The Next Era of Workholding

Matthew Jaster, Senior Editor

We asked what the future holds for workholding and the industry did not disappoint. All the machining trends such as automation, robotics, sensors, 3D-printed parts, etc. are finding their way into workholding equipment. The end game is saving money, conserving energy, mitigating the skills shortage, and highlighting flexibility and consistency in machining.

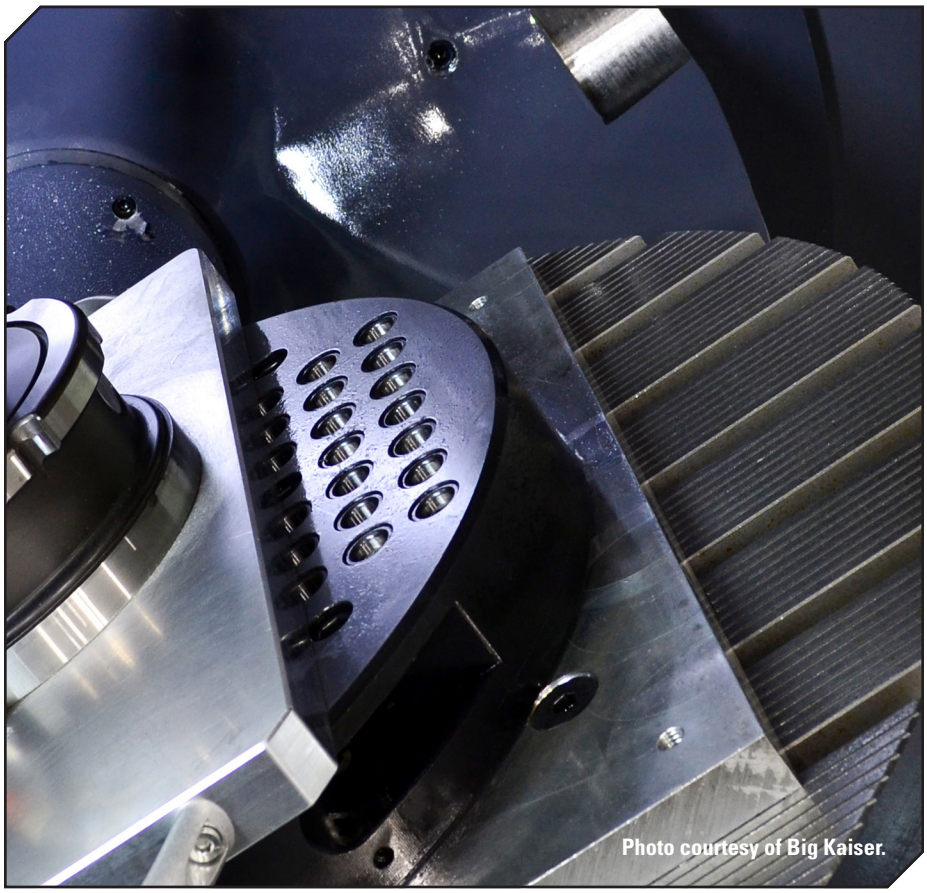


Photo courtesy of Big Kaiser.

Gleason Examines Fast-Changing World of Workholding

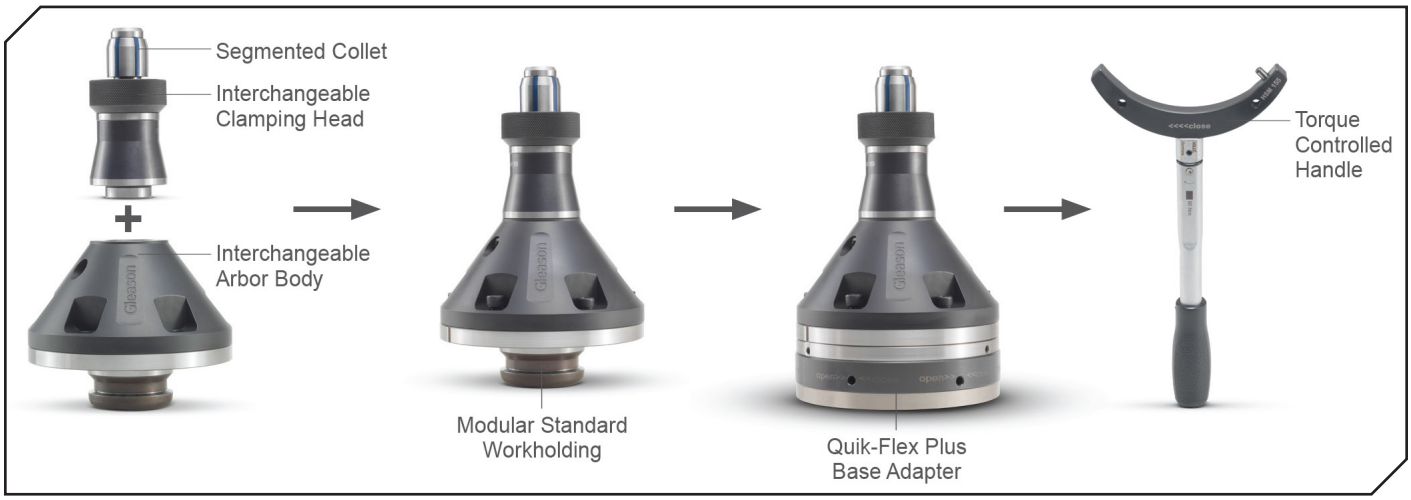
In the brave new world of smart factories, Internet 4.0 and highly automated machines and cells, workholding rarely gets top billing. Fortunately, most gear manufacturers are taking notice, as a new generation of these under-appreciated components that do the 'dirty work' prove their worth. Today, new workholding solutions are having a profound impact on reducing cycle times, scrap and, ultimately, cost per workpiece.

The Arrival of Quick-Flex—and Quik-Flex Plus

"For many of our customers, just-in-time production of smaller batch sizes requiring frequent part changeover is now the rule rather than the exception," said Paul Spencer, manager, new products, workholding at Gleason Corporation. "It was only a few years ago that traditional workholding required 20 or 30 minutes for changeover and considerable operator experience."

Fortunately, the arrival a few years ago of Gleason's Quik-Flex and Quik-Flex Plus systems have revolutionized workholding changeover for small and medium size cylindrical gears with a system of modules that can be installed on a base arbor that's permanently mounted in the work spindle with just the twist of an activation handle.

Now, accommodating a changeover for different workpieces can be done with a new module that's installed and



Gleason's new Modular Standard Workholding puts the performance benefits of Gleason's tool-less quick-change workholding solutions into a system of standard, interchangeable modules for the most common cylindrical gear bore sizes to greatly reduce lead times.

removed in just seconds, with only a single tool, and by even a novice. (Quik-Flex is so simple and effective that even non-operator contestants in our trade-show demonstration challenges have routinely removed and installed Quik-Flex in under 10 seconds.)

For a gear manufacturer running small batch lots throughout the day, this can mean a savings of an hour or more in spindle time as compared to the old technology. Plus, the speed and ease of changeover when utilizing these new quick-change workholding systems can greatly minimize the need for skilled machine operators and toolmakers, which in this industry are becoming harder to find.

Gleason hydraulically actuated expanding and contracting workholding solutions are an increasingly attractive alternative to traditional mechanical systems. They're ideal for multi-stacking and thin-walled parts, with the added benefit of being sealed against contamination for greater reliability.

Quik-Flex Goes Modular, and Arrives Faster

"Most recently, we've raised the quick-change bar even higher, with introduction of a system of Modular Standard Workholding that puts Quik-Flex performance into a system of small, medium and large standard interchangeable modules that span the most common range of cylindrical gear diameters," Spencer said. "If Quik-Flex results in shorter cycle times chip-to-chip, then Modular Standard Workholding does it one better: shorter *ship-to-chip* time. Now, there's an in-stock, off-the-shelf solution available to users almost overnight to meet the workholding requirements of many of the most common cylindrical gear bore sizes and diameters."

This results in the elimination of many weeks of waiting, and the inherent cost, for special tooling whenever a new application arises. Instead, manufacturers can meet most, if not all, of their needs with any of a family of just eight standard modules covering bore diameters ranging from 18 mm to 100 mm. Compare that to the costly and time consuming 'start from scratch' approach that you often must take to either make, or source, workholding for completely new, and increasingly complex, gears.

"Now, a gear jobber, already stretched thin for time and resources, can assemble most, if not all, of the necessary workholding right off the shelf. In most instances, adaptation, if any, is minimal, requiring the machining of a simple backing ring," Spencer added.

How does it work?

"Simple. Each of these small, medium and large modules consists of an interchangeable upper module connected to an interchangeable arbor body, both of which come in a variety of sizes to form a multitude of standard combinations to fit the user's part-specific application requirements. These modules interface with a base adapter that's permanently mounted in the work spindle. The modules can be installed, and removed, in just seconds with just a quick twist of the system's simple, removable, activation handle. No other tools are required, nor any of the usual mounting bolts, set screws or ejector screws to deal with," Spencer said.

Workholding Gets Smarter

Since customers are increasingly in need of the ability to track critical data, Gleason is incorporating 'Gleason 4.0' and gTools technology into its workholding. Benefits to the customer are significant.

"In the case of our latest generation of workholding, gTools will give users the option to use RFID chips or data matrix codes to ensure that the workholding system is assembled correctly with the right components, and track how many times components have cycled," said Brian Baldeck, manager design engineering and assembly, at Gleason Corporation. "This is critically important in a busy tool room where collets and arbor bodies with various 'miles' on them are mixed and matched, thus increasing the potential for poor run-out or a failure downstream. Data provided by gTools can optimize the assembly process, help the customer to determine when preventive maintenance is required, and trigger reorder points for wear parts such as collets."

One Solution Doesn't Always Fit All

As awareness of workholding's importance has grown, so too have customers' willingness to explore alternative clamping solutions. Hydraulically actuated workholding solutions for bores and shanks, for example, are now available from Gleason for applications once considered strictly the domain of traditional mechanical clamping systems. Most recently, Gleason has developed hydraulic workholding systems for applications

ranging from hobbing automotive transmission gears in high volumes, to Power Skiving large internal gears, in lots of one or two, to high-precision hob sharpening operations. These systems are capable of performing as well or better than their mechanical counterparts. Most importantly, they offer a host of characteristics unique to hydraulic systems that are increasingly desirable.

Some examples:

More Flexibility: Hydraulic workholding offer attractive benefits to manufacturers producing parts with various bore or shank diameters, and/or producing multiple parts in a stacked configuration. The new-design Gleason hydraulic production expanding arbor is available for, but not limited to, the most common size range of automotive cylindrical gears from 12 mm to 100 mm in diameter. It delivers a very powerful and consistent clamping force when hydraulic fluid pressure is applied to a thin-walled expansion sleeve, precision-machined out of tough tool steel. The sleeve expands as required by the application uniformly over its entire chucking length. This gives a single arbor the inherent flexibility to meet the requirements of a variety of parts with different bore diameters.

The ability to produce uniform clamping force across the entire length of a gear's bore also makes it an ideal solution for the machining of both thin walled and multiple-stacked parts. In the case of multi-stacking applications, the sleeve can be designed with multiple expansion zones so that even parts with different diameters can be stacked together and clamped with great precision.

Greater Reliability: These hydraulic workholding systems apply clamping forces in a completely enclosed system that's impervious to the contamination that can plague much more exposed mechanical systems. In high-volume, dry-cutting operations, the periodic downtime required for routine maintenance, cleaning and lubrication can be an enormous burden. The same problems exist in large-part production as well, and particularly so with internal gears where effective chip evacuation can prove more difficult.

"Additionally, Gleason's use of new FEA design tools, precision machining and heat treat resources, and our extensive workholding 'know-how', have enabled us to manufacture hydraulic workholding for greater reliability and extreme accuracy. Our standard hydraulic production expanding arbors, for example, deliver the standard accuracy and repeatability levels — 5 microns (0.0002") TIR — of their mechanical counterparts, but can also be designed for applications where the quality bar is even higher," Baldeck said.

Fast and Economical: Finally, hydraulic workholding can offer attractive economies. Meeting on-going new-part clamping requirements often requires production of new, high precision mechanical collets that are both expensive and require lead times of many weeks or months. In the case of a large-part Power Skiving application, Gleason's hydraulic workholding system was the perfect solution to meet the needs of the customer's ambitious multipart family production requirements. Just two large chucks, with adapting sleeves, accommodate a range of workpiece diameters from 200 to 400 mm. They can operate with less maintenance required as well, sealed against all the chips and swarf produced in this highly productive Power Skiving environment.

Going Beyond Gear Machines

"Increasingly, we're playing a role in providing workholding for machines on the periphery of the gear making processes — upstream, for example for the turning centers and 5-axis machining centers used to produce precision gear blanks. What works for gears on a gear machine also holds true for the blanks. Our new segmented collet, for example, is an exceptionally reliable and accurate bore clamping solution that can be easily adapted to a lathe or machining center with just a change in the base tooling," Baldeck said. "And, from a purely logistics standpoint, single-sourcing workholding where possible translates into more economic inventories, and easier training of a less experienced workforce for workholding that have common designs and functionality."

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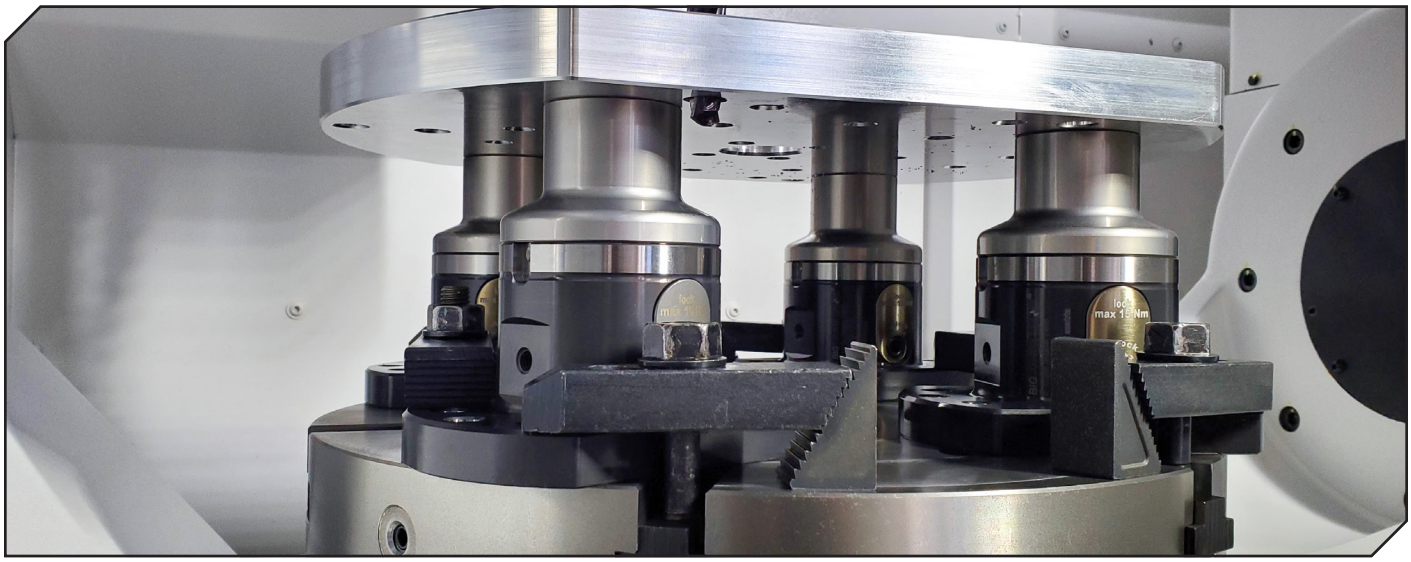

Smart workholding provides levels of control, consistency and safety that are in ever-increasing demand. **Photo courtesy of Big Kaiser.**

The Art of Clearance with Big Kaiser

The modern manufacturing plant is evolving.

"Gone are the days of all work being done in a vise one part at a time as most medium-size production customers are embracing palletization," said John Zaya, product manager, workholding at Big Kaiser. "We can support this with blank UNILOCK pallets the customer can customize to his requirements, or he can buy standalone UNILOCK retention knobs to attach to any pre-existing fixtures. For those that still need their vise, we can palletize them as well in those cases where knobs cannot be attached directly."

Zaya said that workholding has long had a stigma of not being as intelligent as the machine. However, in past years clamping pressure sensors and part presence sensors have been integrated to allow communication between the machine controller and the workholding system or the operator. This provides levels of control, consistency and safety that are in ever-increasing demand.

The challenges in workholding today start with clearance.

"Much like the real-estate sales mantra 'location, location, location,' in the 5-axis workholding market it's 'clearance, clearance, clearance.' Elevating the part up off the table to provide spindle-to-table clearance is the main goal with any workholding system. Next is clearance of the toolholder to the workholding system so many systems try to limit the amount of material they hold to the bare minimum. They also try to get entirely under the part in order to provide full access to the faces," Zaya added.

For customers looking for lights-out production or medium-to-large-scale production, robotic loading/unloading of parts is a key requirement. Robots can handle the fast rate of part picking and placing that is often required. The key to successful automation is how much is customized vs. standardized, Zaya said.

"Many machine builders are doing their integrations in order to provide a one-stop-shop instead of relying entirely on aftermarket integrators. They choose to offer turnkey solutions for machine tending that rely mostly on billets of material. The other end of the spectrum requires many special parts that allow for the customer to deal with a variety of parts. They end up using a pallet-based system that will have semi-standardized blank pallets that can be loaded up with different workholding based on the various workpieces."

The UNILOCK system allows for fast, consistent and accurate changeovers.
Photo courtesy of Big Kaiser.

And does this mean that special fixturing or customized equipment is becoming more mainstream today?

Zaya said in some cases, yes—and in other cases—no.

"Those that recently saw much of their workforce laid off are looking at alternatives to have a warm body sit in front of just one machine. This is where automation of part load/unloading has risen," Zaya said. "For those companies deemed essential and who did not have to let go of workers are so busy they do not have time to consider specials. They are forced to work with what they have already."

Several factors will determine the efficiency and effectiveness of workholding equipment in the future, according to Zaya.

"The use of pallets that can be customized for holding both raw billets, partially processed parts, and 3D printed parts will allow for the greatest flexibility and efficiencies. Vises, grid plates and the like can do this in some cases. So having a common interface, like the UNILOCK Zero Point system, that allows for fast, consistent and accurate changeovers will lead to higher spindle up time and lower costs," he said.

Quick-change products, such as modular stacking systems, allow flexibility to be provided within the system's capabilities and may include a variety of bases, extensions and reductions, all of which can have various diameters and height combinations.

As workers retire, they are being

replaced by a younger generation with a different approach to methods, processes and concepts.

"This will open new avenues to find higher levels of efficiency in all sectors of the economy and manufacturing," Zaya said. "The biggest area that will see most growth is the 3D printing sector. The ability to eliminate waste from the machining process by moving from substrative to additive will have a huge impact."

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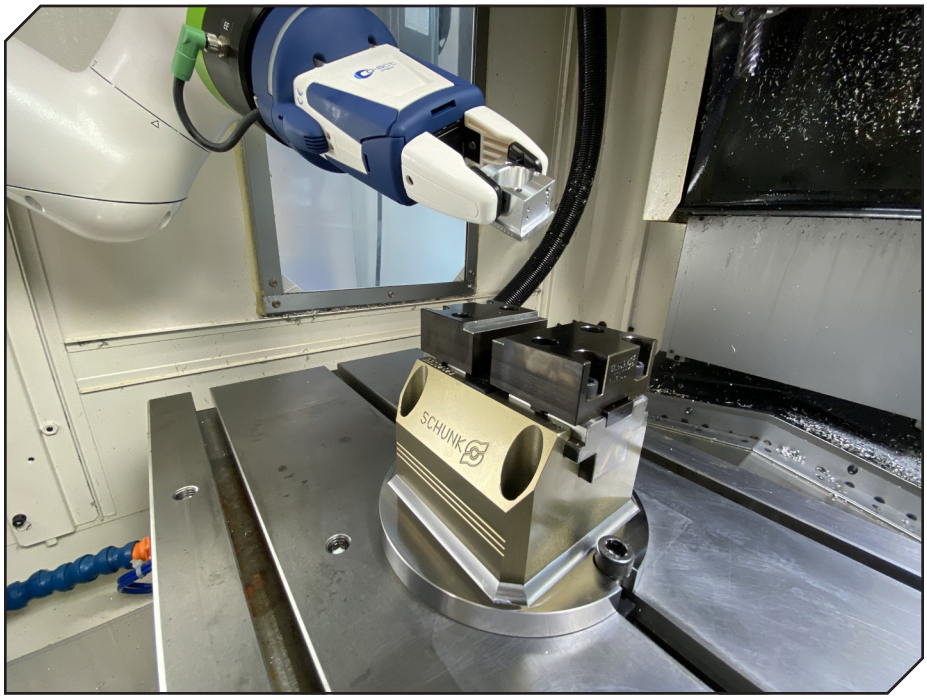
Schunk Offers Specialized Workholding Solutions

Automation is the name of the game for Schunk's customers.

"This means confirmation of clamp/un-clamp functions, sealed systems that require less maintenance, fail-safe mechanisms. Not only automation, but automation with reduced lot sizes. In other words, flexible automation. This requires challenging and modern technologies that automate more than just part clamping. It now becomes necessary to automate changeover for handling a variety of workpieces, etc.," said Michael Gaunce, vice president of sales, tooling and workholding at Schunk. "This means continuous monitoring of the systems/processes — more than just success or failure, but a more granular view on spindle loads, tool-life, and even predictability."



The PGS3 is a compact pneumatic clamping force block for automated metal cutting of small components from Schunk.

For gear manufacturing, it depends on the part, but for first operations using aggressive gripping jaws (impact series claw jaws) can significantly increase machining parameters which means reduced part cycle time. Additionally, quick-jaw change chucks allows for fast repeatable changeover (THW3) and precise hydraulic arbors for finishing operations. These all play a role in smart workholding solutions.

Flexibility is the greatest challenge, according to Gaunce.

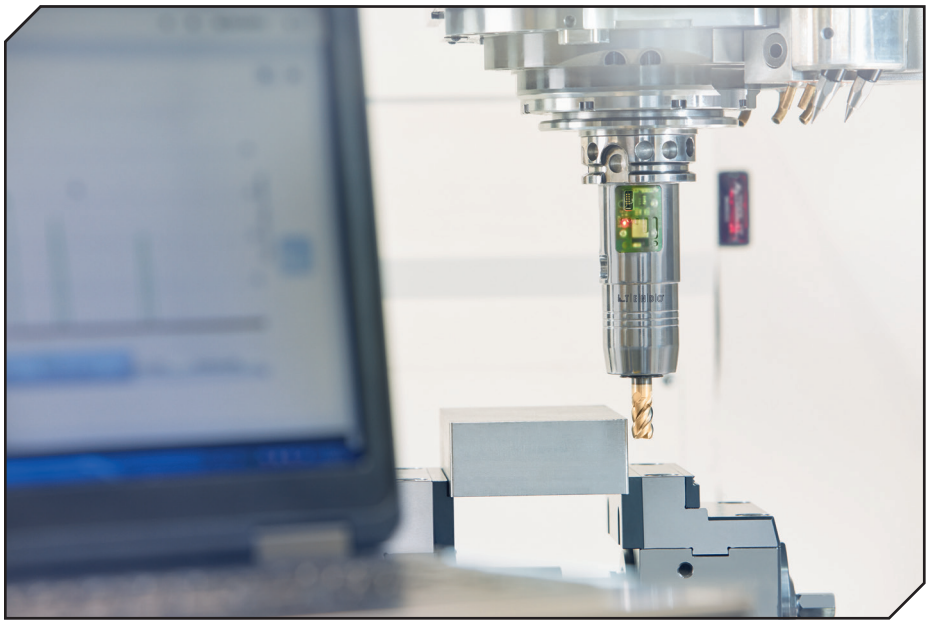
"Five axis machines are incredibly capable. You need to make sure your workholding can match the machine capabilities. Mill-turn machines are more and more common place. A quick-change pallet system (VERO-S) to make the changeover with workholding fast and repeatable. That can save hours of machine time per day," Gaunce added.

No matter the shop size, robotics and automation are the new norm for all machine tools.

"If you're doing nothing but one-off prototyping, you're an exception… otherwise, start automating the part loading aspect of the machining process. Think about it… everything else in the machine tool is automated (tool changer, simulation/verification of machine programs, tool presetting, etc.) Time to automate the part loading as well," Gaunce said.

Schunk finds plenty of value in focusing on specialized solutions. Many specialized solutions are simply just extensions of the company's standard products, but they're tailored to a specific application.

"Also, many times with end-users who are just starting to familiarize themselves with new technology, a special



With the new iTENDO, an intelligent toolholder, Schunkis setting a milestone when it comes to digitalization in the metal cutting industry. Due to the real-time capable data communication, Schunk offers for the first time an autonomous process optimization in the form of a toolholder.

solution is a great start. A tailor-made solution shows the potential of our standard products, and once this is clear to the end-user they will many times start developing their own customized solutions with our standard product," Gaunce said.

On the flip-side, companies like Schunk are also developing more and more off the shelf products that incorporate more automation functionality particularly with regard to integrated software that allows for easy integration.

And what about the future of workholding as these systems evolve?

"This might be a little out there, but most workholding products rely on simple mechanics which ensures rigidity and reliability in automation," Gaunce said. "I could see in the future the possibility of more electrical components being incorporated to allow for more data/information, and more flexibility."

"Flexibility/versatility is key moving forward… You can see the same trend in all aspects of our economy. You need to be flexible, adaptable, and ready to pivot," he added. "Same with your workholding. Find a way to implement lean automation which allows for high productivity while also maintaining that ability to adapt."

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Optimizied Workholding Makes Smart Use of Machine Tool Capabilities

David Jones, Precision Workholding Product Manager, EMUGE-FRANKEN USA

Utilizing machine tool capabilities is helpful for optimizing workholding solutions, whether a mechanical, pneumatic or hydraulic clamping design. Let's start with drawbar driven machine solutions, which are commonly used. A drawbar can be used to pull back towards the machine spindle, but in most machines, they can also do a little pushing out away from the spindle as well. It's important to note some machines have variable, or different capabilities, in one direction or the other. This means the force may be stronger pulling back on the drawbar than it is pushing out on the drawbar. It is important to determine this in advance so the proper workholding design can be implemented.

So how does drawbar movement help make a workholding process more intelligent? EMUGE-FRANKEN USA offers a tool-less mechanical clamping design where the machine side has a locking bayonet connection and a pull stud. The machine drawbar pulls the workholding device into the spindle face, while centering the device into the taper of the machine spindle . The bonus in this design is the absence of bolts, so a quick-change mechanical system can use the existing machine drawbar. With only a few controller commands the machine will reach a specified value for the required clamping force to properly seat the workholding device onto the machine spindle. Using existing machine tool technology is smart, efficient and accurate, as well as saves time.

Now let's use the drawbar in the opposite direction, which is away from the spindle. This action can help facilitate unclamping of a work piece by using the drawbar's axial stroke to push on mechanical rods, which interact with the device's clamping elements to help facilitate their unclamping. This action helps ensure proper workpiece release. Similar to the pullback of the drawbar, the pushing element of a drawbar can generally be set to a max force, or even a set distance from spindle face 0. For security, a mechanical stop is used in the workholding device, so over stroke is limited in both directions.

EMUGE-FRANKEN workholding designs include using the machine drawbar pullback for actuation of one clamping element in the design, and also the axial pullback stroke to release compression pressure on a spring package, which allows the package to expand and clamp a secondary location on the workpiece. So, one axial pullback stroke can accommodate two different clamping areas with the required clamping force for that area's geometry. This is especially important when clamping locations carry different diameters, and/ or, tolerances. To summarize, one clamping stroke can activate two separate clamping locations and meet the requirements for two different zones with two different applied clamping forces, all while utilizing the existing machine tool.

Pneumatic or hydraulic workholding solutions can also utilize other technology from the machine tool. If the machine has air through the spindle, the air can be used in the workholding device — this is called airflow control.

EMUGE-FRANKEN airflow adapted clamping solutions channel this airflow through the device and exit where the workpiece meets the end-stop. With no workpiece in place the air flows freely, but when a workpiece is placed into position against the end stop, the airflow is now restricted, which is something the machine can recognize, and be programmed to begin the clamping and subsequent machining processes.

For a hydraulic design, however, there can be pressure feedback similar to how the airflow control functions. If the workholding device has an onboard piston and hydraulic reservoir, when pressure is applied to this internal piston, it moves axially and compresses a spring package. Or it may create an opposite direction axial stroke, which activates the clamping element in the design. At some point in the cycle, the workpiece will be clamped, and a mechanical stop achieved. In this case the back pressure to the machine increases, which is something the machine recognizes, and prompts the next steps in the programmed process, knowing the machine has reached full clamping pressure.

It is advantageous to efficiently utilize available machine tool technology and intelligence to optimally interact and work with precision workholding devices.

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