

Navigating High-Mix, Low-Volume Manufacturing

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Want to decrease setup times and become more competitive? Before investing in quick-change tooling or a new machine tool, take a look in the mirror: The roadblock might just be you.

If you're looking for recommendations on offline tool presetters, zero-point workholding systems, and quick-change toolholders and chucks, stop reading and go back to work. We could have interviewed those providers (again), but let's face it: All of that stuff has been around for decades.

Yes, it's improved over the years. It's getting more connected, more accurate, and even a little less expensive. But if your shop is not yet using at least some of it by now, the chances are good that no amount of magazine article reading will change that.



This YASDA PX30i five-axis machining center from Methods Machine Tools is equipped with quick-change workholding as part of its pallet changing system, although there's nothing stopping anyone who owns similar equipment from adding quick-change to their existing machinery. (Provided by Methods Machine Tools)

Of Dentists and IndyCars

Jim Van Buskirk is the senior director of application engineering at Methods Machine Tools Inc. in Sudbury, Mass. He has plenty to say about the value of new CNC machinery, which we'll get to shortly. But like the others in this article, he explained that no amount of advanced tooling or machine technology will help shops that are disorganized or not focused on waste elimination to reduce their setup times.

For context, Van Buskirk noted: "The last time you went to a dentist, did she get up from the chair every time she needed an instrument? Or were all those tools delivered to the work area cleaned, kitted, and ready for that day's procedure? Machine shops should take a similar approach when setting up their CNC equipment."

Van Buskirk equates this type of preparation with SMED, or single-minute exchange of die, a concept that lean manufacturing guru Shigeo Shingo introduced to Toyota Motor Corp. more than six decades ago. Methods emphasizes this concept when designing machining

workflows, workholding and tool holding setups, and other customer-specific solutions, he said. “Our department is tasked with unearthing ways to reduce idle machine time and making sure customers get the most time in the cut, so SMED is a mindset, a starting point. It’s a real-world solution and one of the first places we look when addressing a project.”

However, SMED has yet to gain widespread adoption in North America’s low-volume, high-mix machine shops.

Some in the industry might dispute this point, arguing that it takes longer than that just to unpack your lunchbox, but “single minute” in SMED’s case actually means single-digit minute—i.e., anything less than ten minutes. This is a worthy target, Van Buskirk said, one that shops can strive for by analyzing their setup

operations. “Videotape the changeover. Every time that person leaves the area, find out why and then fix it. Document the number of steps it takes to set up a machine. Separate the ones you can do while the machine is running from those that must be performed while it’s idle, then find ways to eliminate any that don’t add value, even if it means modifying well-established procedures. In some cases, especially these.”

People underestimate the amount of planning it takes to do fast changeovers, he added. Preparing everything in advance so that the setup person can be like the dentist and not leave the work area is critical. If this isn’t possible, take an IndyCar pit crew approach—one person to change the tires, one to clean the windshield, and one to fill the gas tank.

“As with an Indy race, each minute counts in manufacturing,” Van Buskirk said. “Adopt a mindset focused on removing any waste from the process. Make a checklist of everything needed for the setup and prepare whatever you can in advance. Know in advance when the machine will be done with a job so you can immediately get started on the next one. As a rule, customers don’t pay for setup time, so it’s critical that you do everything in your power to reduce it.”

The Right Stuff

Methods imports machine tools, designs machining processes and custom automation systems, and assembles option kits, so it’s understandable that Van Buskirk would recommend shops invest in the latest and greatest CNC equipment. He’s right: As lot sizes fall, shops need machinery that’s both fast and flexible, and the ones who stay current have



Are you a high-mix, low-volume manufacturer who wants to turn out the lights and go home for the weekend while the machine continues making parts? Automating the changeover process is a crucial first step. (Provided by Methods Machine Tools)

the greatest chance of success in a market that grows more competitive by the day. To Van Buskirk, this means plenty of pallets, generous tool magazines, integrated probing systems, and, somewhat surprisingly, automation.

Automation in a high-mix, low-volume environment? By all means, he said. “We have any number of customers who’ve set up their vertical machining centers with zero-point workholding and integrated storage carousels. Here, there’s no reprogramming, and the robot can use the same end-effector for every job, regardless of what parts are sitting on the pallet.”

Dave Fischer has similar views. A lathe product specialist for Okuma America Corp., Charlotte, N.C., he’s a big fan of multitasking machines, noting that they are ideal for shops that want the fastest changeover possible. Depending on the model and manufacturers, multitaskers boast large tool magazines with automatic tool changers, secondary spindles, auxiliary turrets, and enough axes to machine most parts complete in a single operation. When equipped with quick-change chucks, this allows shops to set up any number of jobs in advance and switch over within minutes, simultaneously reducing their work-in-process and the tooling costs associated with secondary operations.

“Multitaskers also eliminate the disruption that comes when your best customer calls with a hot job,” said Fischer. “There’s no tear-down of the existing job, no half-finished or orphaned parts lying around, no hours and hours of downtime. You just swap out the chuck jaws, call up the program, and start making parts.”

Baby Steps

For those not yet ready to make the significant investment in a multitasking machine, Fischer listed some of the small steps that shops can take to reduce setup times. For CNC lathes, these include the quick-change chucks just mentioned, as well as quick-change turret tooling, integrated bar feeds, and, as Van Buskirk alluded to, robotic part handling with standardized gripping.

As stated at the beginning of the article, however, many of these timesavers have been around for decades. The question then becomes: Why aren’t more companies using them? Fischer has no idea. “To be honest, I struggle with this. Before starting with Okuma, I worked for a shop where we implemented quick-change tooling. That was well over thirty years ago, and it was hardly cutting edge back then. I know there are a lot of ingrained habits out there, aversion to risk, and just being stuck in a rut, but I’m baffled as to why so many manufacturers are reluctant to make even small investments or change their ways of doing things. The benefits are obvious.”

Fischer added to Van Buskirk's earlier advice, noting that shops should start with an honest benchmark of their current setup times and OEE levels (overall equipment effectiveness). Too many look at these through rose-colored glasses rather than taking a scientific approach to waste reduction. Stop treading the same old cow path and look for ways to straighten it, he said, and if your shop doesn't have the financial wherewithal to invest in the big-ticket items, start small.

"Quite often, shops already have some of the tools needed to address setup and process-related inefficiencies, but they either don't know how to use them or haven't taken the time to implement them," said Fischer. "For example, I worked with a customer once who was breaking drills on a repeat job. It was not only costing them a lot of money but prevented them from running lights out. I showed them how to use the load-monitoring function—a capability the machine came standard with—to solve the problem. It turned out to be the first of many baby steps, resulting in growth that recently allowed them to purchase another machine."

Fischer closed by referencing a 2017 roundtable discussion that included representatives from Okuma, Mastercam, GE Power, and other industry leaders. In it, Sandvik Coromant President Sean Holt made a statement that sticks with Fischer to this day. "He said, 'Think big, start small, move rapidly.' Holt was referring to Industry 4.0 adoption, but his words apply equally well to any continuous improvement activity, setup time reduction included."

Take it Easy

Mike Ferguson, director of engineering at Dayton, Ohio-based Gosiger suggested that the path to setup time reduction begins with organization. "One of our customers has proven just how successful low-volume, high-mix manufacturers can be in the U.S. Every part of the machining process is well documented. Their tool carts are labeled with spots for each toolholder, fixture, or chuck jaw. There are big-screen TVs all over the floor showing real-time data on what's running and what's up next, and whatever the operators need to do their job is within reach. It's impressive."

It's also easy, at least for the operator. Ferguson and his team spend much of their time looking for ways to simplify the setup process, turning what would otherwise be a complex procedure into one that even less-skilled workers can execute. In one project, they made



Generous tool magazines and so-called "wine racks" are essential to reducing setup time in high-mix, low-volume machining environments. (Provided by Methods Machine Tools)

changeover on a family of parts no more difficult than scanning a series of barcodes on a job traveler. This signaled a macro program in the machine control as to what part to run and how many to make.

Another project entailed the development of a closed-loop metrology system that allows the operator to place a workpiece on a shop floor coordinate-measuring machine and have it automatically update tool lengths and diameters based on the results.



A properly tooled and programmed flexible manufacturing system (FMS) like the one shown here can easily outproduce conventional machining centers, even on high-mix, low-volume work.
(Provided by Okuma America)

“For setup times to be low, everything needs to be as simple as possible from an operator’s perspective,” said Ferguson. “This might mean in-machine probing to reduce any chance of human error, or offline presetting systems that use RFID tags to upload tool life status and dimensional values to the control. The fixture locations should also be preset, so the only thing the operator has to do is take the old one off and stick a new one on—in many cases, these steps can also be automated, so that a robot can perform the changeover. Of course, achieving this level of simplicity requires quite a bit of engineering work up front, as one might expect.”

Get with the Program

Ferguson added that all this pie in the OEE sky is not limited to larger companies—engineering efforts to the contrary, even the so-called Mom-and-Pop shops are getting in on the quick turnover action. “We’re seeing many requests from job shops that want to run smaller batch sizes at night and over the weekends, and do so with minimal or even no operator intervention. Given the right equipment and tooling, it’s very feasible.”

For shops like these, it’s easy to achieve Van Buskirk’s target of less than ten minutes. Yet as Jason Lutch explained, there’s more to the high-mix, low-volume equation than advanced tooling and machinery. There’s also the programming. “I spent a lot of years in the tool and die business, and for me, being efficient at short-run production and one-offs came down to having your CAM software dialed in for the work you’re doing.”

That was 20 years ago. Today, Lutch is an applications engineer for Absolute Machine Tools Inc. in Lorain, Ohio. He said optimizing your shop’s tooling libraries and operating parameters might require a significant amount of effort. But for him, at least, it made programming both faster and more accurate. And once the job hit the floor, setup required little more than establishing the work coordinates. “It was really critical to helping us pump out as much work as possible,” said Lutch.



Like all five-axis machining centers, this Tongtai CT-350 from Absolute Machine Tools is able to produce a wide range of complex parts in a single operation, reducing WIP, setup time, and operating costs. (Provided by Absolute Machine Tools)

Out with the Old

Fortunately, these efforts are much easier than when Lutch was still picking chips out of his steel-toed boots. For starters, customers can rely on cloud-based tooling libraries such as MachiningCloud and Kennametal Novo for application information rather than hunting through paper catalogs or picking the brains of the tooling representatives as he once did.

Lutch noted that toolpath simulation is also key to reducing programming efforts and setup times. Proving out a program before sending it to the machine tool eliminates errors, increases operator confidence, and most importantly, avoids crashes that might cost tens of thousands of dollars. Lutch has also spent time establishing canned routines for repeat operations such as tapped holes and pocket roughing, making many jobs as simple as importing the file, selecting his geometry, and generating the code.

In that same vein, he points to another technology unavailable during his tool and die days: conversational controls. “Especially with the shops doing straight prototype work, we’ve seen an uptick in requests for on-machine programming systems,” Lutch said. “FANUC’s Manual Guide I, for example, is a nice conversational package that is very user friendly and can be added to a lot of controls.”

With these new programming methods and modern machinery comes the need to educate oneself. Said Lutch, “I hate to point it out, but far too many shops are stuck with archaic machining methods. Here they’ve invested in a beautiful CNC lathe or mill and the operator wants to use a high-speed steel corncob cutter, or you have to explain to them why they should be climb cutting instead of conventional milling. Granted, this has nothing to do with setup time reduction, but there’s a definite need out there for continuing education and an openness to new ideas. Without that, there’s little chance of improvement, no matter the job quantities.”