problems are and where they want to go. Assumptions made at this stage can be disastrous so it is important to talk to someone who knows what questions to ask and what information is important. There is a great temptation to rush in with a preconceived idea and a half thought out solutions, but experience has taught us that there is no such thing as a one size fits all approach to scheduling. At least if there is, I have never seen it. Recommending a solution without knowing how a business works, why a company does things a certain way and what the particular business problems are would be absurd.

A colleague of mine reminded me recently that implementing a scheduling system without first getting agreement on the business objectives is unlikely to succeed. I was encouraged to hear this coming from someone other than me since I believe that this is a fundamental building block to the overall success of a project and there is no point in moving ahead until this has been documented and agreed upon. Ideally it also helps to identify performance indicators that measure the problem and tracks that indicate performance.

Once the overall objectives have been agreed on, then a full understanding of the gap should be documented

showing where a company is and where they want to be. This document needs to detail how the current systems work with a clear description of their limitations.

This information opens the door to an open discussion about a number of potential solutions. What I mean by this is that we will listen share how others have been able to solve similar problems.

Having a solid grasp of what is realistic, doable and likely to work is what helps both parties work through this process to reach a realistic plan. I want to emphasize the importance of having a partner to work every step of the way can save an enormous amount of time, effort and frustration.

As you explore the possibilities, ideas will start to crystallize into a clear vision of what the business solution will look like from a high level.

Solutions should ALWAYS be designed from the inside out. The business problem leads to a vision of what the new business processes should look like.

The deliverable from your Assessment will be a document that outlines at a high level the business objectives and a ballpark estimate of what it will take to deliver the proposed solution.

The Design Phase

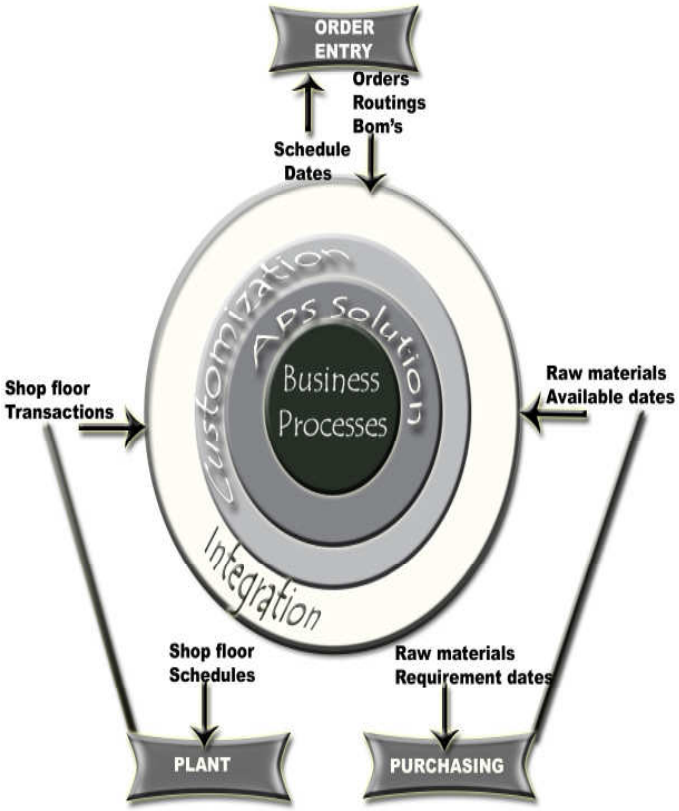
Once the Assessment phase has been completed and there is an agreement in place to move ahead with the project, the next step is to create a document that outlines in some detail the work that needs to be done and the various costs associated with delivering the solution. I have found that many of our clients are looking for a fixed-cost solution, which is a possibility under certain circumstances.

Once the Business Processes have been identified the consultant needs to define the data required to support the business process and the functionality required by the APS solution. Again it must be emphasized that the consultants should have a detailed knowledge of the strengths and limitations of the APS system so that they can clearly identify the customization that is needed to deliver the required results.

At this stage the consultant will deliver the Detailed Specifications. This is a document that includes a flow chart of the new process and a detailed list of the data that will be required. Ideally each piece of data will be stored in only one place so the document should identify the data source, the person responsible for maintaining it and if necessary an explanation of how it will be calculated.

The flow chart will clearly show the way that data flows between the various systems and the work needed to accomplish that. This will include data that needs to be

sent by your APS system to other systems such as your ERP system or your shop floor data collection system. Most of the integration work required with your new APS system will be built around the three touch points identified in the diagram below.



In addition to the detailed specifications, I strongly recommend that time is set aside to create a Scheduling Road Map (sometimes referred to as the Scheduling White Paper).

The Scheduling Road Map document is designed to explain at a higher level how the new scheduling system will impact each of the functional areas that interact with the scheduling system. This is really important and must not be glossed over because the real success of your system depends on changing the way companies work together. Those that can't change will miss out on the really big benefits of your new APS system.

The Scheduling Road Map should explain how the new system will impact each functional area, what new information they will have and what is expected from them. The reality is that most people tend to fight change and each group will resist losing its identity so there is a need for constant training and guidance until they fully understand how the benefits to them and the company far outweigh the risks of change.

The process of creating the Scheduling Road Map gives everyone the opportunity to make suggestions and become part of the solution. This should negate some of the backlash that is common when management just mandates change. The truth is that one of the biggest reasons that scheduling systems fail is because those who could benefit the most don't understand why they need to change. They don't understand what is in it for them and they don't understand how it will help the

company, so their tendency is to continue doing things the same old way.

It is the consultant's responsibility to review both the Detailed Specifications and the Scheduling Road Map with the client. Although it makes no sense moving to the Development Phase without agreement from all the key people, there are times when it might be needed to build a prototype before finalizing all requirements. This is a better option than paralysis by analysis, which can kick in when people are unsure about their options. The prototype allows everyone to get a better understanding of how the new system will work.

The system design must reflect the high level decisions outlined in the assessment and next to the assessment it is the second most important phase of your project. During the design phase, there is often pressure from the client to add more functionality. Although there are exceptions, the need to add more functionality must be resisted because it can quickly put the rest of the project at risk.

The development/prototype phase

The development/prototype phase is designed to produce a preliminary, working model of the new system using a set of test data. Most of this work is completed off-site and is based on the specifications developed in the design phase.

The reason we try to create a working model of the system as early as possible is that sometimes it is very difficult for users to comprehend the scope of the new system until they start working with it. This means they are unable to understand some of their options or anticipate some of the potential problems until they can actually see and touch it.

For obvious reasons this is not necessarily ideal but it is often part of the reality associated with introducing change. This is not to say that the design phase can be sloppy, and every attempt should be made to get it right the first time if possible. If, however, there are issues that cannot be easily resolved then the development must be done with the purpose of creating a working model or prototype as quickly as possible.

Either way, like the assessment and the design phases, the development/prototype phase should be accomplished using the Eighty/20 process with the emphasis on getting the fundamental functionality right before worrying about the rest.

The Testing Phase

A whole book can be written on this subject alone but the important thing to understand is that there needs to be two levels of testing.

Unit testing is designed to test the basic functionality of the software. Ideally unit tests should be identified in the design specs.

Integrated testing is designed to test the functionality of the integrated system and requires the tester to create a documented script for each possible business scenario such as what happens to a new order, a change order, and a deleted order. It is strongly recommended that the users be given responsibility for creating their own test scripts because this is a great way for them to learn how to use the new system and the best way we know of identifying any kinks in the new business process. Any time spent by the user in the conference room pilot (CRP) will increase their comfort level and make their transition to the new system less stressful.

Each script should identify the source data, a list of the steps to be performed, and the expected results. Integrated tests are usually performed in a CRP. The idea is to get everyone who will be impacted by the new system into one room where they can interact with each other for a concentrated period of time. The CRP will usually take three to five days.

I recommend that the scripts be kept in a loose-leaf book and that users sign off when a test passes and document the problem when a test fails.

The CRP deliverable is a detailed understanding of what is working and what isn't working. If there are issues that cannot be resolved during the CRP then there may be a need to run more than one CRP.

The Implementation Phase

The implementation phase starts with a "Go Live" plan of all the activities that need to be completed to turn off the old system and turn on the new system.

Whenever possible it makes a great deal of sense to run both systems in parallel. This allows you to validate the results you are getting from the new system against the old system before you turn off the old system.

As a rule the implementation phase will turn up a number of issues that were not identified during the CRP so it is important for the first few days to have someone on site who can continue to fine tune the system.

Like the CRP, the "Go Live" plan should document a number of tests or reports that would validate how well the new system is working. Once all the tests have been validated then the system is considered to be "Live" although the consultant still needs to have someone available at short notice to fix any issues that may arise over the next few months.

Usually the client will set up an issue list to track each issue. This should show when an issue was reported, the priority of each issue, who is responsible for the issue, and the status of each issue. This must be reviewed at least once a week until it ceases to serve any purpose.

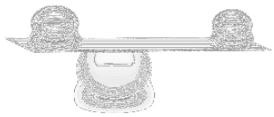
Once the users see what they can do with the new system they often get a flood of creative ideas on how to use it . When this happens there is a great temptation to add functionality to the system on the fly. Once again common sense in the Eighty/20 process kicks in. The priority should be to concentrate on getting to stability because nothing destroys confidence in a new system quicker than a never-ending stream of errors and problems.

If possible, all new requests for functionality should go into a new document for "Phase 2." This serves two important purposes; it lets each contributor know that their ideas are important and will be addressed, and it keeps proper focus on the implementation in progress.

At some point the consultant will sit down with the manufacturer to decide if there is a need for a "Phase 2." If there is a need, then a process must be followed to prioritize the requests for additional functionality. The consultant should help to create clear specifications for each request that follow a standardized format.

The format identifies the business problem, the business benefits, the solution, the estimated work, and the costs.

In effect, the Eighty/20 process is starting all over again, and failure to do this systematically can hurt progress to date.



Chapter 6
Conclusion

The ten biggest mistakes made implementing scheduling systems.

This chapter was put together with the help of my great friend Denis Picard who currently works with Alvarez & Marsal in New York. The reason I have included this chapter is to identify some of the potential pitfalls that can derail a scheduling project or for that matter any tough project.

I asked Denis to help me because I have worked with him on a number of big projects, and I've come to admire the way he's able to consistently deliver results under difficult circumstances. You see with Denis Picard, failure is simply not an option. Some of his ideas will reinforce what is already known, but some of them may be a surprise.

Just before going to print, I realized that I had totally overlooked the most critical mistake, and so I went back to Denis to get his input on what happens when the right people are not in the right places. Denis had already covered this in an article published by START-IT magazine SUMMER 2007 where he said the following:

A lot of companies put in systems because everyone else is. If that's your reason, stop. You're wasting your money.

Get serious about it. What do I mean by getting serious? Figure out who the best people in your company are and commit them to the project. By managing the project very carefully and having the best people involved in the project, by keeping the project moving along, and by getting it done quickly, I think we get far better results.

Experience has taught us that putting the right people in the right positions will have more impact on the success of a project than any other factor. I have found that the most important qualities of a leader are attitude, the ability to stay calm under pressure, and the ability to make quick decisions.

Those who make it obvious that they are sitting on the fence waiting to see if the new system will be a success or not should be removed from the project as quickly as possible.

Here is Denis's list:

1) **Not setting up for success.** Before embarking on implementing a new scheduling system, it is important to identify how success will be measured. Does it mean that late orders will be reduced; that lead times will be reduced; that profits will increase, or all of these? Simply implementing new technology is rarely an acceptable outcome; there must be a business

impact, and it can usually be quantified. Successful project leaders take time early in the project to identify objective criteria for how success will be measured.

Without something that can be clearly measured, people have a million ways to interpret the success or failure of the project. The reality is good scheduling systems can be complex in nature and things can sometimes get rough, feathers can get ruffled and you can absolutely guarantee that there will be problems. Get past this and focus on the results because the stakes are too high and the rewards are huge.

This issue is compounded because complex projects, such as implementing a new scheduling system, will attract many people eager to offer opinions on what and how things should be done. It is smart to keep in mind that "*success has many parents and failure is an orphan*".

Given that the new system will impact many people in different ways, it is essential that concurrently with defining "how" success will be measured, project leaders also understand and document "who" will measure success. Meeting the expectations of several decision-makers is indeed difficult, however, it is far easier when those decision-makers are

identified early and included in the design phase.

2) **Buying a software package because someone else did**. In a variation of keeping up with the Joneses, managers will sometimes buy a scheduling package because the vendor claims to have a large market share, or because they hear that another company used it successfully. Software alone won't solve scheduling problems but if you select the wrong software you may severely reduce your chances of success. Because scheduling is so critical to everything that happens in a manufacturing company, it requires hard work to align customer service policies, organizational structure, business processes and systems into an effective solution.

3) **Trying to "do it yourself".** The availability of powerful information technology and inexpensive programming can cloud management's judgment into believing they can design and build their own system. Buyers beware! Much like do it yourself surgery, creating your own system is tougher than it looks. Finding a partner who is experienced is also critical because a company's future is at stake. Some of the larger consulting companies have a history of using projects like this to train the latest batch of bright college graduates and

this might not be in a company's best interest?

4) **Buying an "integrated" solution because it is integrated.** On the surface, what's not to like? Buy a scheduling system from an ERP vendor and it's already integrated and ready to go. The appearance of integration is only the tip of the iceberg. Be sure to clearly understand the heritage of the scheduling module (many were acquired from third parties) and in many cases they have been poorly integrated with the ERP system. Implementing an APS system is as much art as it is science and the skill is in matching the capabilities of the software to the highly customized needs of the manufacturer. This is not something that lends itself to a standard, one-size-fits-all approach.
5) **Too much design/not enough testing.** Some companies spend months analyzing their needs on paper with the intent of designing a scheduling system that meets all of their needs. More months pass as they either write their own system or configure packaged software. As pressures to complete the project grow, they rush through testing and put the system into production, only to find serious deficiencies in the way it supports their needs. Savvy managers will work with experienced consultants to move quickly into a "prototyping" stage where the software can be put through its paces in a test environment and where issues can be identified and resolved

prior to moving the system into production.

6) **Letting "better" be the enemy of a good solution.** Another error frequently encountered is attempting to design a system that will meet all possible contingencies. Rare is the company that can completely eliminate all human involvement in scheduling. Most companies will instead change the role of schedulers from processing routine transactions towards decision-making. Using the 80/20 Principle, Scheduling systems should be designed to address first 80%, then 90%, then 95% and finally 98% of the possible scenarios; however managers should recognize that the cost and time to automate the final 1 or 2% of scenarios may simply not warrant the time and expense required – and may delay realizing far more in benefits.

7) **Forgetting that all customers are not created equal.** A key consideration in implementing a scheduling system is to focus on prioritizing around the needs of your "best" customers. While the definition of "best" may vary from one business to another, there are always a sub-set of customers that are the most profitable, most reliable, most strategic, etc. It is critical that these customers are identified, and their needs prioritized by the scheduling system. Creating a system that is designed to treat all customers the same runs the risk of

disappointing, and eventually losing, some of your best customers.

8) **Did I mention not doing enough testing?** There are two kinds of testing. Unit testing is designed to make sure that each of the solution components are tested in stand alone mode to see that they are producing the expected results. More difficult is the integrated testing, which is usually done in a Conference Room Pilot (CRP). The CRP requires that users and leaders create scripts, which are designed to test that data flows through the system and delivers the predicted results at each stage and at the end. Nobody ever spends enough time building scripts and testing at the detail level.

9) **Failing to train adequately.** New scheduling systems and capabilities will make new potential possible – but only if schedulers understand the power of the new tools. Don't rely on schedulers figuring out the new system's capabilities on their own. Instead, spend the time and money to have experienced professionals that truly understand the system work with the staff to teach them the nuances of the new system. In addition, be sure the staff understands how their decisions affect others in the organization. Good schedulers understand far more than the scheduling system; they also understand the importance and impact of scheduling throughout the

organization, including inventory management, purchasing, working capital, customer service, and maintenance.

10) **Believing that successful implementation is the end.** Successfully implementing a new scheduling system gets a company halfway towards the goal of improved capabilities and performance. Companies that believe the job is finished when the new system is implemented are often missing out on the really big pay back. The best organizations realize that improving scheduling and customer service is an ongoing challenge. The new system provides new capabilities that should lead to new processes and perhaps customer service policies. Managers should continue to listen to customers and seek out ways to improve performance. A solid scheduling system will provide a strong foundation for enhancement and a lasting competitive edge.

How much should a company invest in new planning and scheduling systems?

Conceptually this is actually a very easy question because I believe that it can be directly tied to the cost of losing one or more key customer. If this is the cost of not doing anything, and I believe it is, then it should make decision-making easier.

The reason I say this is because without stepping up to the plate and putting the right systems in place, sooner or later someone else will. It is not a matter of trying harder it is simply a matter of putting in systems that consistently enable the providing of key clients with the level of service they need.

Although this sounds tough, there is some good news:

- it will probably cost much less to implement a good scheduling system than it will to lose even one key customer
- for the most part the new system will be a one time cost that will deliver results year after year
- the competition is probably in the same situation, so getting there first can give you a lasting competitive advantage leaving them playing the "me too" game

What I am trying to say is that it is far more important to do this right than it is to save a few dollars because the cost of designing it wrong or implementing it poorly will almost certainly be a complete waste of time and money with zero benefits.

The best way to reduce risk is to find a partner that has scheduling expertise and that you can trust. The reality is that in order to be useful, the scheduling expert must have detailed experience with one or more APS solutions. This option however is usually much more viable than working with a consultant who claims to be completely neutral. Chances are that consultants who claim to be neutral are either not telling the truth or they are unable to help you at the detail level. Either way this is not someone you want as a partner.

It is quite easy to find consultants who will give you high -level advice but typically what you need is someone who will roll up their sleeves and resolve complex day to day issues.

How to beat the competition from China, India, and Japan.

It is no secret that in the last twenty years an enormous amount of manufacturing has moved away from the US and Europe to countries such as China, Korea, Mexico and India. The driving force behind this transition was the abundant supply of cheap labor in these countries.

Recently, however, there have been a number of very interesting trends that I believe will impact the manufacturing landscape in the future.

1. The sharply rising cost of oil is having a huge impact on transportation costs:
    - Increased cost of imported goods.
    - Fear of uncertainty based on events in the Middle East, which could have a disastrous and unpredictable impact on supply lines.

2. Financial growth in the emerging countries:
    - Increased wages leading to increased cost of labor
    - Higher wages will lead to an increased demand for US and European goods

3. The US dollar has been falling consistently for a couple of years, which effectively reduces the price of goods manufactured in the US.

4. Other factors:
    - More organized labor laws in developing countries will start to increase manufacturing costs.
    - Pressure from the rest of the world to improve working environments in developing countries will also increase manufacturing costs.

In addition to all these trends there is a growing need for customized products and shorter lead times, which cannot be easily addressed by off shore manufacturers. So it is my opinion that all the above factors will lead to a resurgence of manufacturing in the US and Europe, but there is a catch here.

In order to compete in the new world market place, US and European manufacturers will have to put the building blocks in place that will enable them to deliver high levels of service built on speed and flexibility.

Interestingly enough when it comes to competing with the Japanese, it is my experience that they also rely heavily on Planning and Scheduling. But apart from the leading companies like Toyota who have implemented specialized scheduling systems, many Japanese companies are happy to throw manpower at the problem. In my opinion U.S. and European companies who implement high powered, automated planning and scheduling systems should be in a much better position to meet the future head on.