INSYNC SOLUTIONS WHITE PAPER

The Next Generation of Planning and Scheduling Solutions

synchrono®
manufacturing software

Evolution of Manufacturing Goals

The primary goal of most manufacturers has remained constant over the last 50 years: make money now and into the future. Yet the underlying process and objectives to achieve this goal have changed considerably. There was a day when manufacturers operated on the "my customers can have their car in any color, so long as it is black" mentality. A world in which the equation of cost plus profit equals sales price still worked. Over the last 50 years, the change has been dramatic with a conversion of the equation to sales minus cost equals profit.

New realities put intense pressure on manufacturers to continuously improve or face extinction.

Today, customers have too many alternatives for manufacturers to be able to set their sales price and therefore, the market sets the sales price irrespective of cost. This new equation has led to continuous improvement methodologies like Lean manufacturing whose mantra is the continuous and relentless elimination of waste. This is how profit increased in the year 2011 and beyond. In addition, manufacturers are now in a world where they are expected to deliver what the customer wants, when they want it, for a reasonable price. These new realities put intense pressure on manufacturers to continuously improve or face extinction.

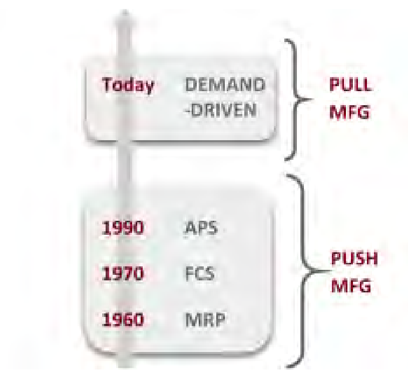
Manufacturers face increasing variability coupled with increased product and supply-chain complexity.

Getting on the path to continuous improvement is easier stated than achieved. Manufacturers face increasing variability coupled with increased product and supply-chain complexity. The impact of ever-increasing variability and complexity is often a degradation in delivery performance and results in higher inventories, rising fulfillment costs and poor utilization of labor and equipment. In environments where variation and complexity have taken over, confusion and chaos reign supreme and fire-fighting is the norm. Profits erode as manufacturers employ more people to manage the chaos, pay expedite and premium freight fees to overcome material deficiencies, pay overtime premiums to try and get orders back on track and pay late fees. Worse, they lose customers based on their inability to meet customer commitments.

Evolution of Manufacturing Systems

Companies have invested thousands of man-hours and up to millions of dollars in infrastructure and software systems. Enterprise Resource Planning (ERP) systems serve as the transactional backbone and database for the entire

THE EVOLUTION OF MANUFACTURING SYSTEMS



enterprise. Within most ERP systems, Material Requirements Planning (MRP) was incorporated as the primary solution for manufacturing. MRP had many deficiencies that, over the years, led to the introduction of point solutions to try and make manufacturing more effective.

The following is a discussion of the evolution of software solutions within manufacturing from the 1960's through present day.

MRP

MRP was invented in the sixties to prevent manufacturers from running out of purchased materials necessary for production. Manufacturers still viewed inventory as an asset, both from a financial and philosophical perspective, so it was perfectly acceptable to run large batches and have mountains of inventory throughout manufacturing and the extended supply chain. In addition, at the time of MRP's inception, capacity was not perceived to be a constraint as machines were almost all general purpose and adding more people easily increased capacity. Therefore, MRP assumed infinite capacity and provided for fixed lead-time offsets from order delivery date to purchasing.

Demand-driven manufacturing techniques are moving us towards a customer-order centric model of manufacturing.

Material-Centric Planning and Scheduling

Fast-forward 50 years to present day where Just-in-time (JIT)/Lean manufacturing principles have taught us the true effects of inventory and where competitive pressures have changed key performance indicators to metrics like return on assets. MRP took a material-centric view of the manufacturing process with the goal of ensuring that within a daily bucket, there were enough planned supplies to cover demand so our projected inventory did not go negative. It was never designed to function in a lean environment where concepts such as JIT and single-piece flow force a level of synchronization that MRP is ill-equipped to handle. The concept introduced by MRP of using work orders for each level of the bill of materials (BOM) to de-couple supply and demand cannot survive in a world where demand-driven manufacturing techniques are moving us towards a customer-order centric model of manufacturing.

Backward/Infinite Scheduling

With regard to scheduling, MRP deploys only a backward scheduling algorithm which schedules late orders in the past ("late bucket"). If demand exceeds capacity at just one constraint - in the many and complex series of operations - then deliveries will become erratic with no early warning for orders that will become late. Because it does not schedule forward, it not only is incapable of projecting completion dates accurately, but also causes de-synchronization of the work-in-process (WIP). For example, if part "A" is built from parts "B" and "C", and there is not enough capacity to make part "A", MRP does not delay the release of parts "B" and "C" causing them to now become WIP waiting on capacity to open back up to produce "A".

FCS and APS

PUSH SYSTEM:
When a replenishment order is made, the build quantity is based on machine or process time and expected future demand.

The quantity is typically larger than the immediate demand and the balance waits in inventory to be consumed.[1]

Finite Capacity Scheduling (FCS) systems and Advanced Planning and Scheduling (APS) solutions were both built as add-ons to MRP to overcome the inherent flaws within the system. FCS emerged in the seventies and focused on eliminating the "infinite capacity" issue within MRP by taking the work order outputs from MRP and using backward/forward scheduling techniques applying finite capacity to arrive at a level-loaded production plan.
APS became popular during the nineties as the next advancement to FCS using operations research techniques such as linear/integer programming to "optimize" the finite production schedule to minimize overall setup time. In addition, APS made a large improvement over FCS by simultaneously considering both capacity and materials.

Push-Based Manufacturing

Both FCS and APS have similar deficiencies, so both will be covered in this section. While MRP took a work order-centric view of the manufacturing operation, FCS and APS take a resource-centric view. This resource-centric view takes us further down the flawed path of believing that local optimization leads to optimization of the enterprise. Both FCS and APS will continue to release work to the shop floor in order to maximize utilization of each individual resource regardless of whether or not it is needed by downstream resources or ultimately the customer. There is a definitive word for the type of manufacturing that prevailed in the 60's, 70's, 80's and part of the 90's, it is called PUSH manufacturing. The debate over which is better,

[1] Robert W.F. Krause II, Lean Manufacturing - Push vs Pull Systems

push versus pull has been soundly decided, as only the uninformed would continue to argue that demand-driven PULL techniques are not the decisive victor. Producing without regard to downstream customer requirements floods the shop floor with work-in-process (WIP). These excessive and varying levels of WIP created through APS and FCS solutions cause large variations in queues, cycle times and throughput and have a devastating effect on synchronization. And while APS may increase resource efficiencies, by de-synchronizing the manufacturing plant, it disrupts convergence points and drops overall throughput leading to a decrease in return on assets because return does not occur when a resource produces a part, it occurs when the product is shipped to the customer.

Deterministic Run, Setup, and Move Times (Impact of Variation)

FCS and APS assume that setup, run and move times are known. In reality, all of these times are the average or statistical mean and not known values. In other words, each time a part moves through a resource, we would expect the actual times to rarely if never match the defined time. Instead, we would expect to see a distribution around the mean with some reported times being shorter and some being longer than the defined (average) setup, run and move times. We will cover the effects of this reality on expediting within FCS and APS environments a little later. For now, let's focus on how FCS and APS respond to resources not performing exactly to the average setup and run times defined in the routing. Keep in mind that FCS and APS prioritize work based on their view of finite capacity and the optimization of it. That is, whenever an operation produces something early or late, the schedules of all upstream and downstream resources must be re-aligned – de-prioritizing work that is completed late on downstream operations (as it will no longer be available when originally planned) and accelerating plans for work that is completed earlier than expected. We call the impact of this type of planning "The Butterfly Effect" where small variations in one part of the system are propagated throughout the rest of the dependent system. So, rather than dampening the effects of variation, APS and FCS amplify it.

***PULL SYSTEM:* *Build based on what is consumed; the inventory level is only what is required to satisfy current customer demand so excess inventory is minimized.*[2]**

Additional Issues with MRP, FCS and APS

Some of the inadequacies across PUSH-based MRP, FCS and APS systems are similar, including treating setup, run and move times as known values. In this

[2] Robert W.F. Krause II, Lean Manufacturing - Push vs Pull Systems

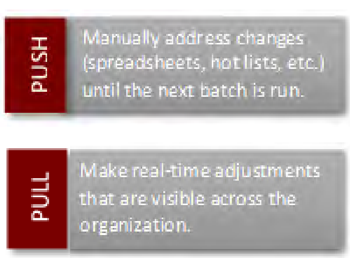
section, we will cover some consequences of these deficiencies along with additional issues that are common across all three solutions.

The problem with MRP, FCS and APS systems is that they signal the need to expedite even when the variation does not put the overall order in danger of being late.

Deterministic Run, Setup, and Move Times (Expediting)

Treating run and setup times as known values leads to one more very large issue within manufacturing environments. When resources complete their work late, even if it is a normal variation, they trigger an expedite alert in MRP, FCS and APS. The problem with this is at the resource level, as it is impossible to tell if an expedite signal is really needed or not. If you think of variation across multiple resources within the overall process flow, we could expect that through normal variation, some resources would complete work slower than expected while others would complete work faster than expected. So, even if work falls behind at one resource through no expedite action, it could catch up at downstream resources. The problem with MRP, FCS and APS systems is that by taking their work order-centric or resource-centric view of the manufacturing operation, they tend to signal the need to expedite even when the variation does NOT put the overall order in danger of being late. Anyone who has worked in a manufacturing environment knows the disruptions, in-efficiencies and chaos that expediting causes, so why would we want systems that drive expediting even when it is not required?

MANAGING VARIATION



Batch Processing

Since they all evolved from one another MRP, FCS and APS systems all carried forth the view of functional silos within manufacturing. In all three of these solutions, planning and scheduling are carried out through a batch process with a twice daily, daily, or weekly regeneration of the schedule and material plans. After scheduling is complete, it is passed over the wall to the manufacturing plant and purchasing to execute the plan. Again, the issue with this is variation. As variation occurs in the system, whether it be changing dates to existing orders, new rush orders, machine breakdowns, etc., the plan quickly deteriorates until the next regeneration where the cycle can begin again. This is why in environments running MRP, FCS or APS systems, there are always auxiliary ways of communicating the schedule to the shop floor via Excel spreadsheets, post-it notes, hot lists and hot–hot lists. The system does not keep up-to-date with variation and new information available, so these auxiliary ways to maintain and communicate the schedule are created and used.

Command and Control

Lean manufacturing put practical tools in the hands of manufacturers looking to convert the employee empowerment movement of the nineties into reality. The movement took hold and is embraced widely today. MRP, FCS and APS were built on the command and control mantra of old. All of these solutions believe that the system, along with the planning and scheduling department, can create the perfect schedule that will be communicated to the shop floor to execute. We have already discussed the fact that variation renders these plans useless soon after their release. Yet, it is important to iterate that these solutions believe that planning and scheduling - along with the planning engine of the software - can be more effective in defining the optimal schedule than the people who spend their lives managing the shop floor and running the equipment. Outside of completely automated environments, how could this ever be true?

Electronic Concrete

The final item to cover with regard to MRP, FCS and APS is system or model flexibility. All of these systems are very data dependent and operate at a very granular level in scheduling production. It is very hard within each of these systems to keep the model in alignment with reality. For example, say we hold a kaizen event to improve flow of a product through the value-stream and find that all of the physical changes made led to a decrease in cycle time (time from release of material until completion of the shipped product) from 100 hours down to 80 hours. In our MRP, FCS or APS systems, which of the thousands of variables do we need to change? Should we adjust run, setup, move or queue times? On which resources? How about resource utilization or our setup matrix? Each of these systems was built with very complex models and data dependencies that make them hard to adjust to reflect new capabilities brought on by continuous improvement. At Synchrono, we call this “electronic concrete” – set up the system once, let it set, then hope you don’t ever need to change it. This is why in so many manufacturing environments, the software is viewed as an inhibitor rather than an enabler of demand-driven pull and Lean Manufacturing.

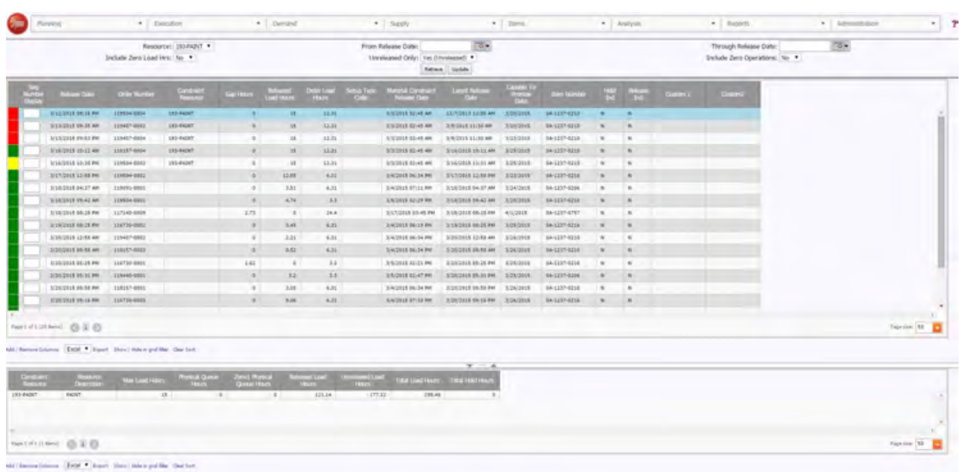
The Next Generation of Manufacturing Systems

Fortunately Synchrono did not fall into the same trap of trying to evolve APS one step further when inventing its patented planning, scheduling and execution solution. When developing SyncManufacturing™, the focus was on creating a solution that allowed manufacturers to run their operations and extended supply chains based on demand-driven pull methodologies. The company did, however, continue down the path of leveraging information from existing ERP systems, but broke free from the push-based path that MRP, FCS and APS followed.

Order-Centric, Flow Based Scheduling and Execution

An order-centric approach optimizes flow through the entire system rather than inividiual components - this drives increased throughput through the entire system.

SyncManufacturing software is the first solution to look at manufacturing from a value-stream perspective. It does this by taking an order-centric view of manufacturing and focuses on synchronizing man, material, method and machine to produce the order in the most efficient way possible. This order-centric view of the manufacturing process drives the system and those who use it to optimize flow through the entire system rather than individual components. Focusing on flow through the entire process leads to increased throughput through the entire system. And throughput through the entire system is what impacts the bottom-line. Local efficiencies that are not synchronized with the overall system lead to increased WIP, decreased flow, decreased throughput and ultimately decreased profits.



The scheduling engine instantly identifies resource and/or material constraints, providing actionable information to resolve issues before they become problems.

Decreased Expediting

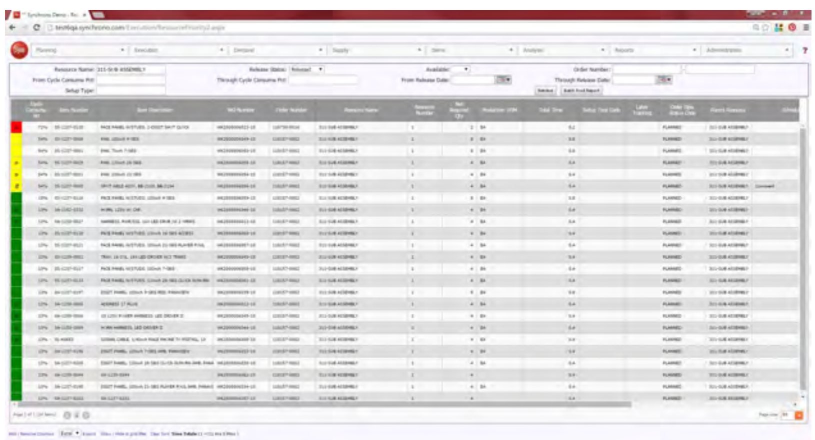
By taking an order-centric view of manufacturing, SyncManufacturing plans the entire production flow as an extended process. This allows the software to overcome many of the deficiencies inherent in preceding solutions. The order-centric view allows SyncManufacturing to monitor the cumulative variation across all resources required to produce the order and only signal expediting when the order is in jeopardy of being late rather than sounding

Monitor variation across all resources and only signal expediting when the order is in jeopardy of being late rather than sounding the alarm when an individual resource falls behind.

the alarm whenever an individual resource falls behind. So, with SyncManufacturing, expediting is reduced along with the chaos and inefficiencies that expediting causes.

Dampen and Manage Variability

SyncManufacturing fundamentally believes that all data points for determining the perfect schedule are not known and even if they were, that variation makes the effort of generating such a schedule a frivolous act. Instead, SyncManufacturing ties the priority to the customer delivery date throughout the system. SyncManufacturing utilizes a unique prioritization method based on a cycle consume percent calculation to synchronize man, material, method and machine throughout the enterprise. Instead of trying to define the perfect schedule, the high-level goal is to synchronize these elements to increase throughput and achieve customer commitment dates.



Red, yellow and green color-coding indicate order availability and urgency. This makes it easier to identify orders that demand quick action to resolve materials and/ or capacity issues.

Cycle consume percent identifies priority based on color - red, yellow, and green zones communicate a sense of urgency and indicates to operators when all inputs required to perform an operation become available (materials, tooling, fixtures, work instructions, programs, etc.). By providing this information to the shop floor, SyncManufacturing empowers workers to make the decision of what to work on next - at the latest possible moment. At that time, the effect of all variation is known and operators have the most information with which to make the best possible decision. Real-time decisions that support maximization of flow and throughput through the entire manufacturing process and ensure on-time customer delivery.

Cycle consume percent is a calculation that synchronizes man, material, method and machine throughout the enterprise.

"90% of manufacturers who are not demand-driven, want to be."

(Gartner)

Pull-Based Manufacturing

SyncManufacturing utilizes a patented CONLOAD (continuous load) methodology to determine capable to promise dates and to control release of work to the shop floor. The CONLOAD methodology focuses on constraints or control points to determine the pace of the overall manufacturing process. CONLOAD reduces the reliance on data by focusing on a handful of control points to schedule as opposed to every resource within the production process. In addition, CONLOAD gates work into the production process based on the shop floor's capabilities and actual performance. This gating of work creates a demand-driven pull environment in which authorization is only given to the upstream work center to produce when the downstream control points indicate, or the customer requires it.

Material and CTP Synchronization

While priority of work on the shop floor may not fluctuate based on variation within the production process, when purchased material is required and when the order might be completed can fluctuate. SyncManufacturing continually monitors the status of the order throughout the system and will make adjustments to material requirements and the capable-to-promise (CTP) date to be in alignment with the actual performance of manufacturing.

Real-Time Planning, Scheduling, and Execution

SyncManufacturing is the only system on the market that has a real-time, adaptive scheduling process. The importance of this cannot be stressed enough. Without a real-time system that does not delineate between planning, scheduling, and execution, manufacturers cannot get to a point where the system is the schedule and the schedule is the system. Without a system that is taking into account all of the variation in real-time, we will need to have auxiliary systems to handle variation that occurs between regenerations. How else would manufacturing be alerted to the customer order whose delivery was moved up by two weeks, or the part that was just scrapped that is needed to make good on your commitment to a heavily valued customer? SyncManufacturing considers scheduling and execution to be one in the same, scheduling must always know what execution is doing and vice versa. Chaos - a not so silent killer of throughput - is dramatically reduced with SyncManufacturing because all points of variation and how they relate to scheduling and execution are known and can be managed.

Links to helpful resources:

White Paper: *Why Become More Demand-Driven? Responding to Customer Needs*

Article: *What is Demand-Driven Manufacturing?*

Article: *CONLOAD Scheduling Methodology*

Support, Enhancement, and Acceleration of Continuous Improvement

Finally, by taking an order-centric view of the production process, SyncManufacturing makes it relatively easy to make changes to the model to take into account new capabilities in manufacturing. Going back to our original example, if a value stream map is done and kaizen events are carried out that decrease the cycle time on a particular product line from 100 hours down to 80 hours, the SyncManufacturing model can be quickly adapted to take this new capability into account. SyncManufacturing was built with the idea that the model must change otherwise we are not improving. Because of this flexibility, SyncManufacturing supports, enhances and accelerates the continuous improvement process.

The Next Generation is Here

SyncManufacturing provides the next generation of planning, scheduling and execution software that drives manufacturing based on demand-driven pull techniques. It addresses variation head-on and uses innovative methodologies to manage the variability and control the chaos so that the system can become predictable and throughput can be maximized. More information is available at www.synchrono.com.

About Synchrono.

Synchrono is leading the movement in modern Demand-Driven Manufacturing software with a portfolio of applications that focus on enterprise and operational management – from supply chain and inventory management to production and execution systems. All delivered through a real-time, dynamic and web-based technology platform.

Bringing Lean and Constraints Management principles to life, the company's inclusive, yet modular approach allows for continuous, real-time information integration and flow throughout the plant and beyond to the extended supply chain ecosystem. With Synchrono, manufacturers gain visibility across their organization for greater clarity while enterprise-focused tools help control costs and variability driving on-time performance and a clear competitive advantage. Visit www.synchrono.com for more information or to request a private demo.

About the Author.

As vice president of product strategy, John Maher is responsible for providing the strategic direction for the Synchrono product roadmap. John also oversees the technology and delivery functions within the organization and has spent the last fifteen years working to leverage technology to provide real-time constraints management, improve flow and drive on-time production for manufacturers. John's subject matter expertise in ERP, MRP, APS, supply chain, planning and scheduling systems and constraints management drives continuous refinement of the company's Lean and constraints management-based software and services.

John earned his BBA in production/operations management from University of Wisconsin, Whitewater, and an MBA from the University of Minnesota, Carlson School of Management. He has APICS CPIM certification in production and inventory management and Jonah certification in Theory of Constraints from the Goldratt Institute.

