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How Real-time Dynamic Scheduling Can Change the Game: New Software Approach to Achieving Stable Success in High-Change High-Mix Discrete Manufacturing

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Executive Summary

In most high-mix discrete manufacturing **plant floor management is a misnomer**: schedules cannot be executed, production analysis is too late to help the next shift, and there is no visibility into bottlenecks, WIP, or order status. As a result, manufacturing is often not as reliable or profitable in meeting customer demand as it could be. This environment has plagued high-mix and job shop manufacturers for years. Fortunately, that can now change.

The key is to coordinate among four functions: production planning, execution, tracking, and analysis.

- Planning and particularly detailed scheduling must be aware of what has just happened in the plant (execution) to effectively update the schedules and plans, in a timely manner.
- Execution can only tell whether the next activity is feasible with automatic tracking of resources and orders parsed through a dynamic scheduler that sees current and near-term constraints.
- Execution and planning both need intelligence of what happened in previous runs to optimize for the best customer outcomes either immediately or in the future.
- Tracking and intelligence become directors for improvement rather than just static reports when integrated to execution, planning and scheduling.

Fortunately, a new type of scheduling software is now available that includes and dynamically synchronizes those four key functions. Focused on scheduling in a high-change environment, it includes elements of planning, manufacturing execution, tracking and analysis all supporting each other seamlessly to create an effective process. The result is a proactive ability to manage the plant floor and schedule the near-term future as reality shifts.

High-mix plants require real, effective plant floor management. Only with this coordinated approach can a company reliably improve the factory's performance on what matters most to the customers and shareholders: **getting orders out on time at a low cost, reliably and consistently.**

The High-Change, High-Mix Challenge

Anyone who has worked in a discrete manufacturing environment where the mix of products is dynamic has lived through constant change. It makes efficiency daunting and improvement challenging. Production plans rarely meet the reality of what is made when and how, and tracking what did actually happen requires extra vigilance. Lean Manufacturing, Six Sigma and other operational excellence approaches can only create a certain degree of improvement because there is no steady state to achieve.

Many environments fit this description: job shops, custom shops, engineer-to-order and configure-to-order environments are all in this category. Typically this environment is one where customers can get what they want either quickly when they need it or at a reasonable cost, but rarely both. Because the specific products ordered vary so much, these manufacturers typically either buy materials as orders come in, hold raw materials at a high cost, or hold semi-finished materials and finish them when the order comes.

The tradeoffs for plant managers and their staff are even more daunting. As each order is promised to a customer, it creates a disruption in the plan on the floor, often with contention for resources already planned to be in use for other orders. The resources include employees, machines, and tooling as well as direct and often also indirect materials such as fixtures. Planning and scheduling can be complex and require knowledge and experience to even attempt to balance resources to demand.

By the time the difficult schedule creation task is complete, the situation has usually changed (see Figure 1). Internal changes happen as employees call in sick, machines break down, tools can no longer hold the needed tolerances, or engineering changes a design specification. External changes occur when materials

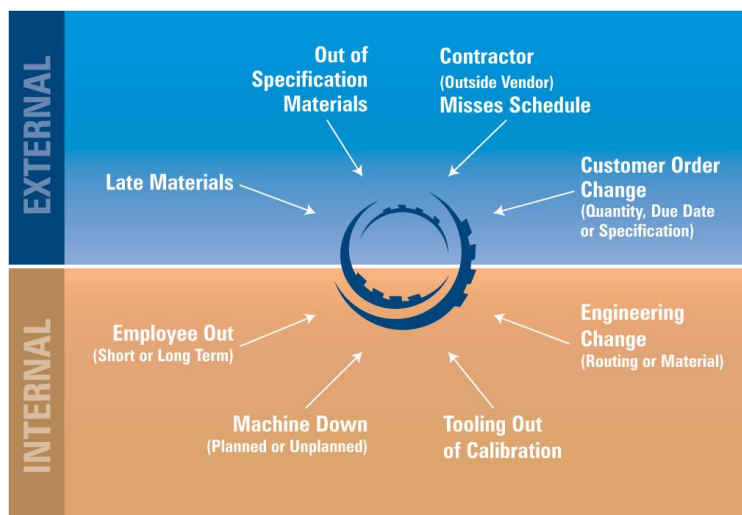


Figure 1: Many sources of change commonly disrupt manufacturing and require schedule changes.

come in late or not in the condition expected, external finishing or contract houses can't meet your requested schedule, or customers change their order specifications, quantities, or due dates.

Some companies have applied the management tools of high-volume, low-mix environments with some benefits, but still

no ability to manage smoothly. Initiatives such as Lean Manufacturing work best in a higher volume or repetitive environment. Another core assumption of Lean is that machines can be logically and cost-effectively moved into work cells, which typically is not true in environments with expensive and/or bulky shared equipment. Software systems such as enterprise resources planning (ERP), manufacturing execution systems (MES), and operations intelligence (OI) can help, but are typically not designed for this level of volatility and change.

The instability of high change and high mix may be supported, but not managed with most manufacturing management and improvement tools. So companies have simply lived in this fashion for many years.

Four Key Functions Drive Each Other

To truly manage high-mix, high-change manufacturing is to synchronize and prioritize activities across many functions and dimensions. The trick is this must be done dynamically, as change occurs.

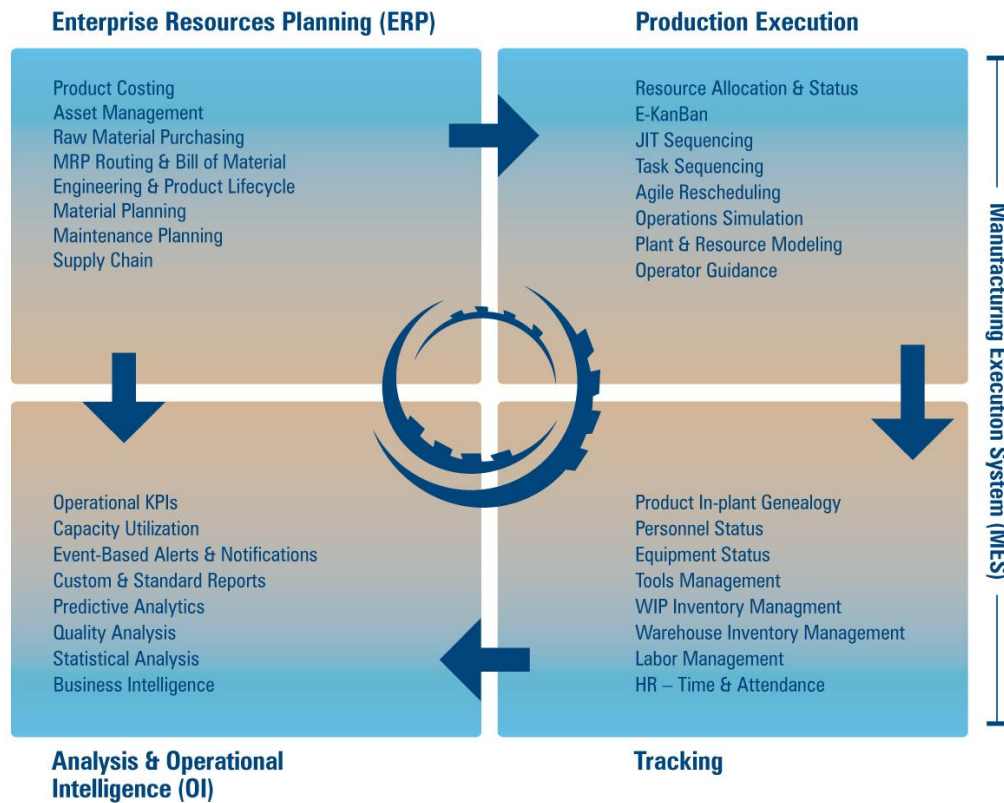


Figure 2: Four key functions drive each other, each with many specific functions that are more or less closely linked with factory operations.

There are four main functional areas that together deliver effective plant floor management: planning, execution, tracking, and analysis (see Figure 2). These are

all known functions, but they typically are not defined in terms of how each of these provides support for the other three. Here we define not just the core function, but how that function works with the other three to improve stability.

Planning – Most managers are clear on the value of planning in production. Planning is a future view of what materials, equipment and other assets will need to come together to produce expected orders. The underlying assumption is that planning is a strong support for smooth execution of orders. What may be less explicit but equally important is that the plan provides a baseline of expectation against which manufacturing is both tracked and analyzed.

Execution – Production activities may include not only what the operators, machinists and technicians do as direct value in transforming the materials, but also short-term task sequencing and guidance for those operators. What actually happens in execution is a gauge for the effectiveness of planning, and it is the activity to be planned, tracked and analyzed. This is where customer orders either are or are not produced on time as promised, at an acceptable margin – or not.

Tracking – Most products today must have a full genealogy whether for regulatory purposes to track materials or to satisfy customer requirements to understand the equipment they buy. The track and trace function not only delivers this backward-looking view, but also a current status of personnel, equipment, tools and work-in process. In this way, it supports execution. Tracking is also a key data source for analyzing performance and capacity.

Analysis – Increasingly, companies have realized that understanding the production process in depth is a key to success. Turning data from all of the other functions into intelligence helps drive sound decisions at every level for:

- The operations team as they work;
- the planning team as they look to optimize the next plan;
- Management as they decide on hiring and investments.

Analysis also can support the tracking process by providing context and by indicating areas for improvements.

Clearly these functions or processes are not independent. Planning, execution, tracking and analysis support and drive each other. However, in most companies, separate departments manage each of these activities. Typically these disciplines include planning, manufacturing, maintenance, continuous improvement, materials management, and tool crib. They may all report to the COO or VP of Operations, but they often have independent goals and performance metrics that can be in conflict. This independent approach can often result in groups working at cross purposes and inadvertently sabotaging each other and the business outcome.

Traditional vs. New Software Approaches

Despite the availability of software for each of these four functions, most high-mix, high-change manufacturers are struggling to manage their plant floor. The software solutions that cover each of these four functions are: enterprise resources planning (ERP) for planning, manufacturing execution systems or manufacturing operations management (MES/MOM) for execution and tracking, and operations intelligence (OI) for analysis. In our experience, few companies have them all implemented. Even when all of these applications are in place, they often do not fully support each other.

Most high-mix, high-change factories do not use commercial software systems for all of these applications. Many use paper travelers for tracking on the plant floor, which serves the core function but cannot easily support real-time intelligence or rapid re-scheduling. Others use homegrown software that provides some sub-set of functionality but typically not everything. Maintaining the model in these systems is challenging and usually they do not attempt to provide real-time tracking and intelligence. Some companies use ERP, but nothing more than the “plant floor module” in the plant, which does not deliver scheduling or intelligence.

Even plants that do have all of these tend not to solve the plant floor management problem.

There are some reasons why problems may persist even with up-to-date, modern software:

- These applications typically are not intended to fully manage a dynamic manufacturing environment. ERP is primarily focused on planning and enterprise record-keeping for financial reporting. MES is focused on executing in the plant but typically expects the plans to be correct, and OI often centers on metrics that best suit a high-volume plant.
- Applications do not have real-time dynamic information flows between them. For example, many companies have a daily back flush function to synchronize between plant actuals and the ERP plans. Traditional business intelligence (BI) tools use mechanisms that cannot be executed in real-time.
- Many ERP and supply chain applications have functions called “planning and scheduling” where schedules are basically short-term plans. However, this is inaccurate and often results in a painful gap between theory and what is actually possible. While the plan is what the company intends to make at a future date, a real schedule shows the most efficient sequence in which to perform tasks based on the actual orders, resources available and limitations caused by incomplete prior dependent tasks in the short term.
- Much commercial software does not match the high-mix environment well, thus trying to manage a dynamic environment with static tools such as schedules not designed to easily change or execution systems where

operators are guided only to execute as planned, even when the situation makes it impossible.

- Often, applications have not been designed to reflect the current state of the factory. So the model may not show current equipment capabilities, specifications, and requirements. Few applications deliver a real-time tracking and status view to redirect execution and re-plan operations and materials on the fly.
- Many software products that deliver a real-time view are not focused on the scheduling, sequencing and allocation challenges that arise in high-mix fast-changing environments. Most are focused on reporting and not on reacting in an optimal way.
- Job shop software usually focuses on quoting accurately more than managing the complexities that arise in the plant. To the degree it does, it may not have a scheduling capability to reallocate resources quickly as conditions and requirements change.
- Most manufacturing software treats all resources as equal – not accounting for employee skills and certifications, equipment ability or cost to meet certain specifications, or material substitution capabilities.

The Missing Fifth Element

A new class of software is now available that is specially designed to manage dynamic high-mix manufacturing environments. This software includes certain vital elements of planning, execution, tracking and analysis. It also has a new type of real-time dynamic scheduling at the core to coordinate all of those functions (see Figure 3). With all five elements in one real-time dynamic system, the possibilities for improvement are evident.

The dynamic scheduling engine at the core of this software is not like that of traditional ERP, MES, or Operational Intelligence. This engine is probabilistic, not algorithmic, focused expressly on achieving optimal management of the plant floor in high-mix, high-change manufacturing. To do this, it takes into account resource availability and capabilities, to replicate the conditions of each operational environment as they change. Fully dynamic scheduling of all production activities for each order across all resources (employees, machines, tooling, and materials) results in a schedule that is feasible and optimal at the moment work needs to happen in the plant – not just at the moment it was developed. Ideally, a scheduling engine also provides forward visibility into future demand, bottlenecks, and open resource capacity. This is critical to balancing planning with what is likely to be executed.



Figure 3: The new category of software combines the factory-driving pieces of the four functional areas with a dynamic scheduling engine at the core to cope with constant change.

The first example we have seen that implements this mix of functions is nMetric. This company has a patented scheduling approach that embeds knowledge into each job. It leverages real-time and predictive information to always drive to the best outcomes after each change in the situation.

Managing the Plant Floor for Best Outcomes

Because it incorporates the scheduling engine to synchronize and drive all four areas in a single dynamic model, this new style of software application can deliver stability. This approach ensures not only that the four functions are working well, but that they are working in unison to drive the best possible outcomes. Planning and execution are necessarily synchronized, and tracking and analysis informs activities both for the forward-looking plans and for the right-now execution.

This scheduling-centric software assumes things will change from the original plan, and is dynamic, covering past, present and future to:

- Track when changes have happened and instantly start the process to re-schedule for reality;
- Alert anyone who might need to know of this change (customer service, suppliers, supervisors, etc.);

- Alter current activities to make optimum use of the resources currently available based on order priorities;
- Predict what is likely to happen in the near term and create plans to have appropriate resources ready and schedules that will be actionable;
- Prepare management to proactively address near and medium term challenges;
- Report not only on what actually happened, but on the impact that had across various plant floor performance metrics as well as customer and financial or business metrics.

In this environment, schedules can be executed and are changed when they cannot be. Production analysis is available to help the next shift. The system provides forward visibility into bottlenecks, WIP, and order status. The genealogy record is generated automatically as production progresses. The impact of changes (whether disruptions or improvements) is visible. High-priority orders are truly given top attention in the plant.

That is what shop floor management can look like. The results are

- More reliable and profitable manufacturing;
- Higher likelihood of meeting customer demand as promised;
- Happier plant managers, supervisors, and operators who have lower stress and greater visibility
- More satisfied customers who get what they want when they want it or a warning if they won't
- Value that shareholders will see in lower costs and higher revenues

Most companies in this type of business cannot lower the mix or rate of change in manufacturing. However, now they can achieve a new level of stable success based on true management of the dynamic plant floor environment.



About Iyno Advisors

Iyno Advisors is an independent advisor on how manufacturing and production companies can best benefit from software applications. Julie Fraser, the Principal, has 25 years of experience and passion in driving healthy understanding of opportunities that can drive added profitability and success.

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About the sponsor nMetric

The nMetric team has one guiding principle make the job of scheduling easier, less time consuming, and more productive. nMetric develops scheduling and task management software, and holds patents on the Smart Job[®] method of dynamic scheduling.

nMetric Smarter Scheduling[™] uses the scheduling engine to synchronize planning, execution, tracking and analysis. This approach ensures not only that the four functions are working well, but that they are working in unison to drive the best possible outcomes.

nMetric 6.0 is a unique solution that allows organizations to achieve Smarter Scheduling, and realize a high level of efficiency, productivity, quality and reliability. nMetric's software solution has the ability to adapt to change, complexity and real-time events that could otherwise derail the schedule and produces the greatest possible scheduling flexibility. www.nmetric.com