Mint Jutras

Making Enterprise Business Systems Pay Dividends

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# LillyWorks APPLIES PROTECTED FLOW MANUFACTURING CONCEPTS

## ELIMINATES THE NEED FOR MRP AND FINITE SCHEDULING

*LillyWorks is challenging the assumption that manufacturing functionality was perfected decades ago, taking a radical new approach to planning and execution.*

*A recent Mint Jutras report introduced a new concept developed by MRP pioneer Richard T. (Dick) Lilly and his new company, LillyWorks. The concept, called Protected Flow Manufacturing, takes a novel new approach to production planning and execution, an area often underserved by traditional Material Requirements Planning (MRP) or even more sophisticated finite scheduling. Other Enterprise Resource Planning (ERP) vendors have been modernizing technology, but assuming manufacturing functionality was perfected decades ago. LillyWorks is challenging that assumption and taking a radical new approach to planning and execution.*

*In our prior report, Mint Jutras suggested Protected Flow Manufacturing was "better" because it:*

- *Applies simpl, rules that are equally easy to understand in the back office and on the shop floor*
- *Reflects realities of production, including variable wait times, capacity constraints, and relationships between individual orders*
- *Builds trust by not ignoring human nature*

**Protected Flow Manufacturing**

- ✓ *simplifies planning and execution*
- ✓ *prevents premature release of work*
- ✓ *reduces time jobs spend waiting*
- ✓ *protects promise dates*
- ✓ *provides a clear priority to each operation, without complicated finite scheduling*

*The concept of Protected Flow Manufacturing simplifies planning and execution, prevents premature release of work, reduces time jobs spend waiting, protects promise dates and provides a clear priority to each operation, without complicated finite scheduling. But so far we have just talked conceptually. Here we take a deep dive into how the team at LillyWorks has put these concepts into practice.*

## A REFRESHER

If you are coasting along thinking MRP and traditional scheduling methods were perfected years ago, we might suggest you review the previous report, which addressed (in depth) the question, "What's wrong with MRP?" While MRP was game changing back in the day, it suffered from a variety of flaws, many of which persist today. The sad reality is that many manufacturers still rely on spreadsheets, manually updated schedule boards and the ubiquitous daily production meeting to actually manage what goes on in the production facility.



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**Little's Law**

"In queueing theory, a discipline within the mathematical theory of probability, **Little's result**, **theorem**, **lemma**, **law** or **formula** is a theorem by John Little which states:

*The long-term average number of customers in a stable system (L) is equal to the long-term average effective arrival rate, λ, multiplied by the average time a customer spends in the system (W); or expressed algebraically: L = λW."*

Wikipedia

The concept of Protected Flow Manufacturing is based on Little's Law, which is the same theorem we all intuitively employ in our daily lives. When you walk into a bank (or store, or registry of motor vehicles), the fewer people there, the less time you wait.

Applying that same reasoning to a work center or piece of equipment, the less work you bring out to the shop floor, the less time jobs wait between operations. Shrink the wait time and you also shrink the lead-time. Shrink the lead-time and you get more done. Perhaps you are even able to sell more. The moral of the story: Don't start too early.

This is actually counter-intuitive. Many make the mistake of not trusting lead-times and so they start work early, just to make sure there is adequate time for all the mishaps that are likely to occur. Yet flooding the shop floor with work has the potential of producing the exact opposite consequence of what you intend.

So Protected Flow Manufacturing prevents the premature release of work, while protecting promise dates with a buffer. But that buffer is not assigned to a specific operation or resource; instead it floats to wherever it is needed. It can predict exactly where it will be consumed by simulating work that is due to be completed.

Let's examine how LillyWorks has applied these concepts to change the game, eliminating the need for both MRP and complex finite schedulers in a brand new ERP solution.

## TIME PROTECTION

Before you can understand how LillyWorks has incorporated these concepts into its new solution, you need to understand how it applies time protection. Time protection is the buffer noted above. In traditional MRP and scheduling systems, this buffer comes from queue times. Historically queue times have been added to individual resources or work centers. This is the average amount of time any job sits waiting in the queue before it is worked on. Bottleneck work centers tend to have the longest queue times.

These times are just that – averages. As such, they are quite variable. We know that high priority jobs tend to push through to the head of the line, while lower priority jobs suffer longer wait times. And yet planning and scheduling algorithms treat them as constants.

*LillyWorks elevates the buffer from the individual work centers to the job itself.*

LillyWorks recognizes the need for this buffer, but also acknowledges the inherent variability. So it elevates the buffer from the individual work centers to the job itself. You know that if you had only one job to run, it would take you 3 days to complete the setups and run time. But you also know that it typically takes at least 12 days for a job like this to complete. Intuitively you know that you must allow a buffer of 9 days to be safe, regardless of what the

  

production and queue times add up to. You have a 3:1 ratio of buffer time to operating time. That's exactly what LillyWorks expects from you. Tell it what that buffer ratio is (by type of job, product line or even individual product). It will calculate the production time from your standards and determine the necessary buffer using the ratio. Based on this, and a due date, it will tell you when to release the order (and not before!)

*As more buffer is consumed, the priority of the job increases when it comes time to decide what to work on next.*

If the due date is on day 15, it will tell you to release it to production on day 3. If you release it as directed, on day 3 you will have 100% of your time protection (buffer) remaining. At that point, the clock starts ticking. Every minute the job sits waiting, either up front or between operations, you eat up some of your time protection. As more buffer is consumed, the priority increases when it comes time to decide what to work on next.

## THE PREDICTOR

Once you understand the concept of time protection, it is perhaps best to look next at a new function incorporated into the LillyWorks solution. It is called "The Predictor." This is the function in which those in the traditional role of planner/ scheduler will spend a good deal of their time, at least in the early stages of implementation when they are still learning to trust the system. But The Predictor isn't a scheduler. Think of it more as a simulator. It actually looks into the future, applies a series of rules and simulates what will happen on the production floor given the current and projected capacity, workload and mix. The Predictor is used to highlight problematic jobs, resources and materials, focusing attention where it is most needed.

*The LillyWorks Predictor isn't a scheduler. Think of it more as a simulator that calculates when each operation of each job will start and finish. The Predictor is used to highlight problematic jobs, resources and materials, focusing attention where it is most needed.*

The LillyWorks Predictor calculates when each operation of each job will start and finish, based on:

- Resource capacity
- Estimated move, setup and run times
- When each resource (work center) will complete its current job
- Material availability

Unlike traditional MRP, The Predictor is not a black box. Once these calculations have been made, it allows you to "rewind" and step through all the decisions it has made. There are two different views available to help planners, schedulers, supervisors or even customer service representatives understand where, when and how long different jobs will be waiting or worked.

One view is by work order or job, displaying the predicted start and completion of each of the operations, not only day by day, but minute by minute. The length of time predicted to be spent at an operation is determined by the setup and run times previously established. The length of

  

time spent waiting between operations will be determined by the move time and the predicted wait time.

*Unlike legacy solutions that ignore move time, forcing you to artificially inflate setup times, LillyWorks segregates this out.*

Unlike legacy solutions that ignore move time, forcing you to artificially inflate setup times, LillyWorks segregates this out. Of course if the job is moving to an operation in close proximity, this can be zero. But if you have to move it any distance (across lots, across town or across the globe) or if moving partially completed work requires special equipment, it is best to accurately reflect this in your predictions. While you establish standard move times, you don't have to create a standard queue time. LillyWorks will tell you how long jobs will wait.

The predicted wait time will be determined by other jobs competing for the same resource and the relative priorities calculated by LillyWorks. Following the rules established by the Protected Flow Manufacturing methodology, that priority is determined by how much time protection has already been consumed.

It is easier to understand these priority decisions by looking at them from the alternative view: by resource. LillyWorks knows a decision must be made whenever an operation completes. It must answer the question, "What's next?" That will of course depend on what is sitting there waiting – not what is there **now**, but what **will be** there at a future moment in time. LillyWorks actually calls it a "current future moment."

*Jobs with the least percentage of buffer remaining have the highest priority. All the operators need to do is follow that rule and the decision as to what to work on next becomes dead simple.*

LillyWorks will make that decision based on how much work has already been completed and how much of the buffer has been consumed. Those with the least percentage of buffer remaining have the highest priority. All the operators need to do is follow that rule and the decision as to what to work on next becomes dead simple.

LillyWorks also provides another important piece of data. This added data is called a "threat level." In fact it is related to the percentage of buffer remaining, but also considers how much production work remains. It is calculated as:

*Threat level = percent of work remaining / percent of buffer remaining*

The threat level starts out at 1 (100% of work remaining/100% of buffer remaining) and it escalates as the job sits waiting. If your percentage of buffer remaining is only 10%, but you are very close to completing the work, you are in good shape. But if the percentage of buffer is 10% and you have only completed 50% of the work, the threat level is now 5. You're in trouble.

Of course if your operating times and buffer ratios are realistic and you follow the priority rules, this is unlikely to occur. But part of the reason you need time protection is because of unpredictable delays such as those due to inaccurate time estimates, worker illness, machine breakdowns, or even weather. It is for this reason you never willingly plan to complete a job on the day it is due. It is

  

*"The min" is designed to help you sleep at night. It is the minimum number of days of buffer that should remain at the completion of the order.*

*The Predictor's ability to "rewind" and step through each decision made is an important aspect, but over time less time will be spent "rewinding" and more time will be spent on improving efficiency and productivity.*

also for this reason that LillyWorks has incorporated an added data element called "the min."

"The min" is the minimum number of days of buffer that should remain at the completion of the order. It is important to note that this does not add to the buffer, but is useful in identifying potentially problematic jobs. If the system were to tell you it would complete the job the day it is due, would you be able to sleep at night? If not, how about two days ahead of the due date? If that makes you comfortable, then your min should be set to two days.

The Predictor in LillyWorks is not a black box. The ability to "rewind" and step through each decision made is an important aspect, at least early on, while you are learning to trust the system. But as time goes on, Mint Jutras suspects less time will be spent "rewinding" and more time will be spent on improving efficiency and productivity. LillyWorks' implementation of Protected Flow Manufacturing concepts can help you do that by giving you a history of how much buffer is left. If you see this starting to grow, it will be a trigger for you to start whittling that buffer down until you are simply operating as a well-oiled machine at your peak performance.

Most likely you will require fewer staff in order to keep your production running. However, those currently doing this planning and scheduling should see this not as a threat, but rather as an opportunity. Over time good planners and schedulers develop good instincts for the production process and the business. Think of it as tribal knowledge. Are you taking full advantage of these instincts and this knowledge? Use it to reduce buffers and lead time and actually improve your business.

## ELIMINATING MRP ALTOGETHER

So far we have only talked about work centers and operations. You might be wondering how Protected Flow Manufacturing impacts material planning. Do you still need MRP to explode those bills of material and net out supply and demand in order to supply the necessary materials? The short answer is, "No." Yet to fully understand the why and how, there are many different scenarios to consider.

Perhaps the scenario that is most intuitively easy to understand is your typical job shop where product is made to order and materials are purchased directly for a job. This also happens to be the environment where traditional MRP is the worst fit. MRP works best in a standard product environment driven by forecasts, standard lead times between levels in a BOM and order policies that group both dependent and independent demand. Job shops might sell a (non-standard) product, but in the end they are really being paid for their ability to deliver against a promised date, usually with constrained capacity.

The team at LillyWorks knows this environment intimately. Prior companies owned by the Lilly family have served job shops for years. So how has LillyWorks addressed the limitations of the classic MRP?

*LillyWorks has replaced the separate bills of material and routings with an integrated engineering model.*

First of all, it replaced the separate bills of material and routings with an integrated engineering model. Materials are linked directly to the operations at which they will be consumed. By directly associating materials with specific operations, the timeframe for when those materials are needed is no longer an approximation based on component offset lead times (typically a pure guess) but the predicted start of the actual operation. And before suggesting you expedite material, it makes sure you have the capacity to use it, eliminating useless and wasted effort.

This is a no-brainer for simple, single level BOMs and simple, linear sequences of operations. However, if manufacturing were that simple, you wouldn't need a job shop. Yes there tend to be multiple levels of operations, some of which need to happen concurrently, ultimately merging at the end of the job. So LillyWorks has introduced a multi-level work order. If you simply rely on separate work orders to create subassemblies (this is what MRP does), you can only **imply** the connection to the next level through a required date. With a LillyWorks multi-level work order, it is directly linked to the specific operation where it is actually needed. Changes made to any level automatically permeate throughout all levels.

*While those making to order promise a delivery date, those making to stock promise instantaneous availability (i.e. the item will be in stock). So Protected Flow Manufacturing protects, not with time, but with inventory.*

Of course even job shops might deal with some stock items. And therefore LillyWorks has built in features to help make-to-stock manufacturers as well. In fact it uses some of the same principles described above in terms of buffers and protection, applying them to inventory. While those making to order promise a delivery date, those making to stock promise instantaneous availability (i.e. the item will be in stock). So Protected Flow Manufacturing protects, not with time, but with inventory. The priority is always given to the work order with the least relative amount of protection remaining, whether it is being made for stock or for a customer. But it never inflates the priority of building (excess) inventory that is not needed.

LillyWorks has also added some nice features to help manage the purchase of materials. Instead of the typical purchase lead-time, LillyWorks has broken this lead time down into four different components:

- Notification lead time
- Order to ship lead time
- Transit lead time
- Inspection lead time

And because sometimes suppliers quote in business days, and sometimes they quote in calendar days, LillyWorks allows you to attach a calendar to each supplier, indicating whether they quote in 5-day or 7-day weeks. This gives the

  

added benefit of being able to anticipate shutdowns and holidays. These are added little features that go a long way towards reflecting the realities we all face in a global environment.

## CONCLUSION

*Protected Flow Manufacturing is a radical new approach to manufacturing planning and execution, the first of its kind in more than 60 years.*

Protected Flow Manufacturing is a radical new approach to manufacturing planning and execution, the first of its kind in more than 60 years. Other ERP vendors have modernized solutions but have also assumed manufacturing functionality was perfected decades ago. Yet this manufacturing functionality is at the very core of the operations of manufacturers, more often than not creating obstacles to optimizing performance and growth. And yet most companies have become complacent, accepting MRP and scheduling systems as if they were as good as they were ever going to get… hence the predominance of spreadsheets, manual schedule boards and the ever-present daily production meetings. Think about what you could accomplish if you could eliminate them and rely instead on a system you trusted.

LillyWorks has thought a lot about this and as a result has challenged those assumptions and has developed a new ERP solution with an entirely new methodology for planning and execution at its core. If the MRP and scheduling functions within your ERP are not creating the perfect plan for you, if you have trouble executing on that plan, go take a look at what Mr. Lilly and his team have done. Yes, it means you might have to rethink how you construct age-old models like BOMs and routings. Yes, the concept of a multi-level work order might seem complex at first. But let them simulate a schedule for some of your most troublesome, capacity-constrained resources. Most likely you will be surprised to learn what you might be doing wrong… and how you can fix it.

***About the author:*** *Cindy Jutras is a widely recognized expert in analyzing the impact of enterprise applications on business performance. Utilizing over 40 years of corporate experience and specific expertise in manufacturing, supply chain, customer service and business performance management, Cindy has spent the past 10 years benchmarking the performance of software solutions in the context of the business benefits of technology. In 2011 Cindy founded Mint Jutras LLC (www.mintjutras.com), specializing in analyzing and communicating the business value enterprise applications bring to the enterprise.*

  