nMetric®
Smarter manufacturing™

Transforming Discrete Manufacturing

www.nmetric.com

Introduction

nMetric is a real-time, real-world manufacturing performance optimization software system for discrete, complex or "chaotic" manufacturing environments. The nMetric system breaks down customer orders into their routing components and creates an intelligent object-based Smart Job™ for each step, which identifies the attributes of the resources it needs and routes itself to its most efficient completion using a stochastic, backward-chaining process. The system framework keeps track of each resource's capability attributes and the compatibilities of those resources, sets the boundaries of resource availability, and maintains the rules for Smart Job interactions.

The nMetric system provides multi-dimensional representations of the demand and supply of resources at all specific workcenters in the context of time. The ability to visualize actual plant floor conditions and extrapolate future "what if" scenarios allows users to more efficiently prepare for various alternatives, use resources more effectively, realize on-time shipment of products, increase staff productivity and reduce hassle throughout the manufacturing process.

Through its integration tool set, the nMetric system connects to existing enterprise systems to extract bill of material, routing and order data to create Smart Jobs™. Combining this information with operational real-time completion data, nMetric's solution provides increased operational efficiency, not only in the plant, but throughout the company. The solution is Web-based and provides demand visibility to suppliers, vendors and customers through secure portals, for increased real-time information sharing throughout the supply chain.

Background

The ERP, MRP, scheduling and other major IT systems currently used by nearly every discrete manufacturing company are deterministic. They view the present and future in the same manner as the past. In actuality, of course, the present is a moving point in time, which cannot be "frozen" and must be constantly updated, while the future is actually a number of multiple alternate sequences of probable events.

One example of this deterministic flaw is the notion that future events can be scheduled in detail, in advance. In fact, both known and unknown variables introduce uncertainty which defy precise detailed scheduling. These variables frequently produce bottlenecks and resource constraints or shortages that require real-time schedule revisions. In most organizations, the ability to report or willingness to admit that schedule revisions are necessary is awkward and sometimes subject to punishment. As a result, the computer system's view of floor operations ends up quite different from reality.

Current scheduling practices seldom compare, and sometimes do not even consider, resource commitments made versus actual resources available over a finite period of time. Traditionally, allocations are made against historical capacity and result in an arbitrary production target, either in dollars or mixture of product units. Some ERP systems assume infinite available resources for each order, others assume a fixed capacity model based on a theoretical limit and, like other systems, have no knowledge of how real-time events have changed the actual capacity or resource availability a company has. With many systems, attempts to measure capacity limitations due to resource constraints typically utilize an iterative process – one that requires so much computer capacity that it is run in batch mode and, therefore, never current, except in a very general and approximate sense.

Existing systems rarely consider real-time changes in actual schedules. Since they are not connected to the shop floor in real time, production is presumed to always be proceeding according to plan. As a result, most production schedules include operations that were supposed to have been completed but were not, and the subsequent departments are left uninformed, disrupting manufacturing operations. Deterministic systems result in underutilized major resources (such as fixed machines and their extensive tool racks) and heavy duplication of floating resources (such as tools, fixtures and inventory), yet still do not achieve on-time production.

The centralized nature of most major IT systems also works against them. The sheer quantity of data involved in planning the utilization of every resource in the production of a product demands inordinate amounts of computing power when traditional forward-chaining programming approaches are used. It is a long path from the product back through all its sub-assemblies, components and resources to the workcenter, and most hardware systems cannot follow that long trail in a reasonable amount of time – let alone consider any of the alternate probable paths to each branch of the trail.

Even when a product is defined in enough detail to plan all resources back to the workcenters, the tendency is to "freeze" the processes for producing that product. No further improvements will be made in production, safety, hassle factor, consistency or costs. Benefits of new production techniques will be lost. The organization becomes a target for competitors who can learn to employ better production methods.

The above are just a few areas in which current IT systems are inadequate to deal with the ever-increasing complexity of manufacturing multi-component products, and to manage effective resource utilization overall. There has been an enormous and unmet need for a technology-based solution that can allow manufacturing performance optimization in complex discrete, or chaotic, environments.·

nMetric Smart Jobs™

As opposed to traditional systems, nMetric operates through a decentralized computing environment using multiple intercommunicating software objects, or Smart Jobs, that contain the routing steps and component tasks required to produce a specific order. Smart Jobs recognize each deliverable unit in the order as a component of the whole. This granularity allows a Smart Job to book requirements at a routing step and resource level, separating the set-up and run-time requirements at some machine workcenters and allowing the capture of lot, serial number, "how-built" and other prime data. Objects can be distributed over multiple processors to scale processing capacity to requirements.

Smart Jobs are tailored to their specific tasks. For example, some may contain fairly simple steps requiring only a common assembly workcenter and basic worker, while others have more complex requirements for a specific type of machine, a particularly skilled worker, a one-of-a-kind tool, specialized raw materials and a specific sub-assembly completed and staged. The more complex the requirements, the more limitations in the probable options for completion. Additionally, all Smart Jobs are equipped with their routing relationship and ship date requirements, providing negotiating power for resource priority with other Smart Job objects.

Smart Jobs are able to respond to requests from other objects and, therefore, to the uncertainty of future events. Communication of demand and supply between them is governed by the system framework, which provides physical boundary rules (overlap percent and transport or wait time limitations) as well as the workcenter and resource attributes available to sync with the embedded requirements. Each Smart Job seeks out its "best path" and reserves the resources required to complete its mission on time. If primary workcenters are not available, they search for alternatives and negotiate with other Smart Jobs to reserve the resources needed. As the assigned time approaches "Now", the level of uncertainty and alternative paths are narrowed until, at "Now" and continuing into the past, only the single path chosen is displayed with 100% certainty.

Each reserved time span must accommodate previous Smart Jobs. Subsequent Smart Jobs are notified so operational linkage and overlap rules are not violated. If the order is in danger of late completion, Smart Jobs will use their priority status to negotiate with jobs from other orders for earlier reservations. As additional orders are added, jobs are completed, material/resource availability changes, worker schedules change, tools break and/or machines become unavailable, Smart Jobs also negotiate with one another to find "new best paths" to on-time completion, with the status of all orders relayed to the system in real time.

Outsourced intermediate routing steps are tracked and scheduled like any other. A Smart Job arranges itself according to the outside vendor's specific attributes as it would with any workcenter, and data is collected on the shipping and receiving of that job to that vendor. Other Smart Jobs monitor its status as they would any other job.

As Smart Jobs are completed, the nMetric system continually gathers data concerning what machine, by whom, with what tools and which materials the Smart Jobs were produced. Also collected are the start and completion times, unit qualities, any operational quality data or operator comments applicable to that Smart Job. Variances between workcenters in yield, cycle time, raw material availability, labor rates and other KPIs are displayed in real time as information is added.

Transparency of Real-Time Operations

If sufficient resources are not or will not be available, the system notifies management of the shortfall and gives a best-can-do production schedule based on current resource availability and requested completion time to meet the entire customer order. Management can then take proactive steps to alleviate the contentions, if possible.

The nMetric system facilitates this process by providing a dynamic, moving, multi-dimensional visualization of data gathered from software objects and relevant systems. This detailed picture of shop floor reality allows a manufacturer to see what can and cannot be done given existing resources, workcenters and time.

The nMetric display shows summary and drill-down graphics identifying workcenters, tools and personnel that are scheduled with high capacity utilization rates. The time axis allows users to scroll forward and backward from the real-time Now-line, to as distant a future scheduling horizon as desired. The vertical axis shows the user's choice of workcenters, tools, people and materials, displaying the demand for those resources across the scheduling horizon. Icons in each span provide alerts to special circumstances involving that job span. Contentions and bottlenecks are visible and clear. Management can then choose to add overtime to workcenters and/or people resources or materials, and tools and/or skill sets can be purchased, trained or duplicated if time allows. nMetric also allows management to manually optimize the Smart Job scheduling process through configurable operational overlap rules, transport time matrices, Smart Job grouping tools, order management tools and other features and toolsets.

As jobs are completed, they move into history and the time blocks for completed jobs move off the left side of the "Now" time axis. As new jobs are added, reservations are made in a workcenter job queue as they are in the other queues for all resources required; in this process Smart Jobs are shifted in a queue or moved to other workcenter queues.

If a workcenter (e.g., a machine) is shut down, the job queue for that workcenter stops moving and the job queue gets pushed to the right on the time axis. Often this will cause an automatic rearrangement of Smart Jobs as they search for more time-appropriate resources. Within this multi-dimensional presentation, users can blend and blur the view of multiple axes in order to examine groupings. For example, resources can be grouped into "all drills" or "all tools" and the system will display these groupings and highlight any contentions within a group. Workcenters can be grouped to show demand and supply for a whole department rather than individual machines.

Through its display, the system encourages proactive decisions. It allows users to react to future events by selecting from alternative actions and encourages intelligent procrastination, so decisions that narrow alternatives can be made as late as possible for maximum flexibility.

Benefits of Decentralized Computing

Conventional MRP systems view products as a combination of materials and, therefore, plan only the need for those materials. In contrast, the nMetric system views products as a combination of tasks and many different types of resources, including materials, packaging, tools, fixtures, labor, consumables, production equipment, etc. By defining these physical tasks and resource features rather than controlling the "process" of producing parts, a backward-chaining way-station is built in the long path from order initiation to product, adding automatic flexibility to production processes. Frozen processes are avoided because the system allows the shop floor to be viewed in terms of its capability to accomplish certain tasks, rather than its capacity to produce certain products. As a result, skilled operators have the flexibility to easily introduce new production processes, rather than being locked in to processes that are "designated" as the ERP/MRP routing.

With Smart Jobs, there is no need for computing hardware with the power to centrally calculate all the myriad paths and possible alternative paths for every job in the plant at every turn. Instead, the nMetric system receives prime data from the floor and knows which workers have the capabilities to operate specific machines, which tools are fitted to specific machines or used in specific workcenters, and which materials are appropriate for various machines or workcenters. Instead of the system determining what is done, when and where, the nMetric system tells the Smart Jobs what they cannot do, and the Smart Jobs choose what they can and must do.

As a Smart Job progresses, fewer and fewer process paths are possible, further decreasing the need for computing power. The system also calculates in advance the demand for specific tasks based on current customer orders. As a result, the system's critical real-time calculations are reduced to comparing the demand for tasks with the supply of tasks, a function well within the capability of common computer environments.

Summary

The nMetric system transforms discrete, complex manufacturing into a highly efficient and reliable operation, powered by self-routing, reactive Smart Jobs and a highly visible, highly accurate and constantly changing view of production capabilities. Schedule adjustments can be made "on the fly" and be seen by users in real time. Potential bottlenecks due to contentions for resources are displayed for analysis and resolution both in advance and during the production process. The organization becomes much more proactive because present and future production developments are constantly available for review by all relevant parties inside and outside the company. As each new order or request enters, and each shipment or operation on a part is completed, a new world of requirements unfolds for analysis, minimizing reactive and time-consuming iterations through a management bureaucracy.