The Artificial Intelligence Revolution in Manufacturing Operations Management

To paraphrase David Brooks on the PBS evening news: "Manufacturing is going through a revolution from a labor intensive, blue-collar industry to a white-collar, Silicon Valley industry".

Two decades ago, the average manufacturing plant in the USA had over 100 employees doing manufacturing. As a result, many manufacturers moved their manufacturing plants to China where labor costs were less. Now, thanks to the use of robotics and automation, the same plant can produce twice as much with only 30 or so employees.

The cost of manual labor, in most cases, has become a small part of the cost of making products. Now, it makes much more sense to manufacture products in-market rather than to make them in China and pay the high cost of shipping products to the USA. As a result we are seeing a rapid increase in reshoring, where manufacturing operations that were moved off-shore are being moved back to the USA.

This reshoring trend is also being driven by the transition from long-run manufacturing to short-run, quick-turn, make-to-order manufacturing. This is being driven by consumer demand for products that are being tailored to their individual needs, ordered over the Internet for rapid delivery, coupled with the cost-saving pressures of the need to maintain Lean inventories throughout the supply chain. These market pressures cannot be met by manufacturing products by the container load in China and then taking 6 weeks to ship the products to the USA.

Today, some big operational costs today for a manufacturing plant in the USA include:

1. Overhead cost of the management team to schedule, plan, track, and manage the manufacturing operations. There are often way too many people required to track, expedite, and manage hundreds of make-to-order jobs flowing through a manufacturing plant at any one time when delivery requirements are measured in hours or a few days at most.

2. Cost of materials consumed in the manufacturing process, cost of work-in-process, and cost of picking, packing and shipping the finished goods. With hundreds of make-to-order manufacturing jobs flowing through a manufacturing plant, efficiently tracking, planning, scheduling, and controlling this flow of materials is essential.

3. Cost of automation and robotic equipment. It is essential to efficiently schedule the use of the equipment and the technicians that set up and maintain this equipment to make sure that customer orders get delivered on time without the need for expedited shipping charges or the payment of late delivery charges. This is easy to do when there are only a few long-run manufacturing jobs in the plant. It is nearly impossible for people to do when there are hundreds of jobs that need to flow through dozens of operations in a very short time.

4. Cost of problems, mistakes and changes. In a busy, carefully orchestrated, make-to-order manufacturing plant things can go wrong, and often do, very quickly. Not only do machines break down and people get sick, but customers change orders after the fact,

which often happens in engineer-to-order projects, and rush orders enter the work-flow. Also people make mistakes, such as using the wrong materials for a job or the wrong processes on the materials. Detecting when things are starting to go wrong and dynamically changing schedules to accommodate these changes is very difficult for people to do, especially when there are a large number of make-to-order jobs involved.

Through the use of real-time Artificial Intelligence (AI) techniques, BellHawk Systems is able to automate much of the real-time problem detection, rescheduling, and replanning that needs to take place. This enables a much smaller management team to manage a manufacturing plant and to efficiently cope with problems as they arise. Also by alerting technicians and managers when mistakes are about to occur or problems are about to arise, the AI technology is able to prevent many problems that would otherwise occur. But, even when problems do occur, BellHawk is able to dynamically readjust schedules and plans to ensure, as far as possible, that customer orders get out on time.

Note that this concept of using real-time Artificial Intelligence to continually replan and reschedule operations is very different from the planning and scheduling performed by ERP (Enterprise Resource Planning) systems. ERP do an excellent job of materials planning and plant scheduling for long run manufacturers. These systems pre-plan production and materials for a single plant or multiple plants for weeks or months ahead based on planned shipment of products. They are, however, woefully inadequate for the dynamic replanning and rescheduling that needs to take place in a busy make-to-order plant with delivery times measured in hours or a few days at most.

What these systems lack is:

1. The real-time detailed status of the manufacturing process, in terms of materials, machines, and equipment as well as their interaction with incoming and outbound supply chains and real-time arrival of customer orders.

2. The artificial intelligence to make routine decisions on behalf of the management team and to alert them when they need to intervene. This enables a make-to-order manufacturing plant to be run by a much smaller management team that can run the plant much more efficiently and can quickly cope with issues as they arise.

One of the major questions I get asked is "Is this just for big companies?" The answer is no. We have these real-time AI methods running very successfully in smaller companies such as a $10 Million a year manufacturer of fabricated steel products and the repair department of an elevator manufacturer. They are also used in applications such as scheduling and planning the conversion of non-woven fabrics into a variety of products and they are being used by smaller manufacturers of FDA regulated products.

Another question I get asked is "What does all of this cost?" The simple answer is way less than the cost of an ERP system. Clients can rent the real-time AI based operations tracking, planning and scheduling software for around $1,000 per month or purchase it outright for about $20,000. Then a typical client will spend around $30,000 in services to implement custom rules and alerts for their business, as well as to implement the needed data capture and systems integration components, for a total cost for software and services of around $50,000.

For this $50,000 or so investment in AI technology our clients get:

1. To eliminate the need for people to expedite jobs, handle customer inquiries about the status of their jobs, do routine materials planning and operations scheduling, and perform other overhead management functions. As the average loaded cost of such a manufacturing support person is over $100,000 per year, an AI based system such as BellHawk quickly pays for itself.
2. Much improved customer satisfaction as the AI based planning and scheduling helps ensure that orders get out on time despite problems that may occur.
3. Much improved competiveness and profit margins by shortening deliveries of make-to-order. Customers are willing to pay a premium for quick delivery of custom made (or at least semi-custom) product because it reduces their cost and risk.
4. Much less personal stress by eliminating "fire drills" when things go wrong or priorities change or a rush order enters the mix. Instead the real-time AI rules and algorithms take care of all the routine replanning and rescheduling leaving managers to deal with "bigger picture" issues and problems that need the manager's expertise. And, even when a manager does need to intervene, the AI system will be monitoring their operations and alerting managers when they need to intervene.

For more details about the real-time AI methods used, please see the companion white paper "Real-Time Artificial Intelligence for Scheduling and Planning Make-to-Order Manufacturing" on www.BellHawk.com.

Author

Dr Peter Green received his BSEE and Ph.D. degree in Computer Science from Leeds University in England. He was a senior member of the reseach staff at MIT, where he performed reseach into real-time intelligent systems under a DARPA funded contract.

He was subsequently a full Professor of Computer Engineering at WPI, where he performed reasearch into software methods for implementing real-time intelligent-agent based systems for the US Air Force and NASA. He then founded BellHawk Systems to continue this development using SBIR grants to enable comercialization of this technology.

While this technology had tremendous potential over a decade ago, it failed to gain commercial traction for industrial use because the real-time data, on which these real-time planning and scheduling systems are based, was simply not available from most systems in industrial use at that time. As a result Dr. Green turned his teams attention to the real-time operational data collection problem and over the past decade they have implemented close to 100 systems that are able to collect the needed data in real-time.

As these systems have grown in capability, and computers have become faster and less costly, the BellHawk team has incrementally integrated real-time AI based scheduling, planning and alerting methods into these systems to solve real-world manufacturing management problems.

For more information, please contact Peter.Green@BellHawk.com. Also, please see www.BellHawk.com for more details on BellHawk System's software technology.

