

Cutting Down on Setup Time

With increasingly smaller returns from improving the speed of the actual gear grinding process, improving your setup time has become a primary way to keep improving efficiency. Here's the latest on how you can do that today.

Alex Cannella, Associate Editor

With machining time itself having gotten shorter and shorter over the years – to the point where it's starting to see diminishing returns – savvy manufacturers looking for ways to improve efficiency have turned towards setup as one of the most important steps of the manufacturing process to shave time off of.

Everyone approaches the task of reducing setup time differently. Bill Miller, vice president of sales and service at Kapp Technologies, splits his company's solutions between mass production lines and batch manufacturing job shops. It's obvious why job shops that frequently switch between small batch production runs would benefit from improved setup time. Dr. Rolf Schalaster, manager of the competence center for bevel gear grinding at Klingelberg, predicts that for small batch job shops, setup can even take up to 50 percent of a manufacturer's time. But Miller believes it's also an equally important topic for mass production companies, even if they only set up a machine once or twice a day. Even if you're only grinding the same workpiece repeatedly, grinding tools wear down and need to be swapped out. Workpieces still need to be periodically tested for accuracy. These processes take time, and they can be reduced with the proper tools.

According to Dr. Antoine Türich, director of product management for hard finishing solutions at Gleason, there are four broad categories in which setup time can be reduced: the mechanical work of physically exchanging tools, workholding, and so on; teaching and setting up a particular job before beginning the actual manufacturing; inspecting finished workpieces; and applying the eventual necessary corrections.

There's also a great deal of focus on



You can speed up setup time with new solutions that reduce or virtually eliminate the need for tools during setup.

reducing workplace errors, as they can be one of the greatest sources of lost productivity. Time spent fixing a mistake is time lost not machining.

Different companies have taken a few different strategies to accomplish this. Some make the setup process simpler and provide instructions on how to set up the machine, while others cut out the chance for user error entirely through automation.

Suffice to say that people have come up with a lot of inventive ways to reduce setup time over the years, and we're going to highlight as many of them as possible. While some of these processes are well-known and have been around for a while, they're still constantly evolving and are joined by other newer or less orthodox ideas.

Reduce the Need for Tools

One common way we can hasten the setup process is to simplify it. After all, the more straightforward something is to setup, the fewer steps and less expertise required, and by extension, the easier and faster the work will be. One

primary way machine manufacturers are accomplishing just that is by simplifying the design to reduce the number of tools required to set up a machine.

"Sometimes, you need a whole toolbox with different tools to setup the machine," Türich said. "Our solution now requires just one simple tool, which makes it much faster and easier."

The solution Türich is referring to is Gleason's Genesis GX threaded wheel grinding machine series, a prime example of the idea. Every screw you need to interact with to complete setup has been standardized so that the machine can be completely setup from start to finish with a single Allen wrench. According to Türich, a central focus with the GX was to make sure the machine was as fast and easy to set up as possible, requiring only 10 minutes of setup time to change out the grinding wheel, dressing tool, workholding and gripper inserts before you're ready to get machining.

Gleason can still do one better than that, though. According to Uwe Gaiser, director of product management of bevel gear solutions at Gleason, the process

can be as simple as just hitting a button or flipping a switch. Just hit a switch to release and swap out the workholding in a process that takes “just a few seconds” instead of dozens of minutes tightening screws. Combine that with a hydraulic, spring-loaded chucking system, and cutters can be rapidly swapped out with ease.

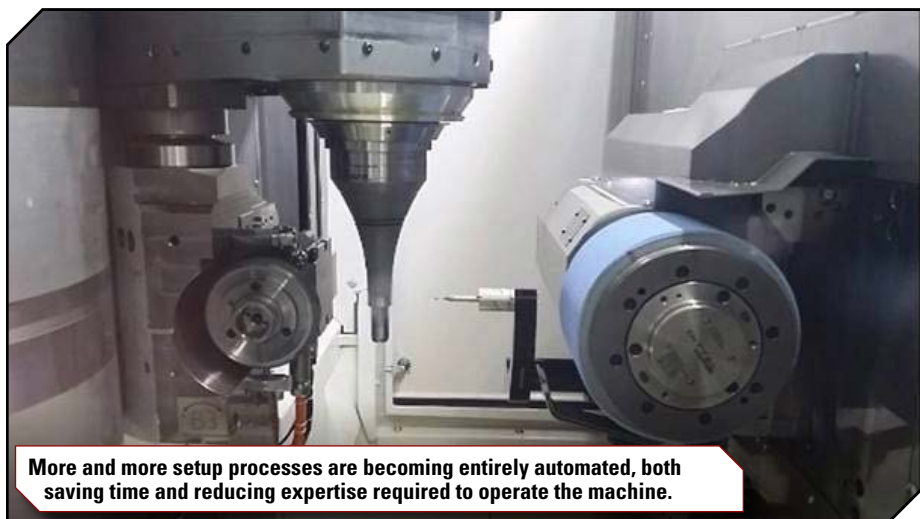
“We have the same accuracy, but instead of taking 10 minutes, you can do this in 30 seconds depending on the size of the cutter,” Gaiser said.

According to Miller, reducing the need for tools can be particularly useful for mass manufacturing because it reduces the need for specialized expertise. In Miller’s experience, many larger high-volume manufacturers can have their processes grind to a halt whenever a machine needs to be adjusted as someone runs to fetch an expert. That might sound like a mundane and barely noteworthy issue, but when workpieces can be ground out in seconds or minutes, taking 10-20 minutes to hunt someone down, get them over to the machine and solve the problem can put you behind.

Kapp’s KX-100/260 Dynamic machines give high-volume manufacturers a boost by requiring zero hand tools or wrenches to set up, meaning no expertise required. Just put the tool on the flange and the machine handles the rest.

Automate!

Of course, options like the KX Dynamic series that just lets you plug a tool in and go couldn’t exist if the entire process wasn’t automated to run itself. Many



More and more setup processes are becoming entirely automated, both saving time and reducing expertise required to operate the machine.

processes ranging from changing out the clamping device to verifying the run-out are fully automated, reducing the amount of time skilled workers have to spend working on a specific machine.

Kapp’s advances are only one part of a larger trend towards automation, the latest advances of which are doing their part to help combat the skill gap and reduce setup time as much as possible.

“In a global view, today’s machine operators are not necessarily experts on what they have to do like in former days with manually operated mechanical machines,” Schalaster said. “We believe that setting up obviously has to be as fast as possible. But in addition, it also has to be as safe as possible since mistakes can quickly lead to time- and money-consuming damages. Therefore, we try to make the system smarter so that the single setup steps are easier, faster and potential sources of error by the operator

are avoided.”

Klingelberg has developed a number of ways to help machine operators and reduce errors with automation. This can manifest in small quality of life upgrades to existing processes such as how grinding machines won’t start a grinding process if the wheel hasn’t been reprofiled after loading profile corrections have been finished, or include bigger, stand-alone solutions such as a smart tooling system.

The tooling system is based around data matrix codes, which each fixture tool in the system comes with. Scan the code and the fixture’s geometry gets loaded directly into the machine without any need for input from the technician. Klingelberg is also working so that in the future, a machine will automatically know the geometry of both new and used wheels immediately after tool changes, reducing the time required to program the machine before it gets to machining.

The tooling system is also currently being implemented to work with Klingelberg machines’ automatic fast profiling program, which minimizes dressing time by automatically determining any necessary reductions of a grinding wheel’s length and which areas need to be dressed based on a list of four to six parameters input by a technician. According to Schalaster, Klingelberg would like to shave that time down even further by implementing the smart tooling system so that technicians won’t even need to input the tool’s parameters, and can instead just scan the tool and go.

Klingelberg’s tooling fixtures themselves have also seen a few



Gleason’s Genesis GX series has multiple new innovations designed to cut down on setup time and simplify the process.

modifications. Most notably, the fixtures can be mounted entirely outside the machine, meaning that the tools for the next job on the machine can be prepped while another job is already running. Once it's time for the next job, it only takes a handful of unscrewed bolts and a few quick steps and the next tool's ready to go. The way Klingelnberg handles its fixtures is just one example of a company-wide focus on another way you can cut down on setup time. Namely...

Do More Outside the Machine

While other companies focus on application-driven solutions or individual steps of the process, Klingelnberg has taken a unique approach to improving setup time. Schalaster categorizes each element of the setup process as either external setup, which can be done outside the machine while it's working on a previous job, or internal setup, which requires the machine to stop. It's not much of a surprise that many of Klingelnberg's efforts focus on reducing internal setup as much as possible, and they've opted to do so by shifting as much of that labor into external setup processes as possible.

"A decisive issue is to shift as many steps as possible from internal setup time to external setup time," Schalaster said.

One such solution is what Schalaster

calls a "one piece oil ring," which is designed for reducing the time required to set up oil pipes and nozzles for your coolant. The idea is for each nozzle to be mounted on a single ring that can be quickly exchanged during setup. Instead of taking time adjusting your nozzles for a new job while the machine is forced to stand idle, you can just swap out pre-adjusted sets of nozzles on each ring and go.

Customers have a few options on how they want to take advantage of the oil rings. Mass manufacturers that only have a machine work on a few different parts can have multiple oil rings that they can slot in and out as each one is needed. For batch manufacturers working on many small projects, however, Klingelnberg also offers a tool trolley that allows you to pre-set an oil ring for the next job while the previous one is still running that can then be slotted in when it's time for the next workpiece.

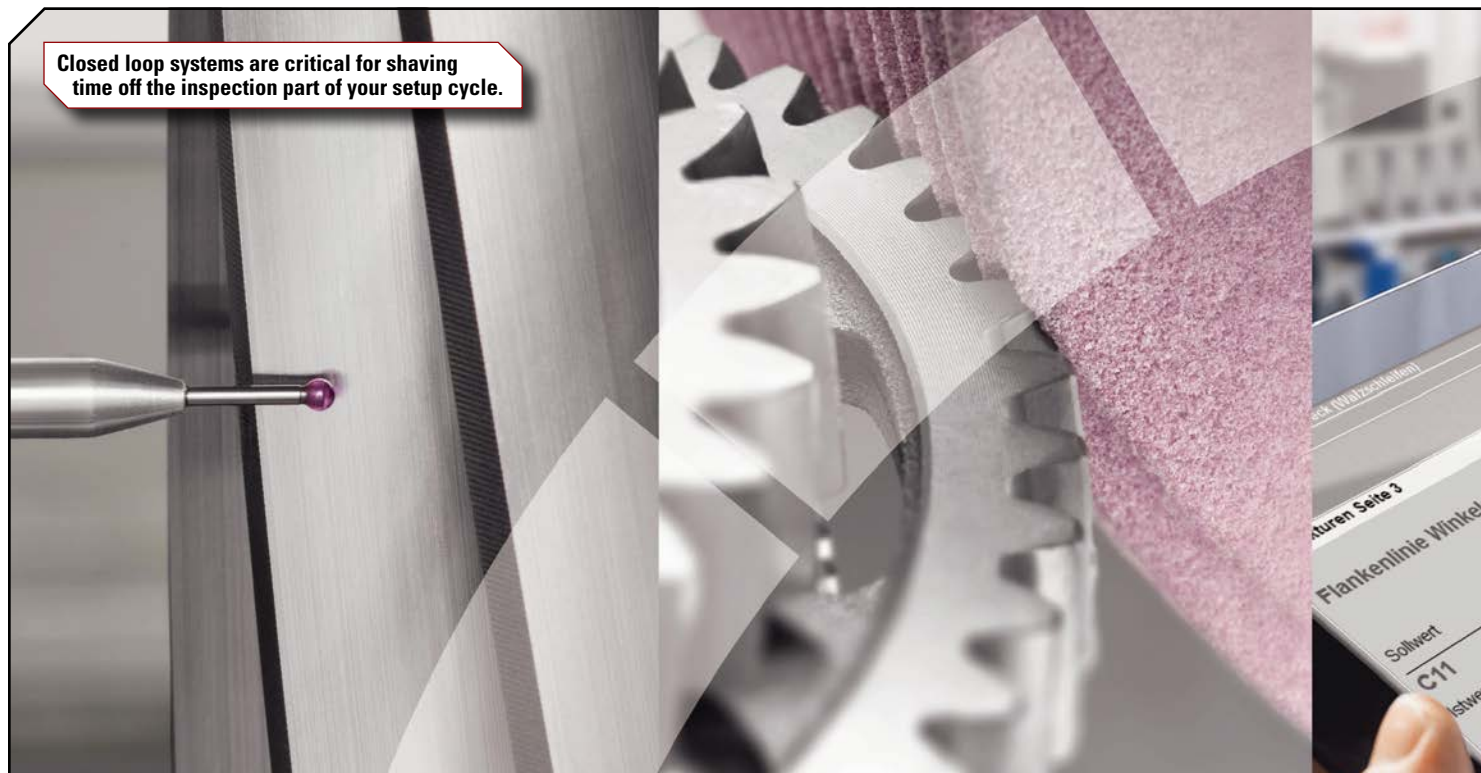
Get Multitool Machines

Shifting as many steps as possible to be done outside a machine isn't the only way you can physically cut down on your setup time. You can always get a machine that combines both external and internal grinding, such as Liebherr's LGG 180/280/400 M series, which can

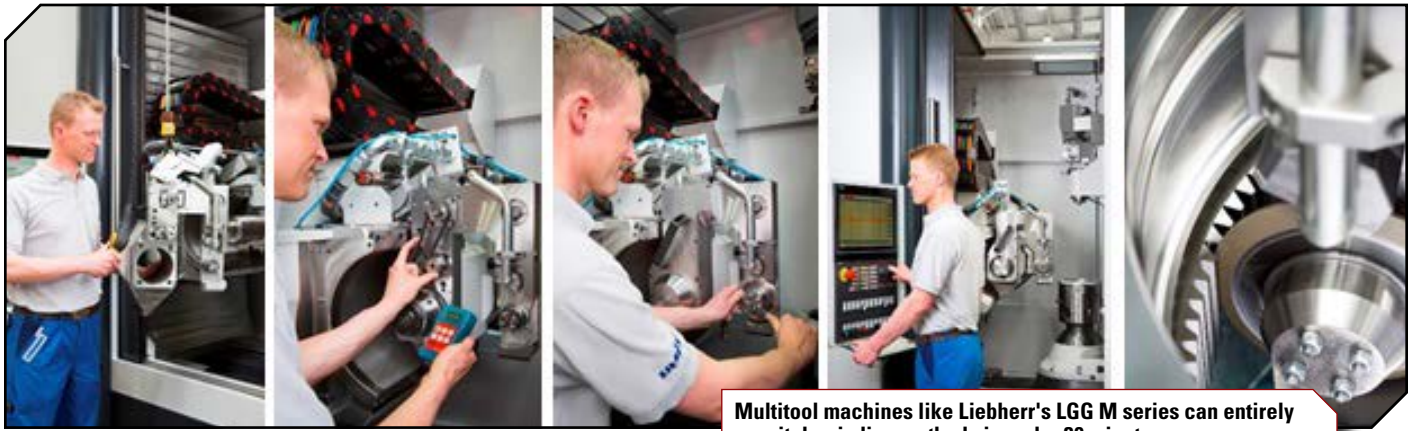
switch from generating grinding to internal profile-grinding in less than 30 minutes.

How does Liebherr accomplish this? For one, they make sure the process is simple and easy. The machines' internal grinding arms can be mounted directly onto the external grinding heads. Like with some earlier machines we've highlighted, no hand tools are required to change out parts like inserts or the clamping fixture. Dressing tools are easy to switch out thanks to a hydraulic expanding arbor. A machine mounted jib-crane automatically mounts the internal grinding arms and changes over grinding wheels. And then there's Liebherr's LHGeartec software, which allows the engineer to load any necessary programs for a given project either at the machine or from an external server and can lead the technician through the setup process with its HMI.

Samputensili's SG 160 Sky Grind similarly utilizes both hobbing tools and a grinding wheel in a single machine. The hobbing tool quickly removes most of a workpiece's stock allowance in one pass, then a second pass with the grinding wheel finishes the job. In addition, it can also change workpieces in the same lot in under two seconds, further reducing downtime by shaving off the margins



Closed loop systems are critical for shaving time off the inspection part of your setup cycle.



Multitool machines like Liebherr's LGG M series can entirely switch grinding methods in under 30 minutes.

of time between each individual workpiece's manufacture.

"The part changing time on the Samputensili SG 160 Sky Grind dry grinding machine, and its wet grinding equivalent G-160, have a very quick part change," David Goodfellow, president of Star SU, said. "It is important to change the workpiece in the same lot in product in less than two seconds. This requires high speed machine movements and design changes to realize this important cycle time reduction."

In general, Star SU and its affiliated companies have specialized in improving setup time with servo and hydraulic quick change actuating devices for hobbing, grinding, shaping, shaving and CNC tool and cutter machines. Like a

few other solutions tackling setup time that we've described, these quick change devices are run without requiring any hand tools or specialized labor. They've also begun to implement those same quick change components in grippers.

Up Your Software

Improving and iterating upon a machine's software is a pretty common method for reducing setup time. Gleason's Genesis GX series, for example, also features software guidance on its screen that will take even unskilled operators through every step of the setup process, telling them exactly what they need to do. It reduces mistakes and allows less skilled operators to work more quickly, both of which translate to less downtime.

Türich related a common occurrence from when Gleason was showing off their Genesis GX line at open houses where, after demonstrating the feature, visitors would volunteer to try and set the machine up following its instructions and, on the spot, were able to do so.

"They were really impressed with how easy it was and how fast they could learn it by using the software-guided instructions right on the machine," Türich said.

Teach Your Machine

Software can also help improve your setup time by enabling your machine to learn how to do new jobs faster than ever before.

According to Türich, one primary holdup in the setup process is the need to teach a machine new motions. Meshing cycles, initial dressing, adjusting coolant nozzles, calculating the tool position; all of these steps take time and expertise to properly execute, and

Gleason has developed software that takes the machine through each of these steps on its own in 10 minutes, prepping it right up until it's time to start machining parts.

"We have taken all these sub-cycles and created a complete new one we call the First Part Cycle," Türich said. "And what this First Part Cycle is doing is going through all the steps which are necessary after the mechanical work until the first workpiece is being ground on the machine. So the machine does everything automatically."

Similarly, you can opt to have your machine remember a job so you don't have to teach it twice in the first place. Gleason offers software for CNC controls that allows their machine to save and remember past settings.

"You can ask after an hour, after a day, after a year," Gaiser said. "If the customer comes back to a specific ratio, it's really just the push of a button to activate that data, activate that machine summary, and you have the same data like you used to have whenever you had the job the last time on the machine."

The benefit of a repeatable setup is self-evident: manufacturers can maintain accuracy and, more importantly, repeatability while greatly reducing setup time by skipping any required calibration.

"If you don't have a repeatable setup, you will have to redevelop the job again..." Gaiser said. "The most preferable way would be to be as close as possible to the part geometry where you had left off the cutting or grinding process whatever time ago."

Streamline Inspection

Unlike with Gleason's other solutions, Türich stressed that much of the



inspection process is outside of the company's control. The process isn't fully automated, so there will be variance depending on how quickly a technician works, and there is no solution for two technicians that need to use the same inspection machine at the same time. But looking at it from the opposite angle, streamlining those processes could also lead to improved efficiency. Organizing your workflow so that everyone isn't setting up their machines at the exact same time (and thus needing to inspect workpieces) and would reduce the potential for downtime where your technicians would be sitting around waiting.

One step that Gleason has implemented is a closed-loop system in which a Gleason inspection machine sends the inspection results directly back to the production machine, removing the risk of errors when interpreting results or inputting incorrect values. The production machine compares the actual values with the programmed target values and applies the necessary corrections automatically.

Closed-loop systems aren't necessarily

revolutionary today, but they're still an essential tool in reducing your setup time. For example, Klingelnberg's Komet software suite automatically calculates corrections to reduce flank form deviations and remembers past corrections the grinding machine can load on its own. Klingelnberg has been working on expanding the software's applications, most recently translating it to cylindrical gear manufacturing, in addition to already being used for bevel gear grinding. But despite the fact that Komet isn't even a new product and its only recent updates have been to expand its applications, the software suite still recently won an Industry 4.0 award, highlighting just how influential and important closed-loop systems still are.

Use One Wheel to Grind and Polish

Reducing the time it takes to set up a machine is all well and good, but what if you didn't have to change your setup



Norton's Xtrimum grinding wheels can grind and polish a gear without having to be swapped out from the spindle.

between jobs to begin with? An option to consider is a grinding wheel that combines two different wheels into one.

For example, Norton | Saint-Gobain has been developing a new line of grinding wheels called Norton Xtrimum that help master the challenges in worm

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grinding, profile grinding and bevel grinding. The new line includes dual-worm grinding wheels which combine a vitrified bond section to grind and a fine-grit resin bond section to polish the teeth of the gear, delivering an improved surface finish quality to reduce gear noise in the final assembly. The dual-worm wheels can be adapted to existing machines.

“Gear manufacturers are being asked to hold tighter tolerances, improve productivity and improve surface finish,” Jennifer Thompson, application engineer at Norton | Saint-Gobain, said. “So instead of having to swap out grinding wheels mid-job for different steps of the process, manufacturers can use the Xtrimum dual-worm gear grinding wheels to rough and finish grind on one spindle to achieve cost and time savings.”

Get Your Supplier Involved

A major part of the setup process can be dressing a wheel before getting to the actual grinding. Manufacturers have come up with a few ways of handling this situation, including dressing a second wheel while the first one grinds so

it's ready to swap in the instant you need it, but Miller recommends getting your supplier to do the dressing for you. Batch grinders in particular can improve their efficiency by getting their supplier to pre-dress their worms before they even arrive on your doorstep.

“Working together with the supplier, it is possible to get that form much closer to the final form to reduce that time,” Miller said.

The idea is to reduce dressing time during manufacturing by essentially having your supplier do some of the work, such as pre-dressing, for you. According to Miller, this can save up to 30-40 minutes of setup time.

Don't Use Just One

Often, many of these solutions are built upon each other, work best alongside each other, or even appear standard together in one machine, such as with Gleason's Genesis GX and Kapp's KX Dynamic. Not every solution is going to fit your specific needs, be they batch manufacturing, mass production, or based on a specific grinding method, but hopefully this has given you a few ideas

as to the wide array of options available to take advantage of, and you'll find a few that you can leverage. ⚙️

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