

Multitasking in the Lean Environment

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For better or worse, the term Lean Manufacturing is indelibly associated with the Toyota Production System in the minds of many manufacturers. In some areas, the connections are obvious, pertinent, and important. Both can claim the mission to continually identify and reduce waste in all areas. In other areas, the term “lean” is a misnomer. Such classic Toyota Production System thinking as, and I paraphrase here, “anything other than what is absolutely essential – time, personnel, material, and equipment – is surplus, and thus added cost,” gets misconstrued to mean that lean manufacturing is synonymous with the absolutely lowest-possible-cost production system, i.e., cheap equipment.

We face this situation daily, both as a machine-tool technology supplier and as a manufacturing and engineering organization – machine tool users ourselves. In every sales situation, application engineers and sales personnel have to be ready and able to discuss how the machine tool technology under consideration fits into the customer’s vision of lean manufacturing, often done with the customer’s lean consultant at his side. In many instances, where manufacturers face the choice between separate turning, milling, drilling, boring, tapping, and grinding equipment, or an integrated multitasking machine tool, the judgment can and does get made: “That’s not lean, it costs too much.”

In reality, multitasking is critical to lean, just not in the way most of the manufacturing world currently sees lean. Market reality as it is today dictates the need for new vision.

Life As It Is

It is no understatement that American manufacturers are facing the toughest economic times in recent memory. Entire industries have responded to slowing economic activity worldwide by consolidating plants, shrinking capacity, laying off workers, and searching for the lowest-possible-cost producers. In the United States alone, more than 2.5 million manufacturing jobs have gone away since the end of 2000. Capacity utilization in many major manufacturing industries has dropped below 70%, and the pressure to cut costs across the entire manufacturing supply chain is the most severe it's ever been. Add to this that customers are not retreating a single inch on product quality, while at the same time products from detergent bottle molds to aerospace components grow in complexity. In the meantime, capital equipment capacity continues to age. The overall result is a tangible and real hollowing-out of this country's manufacturing base. As more and more previous-generation machines glut the marketplace, even if the economic climate improves overnight and customers begin spending again, is American manufacturing in a position to compete globally? For large manufacturers and small job shops alike, business as usual is simply no longer an option.

Our own manufacturing organization is as subject to these market forces as any other. The machine tool marketplace is in a state of oversupply, resulting in lower volumes and thinner margins for all participants. Several machine tool factories, some with legendary names and histories, have closed in the U.S., and industry orders were less than half of what they were at the peak, roughly six years ago.

It became imperative that lean production and reduced inventory become a reality at our own manufacturing operations. Our manufacturing process was typical. We built to a forecast-based production schedule. We built in small-batch production that resulted in parts staging all

across the production floor. And this push-production system was carried out in part by multiple stand-alone machines.

What was needed was building to order on demand, with minimum open finished inventory. Work in process would move across the production floor in orders of one in a pull system. To implement this vision in Florence, KY, took approximately \$20 million over a period of four years and covers four basic characteristics:

- a common software platform for enhanced technical communication across the factory floor in real time
- significant levels of employee cross-training
- new cellular layouts featuring multitasking and material-handling equipment
- a modular assembly system

The new Integrex multitasking Palletech® cell installed as part of this reorganization can machine more than 80 different part numbers, including spindle shafts and chucks for the new Nexus line of CNC turning centers and machining centers. The four Integrex machines in the cell make parts that used to be made on 11 different machines, including three horizontal machining centers, two vertical machining centers, two turning centers, and four multitasking machines. The Integrex machines are two Integrex 300IUY Universal 1500 models and two Integrex 300IISY models. They can turn, mill on multiple faces, bore, and complete complex parts in a single setup. Each of the four machines has a 120-tool magazine and an automatic jaw changer holding 15 sets of jaws. Also, each Integrex features a 12-in. chuck for the main spindle (35 Hp, 3500 rpm) and a 10,000-rpm, 30-Hp rotary tool. The SY models also have a 12-in chuck for the second spindle (30 Hp, 3500 rpm).

The Palletech Manufacturing Cell automatically schedules machining for each machine, and moves workpieces between equipment and loading stations. It has 31 pallet stations, two load/unload stations, a pallet shuttle robot, gantry loader, and four chuck jaw storage stations each holding 10 sets of jaws.

The concept grew out of a new family of Nexus models that would be globally competitive. The objective of our new Production on Demand system was to produce Nexus CNC turning centers and machining centers of higher quality and improved productivity levels than previous Quick Turn and VTC models, but at lower prices.

The new production system works in concert with the design of the new Nexus machines it helps produce to greatly reduce overall lead time and inventory on the Mazak manufacturing floor. On shaft work, the new cell reduces process time 39.4% and overall throughput time 54.7% compared to the previous method. For producing chucks, which used to involve separate turning and horizontal machining centers, the new Palletech® cell reduces process time 46.1% and overall throughput time 49.4%.

Furthermore, in the case of the Vertical Center (VC) Nexus models, once the column is centered on the base, a single worker can finish-assemble the machine in a single eight-hour shift. The goal for delivering VC Nexus models from order receipt to shipment is three weeks; for the Quick Turn (QT) Nexus models the goal is two weeks. Had we not achieved reduced inventory levels and reduced assembly time, the mission of Mazak's new Nexus line -- providing advanced machine-tool technology and efficiencies to customers at reasonable cost -- would not have been possible.

Results have been extremely encouraging to date. Open machine inventory is down significantly on the factory floor, overall cycle times from order receipt to shipment are down across the models of machine tools we produce, machine utilization and labor utilization are up, and overall quality is improved. And the best measure of success is that customers are ordering repeat machines and have very favorable comments on the performance of their Nexus models. In the most severe economic climate in recent memory for US manufacturing, our company as both a manufacturing organization and a technology provider, is establishing a platform for growth.

Where Paths Divide

It should be recognized that the Toyota Production System was developed to eliminate waste from a high-volume production operation. As such, it continues to provide a model for the world that high-volume producers would do well to follow. But while between 80 and 90% of the concepts, such as pull scheduling, quick changeover, elimination of waste, and deployment of teams work equally well in small to medium-volume production, deploying lean manufacturing exercises different priorities when it comes to smaller-volume shops.

In such operations, high variety coupled with low volume is often the rule, and faster machines, or even rows of straightforward and efficient equipment are not the answer. Reducing lead time, changeover time, setup time, and time between operations are critical main targets for reducing cost. A recent magazine article titled “Multitasking the Shop Floor” put it succinctly: “Many major companies have kept alive by contracting more and more work out to medium and small shops. These second- and third-tier contractors stay in business because of their flexibility, their ability to adapt to changes in design and quantity. Because of the operating space of these shops, there’s not a lot of room for elaborate collections of machinery to handle complex tasks. Not unless they use machines that combine several functions into one apparatus.”

Manufacturing firms that are customers of ours tell similar stories. Peddinghaus (Bradley, IL) makes fabricating equipment for the construction industry. Its new PDL 24 machine is a portable drilling unit can be easily transported to a work site for drilling holes in beams, angle iron, plates and rectangular tubes. This makes on-site adjustments of structural beams possible, saving weeks of the time it would take to get a custom beam done. Peddinghaus found itself contemplating a unique situation. The reality was the company needed to produce a large part, a clamp for the PDL 24 with complex features. The company’s vertical machining center could hog out the billets like a champ, but it would require special attachments and multiple setups to complete the part. Their Integrex 300Y, bought for its capabilities and not for

any particular part, was used for relatively small and simple parts, including cylinder caps. According to machine shop foreman Todd Bertrand, “We thought it was a fairly wild idea when our operator came up and said, ‘Why don’t we try this thing on the Integrex?’”

The advantages of multiple machining operations on a single setup quickly made themselves apparent. Workholding, for one, was easier and cheaper due to a single setup as opposed to up to four on the company’s vertical, and at least two subsequently on a lathe. “Anytime you take a part that is partially machined and put it on another fixture or reset it in another machine not only adds time, but also the possibility the part may not be located accurately,” notes Bertrand. “Performing all the operations in a single set up from a solid piece is still more economical than machining from a casting.”

In terms of their lot sizes, Peddinghaus is essentially a job shop. They don’t keep a large inventory of portable drilling units in stock, and often build them on demand. The same parts cost more than 60 percent less to manufacture in-house on the Integrex 300Y.

Consider time as inventory that needs to be reduced in a lean manufacturing environment, and multitasking equipment by nature becomes critical to achieving lean status. Celebrating our company’s 80th anniversary in 1998, we revealed our goal for the next 20 years, an “ultratasking” machine that would combine operations unheard of at present and achieve new levels of speed, horsepower, and operating efficiency. We are not there at present, but such an ultra-efficient multitasking machine is our vision. Closer to reality is a concept involving grouping multitasking machines in networked cells where a single operator can make, inspect, assemble, and test complex products in lots of one. Our working title for such a concept is “fractal manufacturing,” from the mathematical term of a geometric shape that can be subdivided, yet each piece is a similar copy of the whole. “Beyond lean” concepts such as these are the critical next steps in manufacturing’s future.

New Vision

Manufacturing is an evolutionary process, and lean is no less an evolutionary development within manufacturing. In the automotive industry, mass production may have put the world on wheels, but market forces mandate that car companies move beyond the mass-production mindset. The automotive industry today is doing everything it can to reduce the amount of time between new model design and production. Yet smaller-lot production is not inherently better, if frequent part setups and changeovers increase idle time for production equipment.

Multitasking is critical to lean manufacturing, in fact, multitasking *equates* to lean as reducing non-value-added time and overall production costs, frees up floorspace, and improves efficiencies. What can be less wasteful than completing the part in a single setup without complicated fixtures? The accuracy of the machine is used to control the part geometry in a single setup. The two-man job shop or the lights-out automated production plant can equally achieve lean status with this way of thinking and producing.

Lean is not a goal. Profit and growth are goals. But multitasking equipment that can combine operations, reduce setups and changeover time, and reduce or eliminate secondary processes, give their organizations powerful tools for reducing inventory, cutting waste (including non-value-added time) and accelerating inventory turns. These are powerful advantages that face market reality squarely. Such companies have a step up in the natural selection process in manufacturing. Such companies can make increasingly complex parts with high quality and still make money. Such companies are lean in spirit and in fact.

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