White Paper

Demand-Driven Manufacturing

Metrics that Drive Action

Discussion Points:

- What you measure in a customer-centric pull/demand-driven environment changes from the traditional push/forecast model.
- A digitally connected environment allows you to synchronize people, materials, machines, method and data in real-time to improve flow.
- By focusing on the manufacturing Operations *Metrics for Action*, you gain insight to improve operations and supply chain performance.

An Introduction to the *Metrics for Action*

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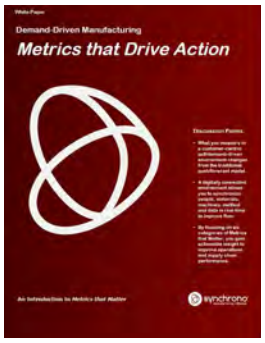

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Introduction: Measuring Manufacturing in a Digitally Connected, Demand-Driven World

As more manufacturers evolve toward a demand-driven (or customer centric) method of manufacturing, the metrics that measure their success change. The focus shifts from improving local, isolated efficiencies to improving global, or the *overall* production flow. In a real-time environment, manufacturing leaders don't have time to manage every individual order – they've invested in software to perform that function. Rather, operations managers and supply chain leaders need to focus on the *exceptions;* the events that *disrupt* production flow. They need to get closer to their data to understand the root cause of issues and deploy predictive analytics to pre-empt future disruptions.

Factories of the Future are embracing the Industrial Internet of Things to digitally connect all their data sources (machines, software systems). In doing so, they are transforming nearly every aspect of their operations in order to drive innovation and respond to competitive pressures. These smart manufacturers are using Demand-Driven Manufacturing software to drive optimal flow in the factory. They are using Constraints Management techniques to determine the leverage points that exist within. They are using systems to monitor and track every order—from supplier to production floor to supermarket—and out the door. They are using that same system's dashboard and alert management tools to notify them of current or potential disruptions to production flow. They are using pull-based replenishment systems to make their vendors and business partners streamline inventory response. Above all, they are accurately measuring the effectiveness of all of these elements to get a real-time grasp of how well their people, machines, suppliers and processes are keeping up with customer demand.

Demand-Driven Manufacturers who have these connected capabilities are providing significant value to their customers – and to their top *and* bottom line. In this paper, we will address how metrics shift in a Demand-Driven Manufacturing environment and how technology is freeing data to enable new ways to visualize information and measure for improvement. We will provide guidance on the capabilities you need to have in place and a streamlined set of operations metrics to focus on to drive *actionable* results.

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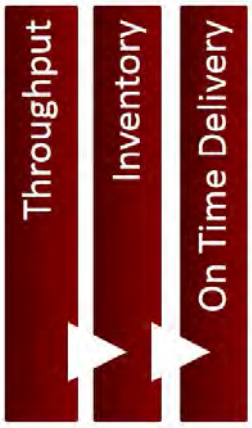
Focus of Demand-Driven Manufacturing Metrics

Production is based on actual demand and managing constraints drives production flow to impact these key metrics:



Theory of Constraints (TOC):

A holistic management philosophy developed by Dr. Eliyahu M. Goldratt that is based on the principle that even a very complex system made up of thousands of people and pieces of equipment can have at any given time only a very, very small number of variables – perhaps only one (known as a Constraint) – that actually limit the system's ability to generate more goal units.

(TOCICO Dictionary 2nd Edition)

The Role of Synchronization in Demand-Centric Measurements

Demand-Driven Manufacturing is production based on actual customer demand (or customer consumption). That is, Demand-Driven Manufacturing enables a synchronized, closed loop between customer demand and production scheduling and manufacturing execution – all while simultaneously coordinating the flow of materials and resources across the supply chain. The foundation for Demand-Driven Manufacturing is synchronization and flow. These are the elements that will ultimately drive what you measure and improve upon.

The Gartner paper, *Introducing the Five-Stage Demand Driven Maturity Model for Supply Chain Leaders*[i], validates synchronization as the starting point for meaningful Demand-Driven Manufacturing metrics. According to Gartner, the first stage that every manufacturer should reach is to have "aligned and synchronized demand, supply and product cycles in the organization." At this initial stage, synchronization may be used as a continuous improvement tool to find issues that are interrupting flow. These issues can often be found in data that connects people, machines, materials and methods in real-time. Next, let's review why synchronizing your systems – and data - is critical.

In many environments, the transaction "system of record" used to measure business results (often an ERP system) is not connected to the systems responsible for delivering these results—the actual production execution systems. Demand-Driven Manufacturers have evolved to a "system of differentiation" that sits on top of their system of record to connect and synchronize all data sources. Consider that your supply chain and operations - just as much as your sales team - delivers or inhibits profitability. So, if your production planning, scheduling and execution data is not integrated into your system of record, you won't have real-time, closed loop reporting and you won't be able to measure how well your production is matching customer demand.

If your machine-level and production system data is not connected to your system of record data, you are not viewing productivity and profitability in real time. If, however, you have synchronized your planning, scheduling and execution with your system of record, you have gained a system of *differentiation*. You can see all

Additional Suggested Reading:

White paper: ***How Technology will Connect Your Enterprise and Create the Demand-Driven Factory of the Future - Today*** discusses how the Demand-Driven organization can use Lean Manufacturing, Theory of Constraints and Six Sigma principles to focus on areas of improvement to drive business goals.

White paper: ***Gaining Control: Exploring Push v. Pull Manufacturing*** contrasts the Push-based MRP with the Pull-based Kanban method to support today's demand-driven manufacturing environments.

White paper: ***The Next Generation of Planning and Scheduling Solutions*** reviews the evolution of manufacturing planning and scheduling goals – and systems, including ERP/MRP and adaptive demand-driven systems.

of the moving parts that contribute not only to reduced variability, waste and expediting, but also to improved quality, increased capacity and on-time delivery. You get a handle on these elements of your enterprise by ensuring that your metrics are clear; they don't conflict, and they drive the right behaviors. Look at the chart below to begin understanding the characteristics of Demand-Driven Manufacturing and how they relate to the metrics we will discuss.

SYSTEM COMPARISON

Pull-Based (Demand-Driven)	Push-Based (MRP)
• Fulfill demand	• Anticipate demand
• Customer-centric	• Planning-centric
• Proactive decisions based on synchronized, real-time data	• Reactive decisions based on available data
• Dynamic adjustments	• Difficult to adjust
• Consumption /replenishment-based	• Forecast-driven
• Inventory aligned with customer demand or consumption	• Inventory aligned with forecast
• Low inventory	• High inventory
• Real-time adjustments with minimal disruption	• Rescheduling sends waves of adjustments
• Flow centric	• Machine/capacity efficiency-based
• CONLOAD™ method for Constraints management	• MRP/ERP, APS

Improved Flow Stems from Synchronization and Management of Constraints

Synchronization connects your people, processes, materials, machines and information. It provides universal visibility to priorities, aligns resources and materials, alerts you to issues and more. In a synchronized environment, everyone is working from the same information to drive flow. This level of visibility can also identify Constraints that control production flow and ultimately, Throughput.

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Choosing a Constraint:

Choosing a Constraint can cause a great deal of anxiety – even a paralysis of action - for many organizations. If you choose a Constraint, and it is not the *actual* Constraint, your metrics will point this out to you very quickly:

- **If the location of the *actual* Constraint is before the chosen Constraint, you will see a great deal of disruption (starvation) in the Constraint.**
- **If the *actual* Constraint is after the chosen Constraint, then you will have increased WIP in the system, and the chosen Constraint will stop working until the actual Constraint consumes the WIP.**

Once you have identified a Constraint (a variable in the system that limits your ability to produce more), you need to manage it. That is, work on what is limiting your ability to achieve your goal to improve flow. Stephen Covey said, "Start with the end in mind." We're saying here, "Start with the Constraint in mind." And all of your metrics—and the activities based on them—will align behind demand.

How you manage the Constraint will, of course, depend on the source of the Constraint. Some possible remedies include:

- **Eliminate defects at the Constraint**
- **Put quality steps in front of the Constraint**
- **Add labor to support the Constraint**
- **Appropriately use buffers[ii] to protect against variation in front of the Constraint as much as possible**
- **Leverage the Constraint by having it set the pace for a constant rate of production flow**
- **Synchronize all other resources to the Constraint**

Regardless of the issue, you will want to ensure that your Constraint(s) always has what it needs, when it needs it, to avoid further disruption to production flow and Throughput.

A Controlled Approach to Constraints Management to Drive Throughput

Leverage Your Constraints

A system operating without Constraints management hides capacity and inhibits flow. Without Constraints management, issues that plague the company seem to wander from one problem area to another without pattern or predictability. Smart manufacturers leverage their Constraints to set the pace for optimal flow through their production environment. (See CONLOAD Scheduling Methodology for additional information.)

Let's expand on this concept a bit: *Leverage the Constraint by having it set the pace for a constant rate of production flow.* The idea is to use the capacity of the Constraint to set the rate at which orders enter the production environment. In other words, establish the amount of work in process (WIP) necessary to avoid starving the Constraint - but no more than that. Typically, this is assessed as the number of hours a job takes on the Constraint (assuming the Constraint is a machine or process). If the number for that Constraint is 10, then you would release 10 hours of WIP for that Constraint at a given time. (Note, this is not 10 hours' worth of work at the Constraint – it is 10 hours' worth of work between the release of work and the Constraint.)

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Links to Additional Resources on the CONLOAD™ Method:

Article: *CONLOAD Scheduling Strategy*

Video: *Manage Manufacturing Constraints and Optimize Production Flow with CONLOAD*

Through this patented method, called CONLOAD™ (constant load), you are releasing work into the system at a rate at which it can maintain a constant level of flow at the greatest velocity. Queues in the process are minimized, because work is flowing. By managing the Constraint in this way, you not only maximize Throughput, you reduce undesirable behaviors associated with too much work in the system, including uncertain priorities, choosing to work on easier setups, or handling materials more than necessary.

Optimizing flow through CONLOAD-enabled software[iii] or manually, impacts downstream metrics too, including Cycle Time, Queue Turns and customer On Time Delivery (OTD).

Local Efficiencies v. Global Optimization

Keep in mind, the individual efficiencies of each resource only matter in regard to its effect upon the Constraint resource. Recognizing that resources are part of an interdependent system leads Demand-Driven Manufacturers to realize that an individual resource's efficiency is only important in the context of its ability to support the Throughput of the system as a whole. Yes, these organizations continue to measure the investment in their assets, but the true focus is not on the individual asset utilization, but on the ways the assets support order flow through each phase of production and how they align production to convergence points en route to the shipping dock. Doing so can transform your supply chain and create behaviors that support demand-driven flow.

Now that we've outlined the roles of synchronization, Constraints Management and flow in Demand-Driven Manufacturing, we'll turn to address how organizations can effectively measure their performance across key functional areas.

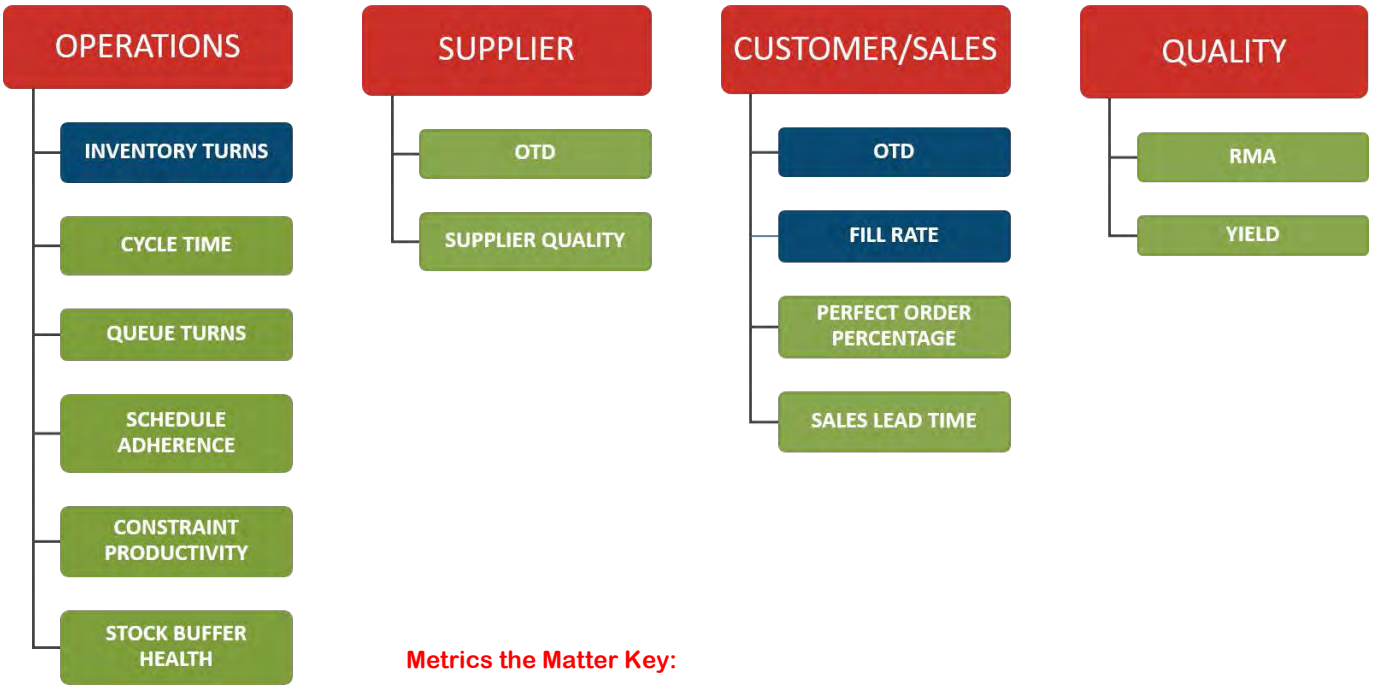
Demand-Driven Manufacturing Metrics for Action

In working with hundreds of manufacturers around the globe, we've found that manufacturers are trying to drive their business based on far too many metrics; metrics that often conflict and put employees in a state of oscillation between contradicting goals. In *Metrics for Action*, Synchrono® creates a distinction between operations metrics you simply report on - and metrics you take action on. These

Demand-Driven Metrics for Action Guide

Download the Guide for an overview of each category and metric, what to measure and suggested actions to take to improve results.

performance impacting metrics are organized into categories (represented in red, below). Again, the metrics within these categories are not intended for overall business analysis; instead, these are the operations metrics that will provide insight to drive *action* to improve flow, manage Constraints, direct continuous improvement efforts and more.



Metrics the Matter Key:

Red = Functional Category
Blue = Operations and Supply Chain metrics that indicate overall health
Green = Metrics that are supportive of the Blue metrics at a more localized level

"Tell me how you measure me, and I will tell you how I will behave."

-Eli Goldratt

We will review each Operations *Metrics for Action* category in subsequent publications and offer a downloadable *Metrics for Action Guide* that reviews each operations metric, how to measure it, and suggested actions for improvement.

For many, moving toward Demand-Driven Manufacturing will require looking at the business through different lenses. What and how you measure will impact behavior.

Aligning Behaviors and Processes with Your Performance Goals

Eli Goldratt, author of the Constraints management novel, *The Goal,* and thought leader for continuous improvement using the Theory of Constraints said, "Tell me how you measure me, and I will tell you how I will behave."

Metrics not only drive behavior—they shape your culture. Supply chain leaders face a seemingly insurmountable issue when deciding metrics by which to manage. And while the *Metrics for Action Guide* offers guidance on how and what to measure, creating a culture that values improvement is also an important starting point. Here are three measurement programs to examine as you begin assessing behaviors and processes that may need adjusting to support your demand-driven goals:

One of the main culprits that wastes time and money is constant expediting. A system that helps control and prioritize the release of orders into the production process based on true customer demand significantly reduces – or eliminates – waste and disruption costs associated with expediting.

Measuring for Lean

Lean manufacturing process improvements minimize waste, first. Yet, it is often forgotten that over-production is a major form of waste. If the full capacity of a machine is not needed to meet customer demand, then the cost of these machines standing idle is much less than the wasted effort to keep them humming without actual demand—plus you're blindly building inventory completely decoupled from demand. You can ensure perfect capacity utilization, but still have thousands of dollars of parts waiting for an order that never arrives. In a synchronized environment, Lean manufacturing activities center on flexibility of resources; they can flex and bend to stay in alignment with actual demand.

Demand-driven leaders know that the only thing that will ensure success is empowering people to find the Constraint, managing the Constraint to protect flow, and creating a culture that drives individual ownership of processes so that it is continually supported and improved at a global process level, not through localized efficiencies.

Measuring for Continuous Improvement

Continuous improvement is a process for becoming increasingly competitive by improving efficiency and quality through systemic, incremental changes normally driven by kaizen (focused improvement) events. In demand-driven environments, continuous improvement efforts look to address the most significant disruptions to production flow. Often, synchronization (connecting people, machines, materials and methods) is used as an initial continuous improvement tool to quickly find Constraints that inhibit flow.

Getting closer to your data through synchronization ultimately allows you to apply a more critical focus to continuous improvement efforts. As mentioned above, the ability to quickly identify Constraints is one example. Another example is to use analytics gained from monitoring machine and materials data to pinpoint quality issues that negatively impact flow.

If data doesn't lie, consider the volumes of truths that a synchronized enterprise can lend to a continuous improvement program.

Measuring Your Culture

Leading a demand-driven transformation isn't easy. Some companies are not ready to migrate from cost-centric to demand-centric analytics and/or manage the change in behavior needed to support the associated metrics. The old Push methodologies adjusted everything according to forecast. Demand-driven leaders know that the only thing that will ensure success is empowering people to find the Constraint, managing the Constraint to protect flow, and creating a culture that drives individual ownership of processes so that it is continually supported and improved at a global process level, not through localized efficiencies.

Reactive organizations are characterized as functional units that are "aligned against specific business unit objectives"[iv] that are, in fact, really just another form of forecasting. These objectives often live in systems that track traditional cost-accounting measures for success. When you are using disparate transactional

systems of record with limited functional support, Lean manufacturing leadership is nearly impossible to affect. These Push-style numbers control the behaviors of everyone involved. A cost-accounting viewpoint is based on past performance with little or no attention paid to the actions taken to meet customer demand. According to this worldview, if the production floor fails to meet projections and *meets every customer expectation instead*, they can still be viewed as a failure!

When a manufacturer synchronizes its processes to visibly follow the customer demand signal through the supply chain, the metrics change—for the benefit of the customer.

Summary

The Push-based metrics of the past worked well—until manufacturers had to react rapidly to new and emerging customer demands. Demand-driven factories change virtually all their metrics because previous measures were based on local efficiencies and *supply-optimized push philosophies*, not pull-based, demand-driven methods focused on *actual* customer orders. With the ability to visibly follow the customer demand signal through the supply chain, the metrics change – for the benefit of the customer. A Demand-Driven Manufacturing Platform becomes a system of differentiation by synchronizing all layers of manufacturing and freeing data across systems for collective reporting, analysis and decision-making. Differentiation is gained through improved quality, increased capacity, on-time delivery, and more.

Like Demand-Driven Manufacturing itself, the *Demand-Driven Manufacturing Operations Metrics for Action* are based on synchronization and managing Constraints to drive flow. Improvements in these areas lead to improvements in the core metrics of Throughput, Inventory and On Time Delivery which in turn, leads to improvements in other key areas.

Demand-Driven Manufacturing Metrics for Action outlines categories of metrics that drive operational actions by functional area. These are not simply metrics to report on, but metrics to act on to improve flow, manage Constraints, direct continuous improvement efforts and more.

The foundational elements outlined in this paper serve to support subsequent articles and papers addressing each category of metric in greater detail. Check

back as we review each measurement's role in the demand-driven value chain, what to measure, and suggested actions for improving performance.

Additional Suggested Reading:

Guide: The *Metrics for Action Guide* provides an overview of each Demand-Driven metric for action along with how it is measured and suggested actions for improving performance.

White paper: *Manufacturing Power and Profit: How Technology will Connect Your Enterprise and Create the Demand-Driven Factory of the Future - Today* discusses how the demand-driven organization can use Lean Manufacturing, Theory of Constraints and Six Sigma principles to focus on areas of improvement to drive business goals.

White paper: *Gaining Control: Exploring Push v. Pull Manufacturing* contrasts the Push-based MRP with the Pull-based Kanban method to support today's demand-driven manufacturing environment.

White paper: *The Next Generation of Planning and Scheduling Solutions* reviews the evolution of manufacturing planning and scheduling goals – and systems, including ERP/MRP and adaptive demand-driven systems.

Article: *CONLOAD Scheduling Methodology* addresses the Synchrono® patented methodology for driving production flow.

Video: *CONLOAD Scheduling Methodology video* shows you how to use your system Constraint(s) to set the pace for maintaining an optimal level of flow through production.

Demand-Driven Matters Podcast: *The Five Key Elements that Drive Flow* is a series of video podcasts that review different strategies for increasing production flow.

Demand-Driven Matters Blog: A collection of blog posts from a diverse set of bloggers covering various Demand-Driven Manufacturing issues.

About Synchrono

Synchrono® LLC enables the demand-driven visual factory of the future; synchronizing people, processes, machines, materials and data to drive production flow from order inception to delivery. The award winning Synchrono Demand-Driven Manufacturing Platform includes a production planning, scheduling and execution system; ekanban inventory replenishment and supply chain collaboration software; a data collection, historian, fault detection and automated workflow engine; alert management and monitoring software; and a real-time visual factory information system. The Platform components may be implemented independently or collectively to enable the Internet of Things and an unprecedented foundation for communication, collaboration and continuous improvement. Synchrono helps clients manage constraints, improve flow and drive on-time delivery to maintain a competitive edge. Sync with us at www.synchrono.com and follow the Demand-Driven Matters blog at www.synchrono.com/blog.

i 26 March 2013, "Introducing the Five-Stage Demand-Driven Maturity Model for Supply Chain Leaders," Tohamy, Noha, Davis, Matthew.

ii Managing Constraints and Bottlenecks Under Peak Volumes, Pete Abilla, Shmula.com

iii SyncManufacturing software, Synchrono Manufacturing Software iv 26 March 2013, "Introducing the Five-Stage Demand-Driven Maturity Model for Supply Chain Leaders," Tohamy, Noha, Davis, Matthew.

iv 26 March 2013, "Introducing the Five-Stage Demand-Driven Maturity Model for Supply Chain Leaders," Tohamy, Noha, Davis, Matthew.