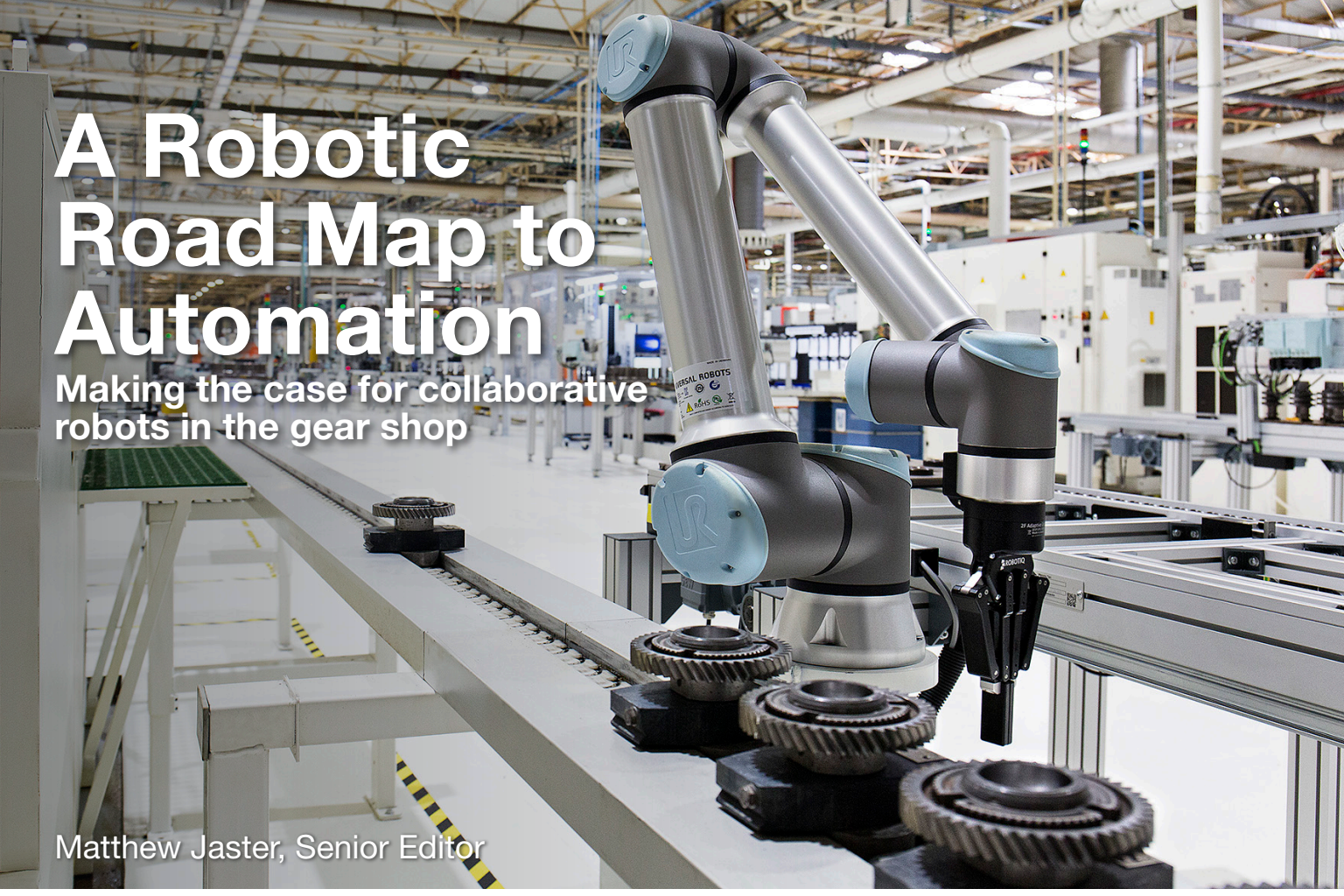


A Robotic Road Map to Automation

Making the case for collaborative robots in the gear shop

Matthew Jaster, Senior Editor

Our annual State-of-the-Gear-Industry survey in January included the question, "What role will emerging technologies play in your organization in the coming years?" Notably, many respondents plan to implement shop floor automation and cobots into their gear shops. The game plan and timetable, however, varies on a case-by-case basis. To assist in the development of an automation program, we've interviewed experts from ABB, Universal Robots and KUKA Robotics to provide insightful and timely feedback on how to start this journey in gear manufacturing.

First Steps

Chris Savoia, UR+ global program director, said the first step for successful automation is identifying pain points on the shop floor—set time aside for a line walk, which is an on-site assessment where key stakeholders observe and analyze manufacturing processes to identify automation opportunities and improve efficiency. Line walks usually involve external experts; many experts will do one for free.

"Before the line walk, clearly define your objectives, like improving precision, enhancing flexibility or boosting productivity. Note how collaborative robots can play a crucial role here due to their small footprint, making them ideal for gear shops with limited floor space," Savoia said.

When ready, Savoia suggests you gather a diverse team with expertise in production, maintenance and quality control. Perform a physical walkthrough of the production line, observing each step closely. It's important to map all manual processes down to the smallest detail. For example, do not omit how an operator may perform a short inspection after picking a part up. Make sure to draw a top-down diagram of the work cell layout and use it to start imaging how a robot would physically fit into the space. Pay special attention to bottlenecks, repetitive tasks and areas where precision is critical.

"Cobots are particularly beneficial in these scenarios because they are easy to program, allowing for quick deployment and flexibility in handling different tasks," Savoia added.

It is vital to engage directly with front line operators to understand their daily tasks and challenges. These insights are invaluable for identifying automation opportunities. Equally important is to collect and analyze data on key performance indicators (KPIs) such as cycle times, quality metrics and productivity rates. This data can identify areas where automation will have the most impact. Cobots, with their built-in safety features like collision detection and force-limited operation, can work alongside human operators without extensive safety barriers, enhancing both safety and efficiency.

"It's important to understand that collaborative robots can be used in ways that traditional robots can be used. Every day, collaborative robots are getting more payload and more speed, while maintaining their safety systems and ease-of-use," Savoia said.

Corey Ryan, director of medical robotics at KUKA, says shops should first consider what the cobot's role will be and what it will be doing.

"In most gear shop operations, the cobot will act primarily as a machine tender, loading and unloading workpieces into the machine to eliminate the need for an operator to tend the machine all day. Most cobots are not robust enough to hold or manipulate the workpiece during heavy machining, however, some applications might allow the robot to transfer the part to a light secondary operation such as buffing, polishing or deburring," Ryan said.

Andie Zhang, global collaborative robot product manager, ABB Robotics, believes a good first step would be to identify repetitive, labor-intensive, or precision-critical tasks that a robot could improve and ensure that it is feasible for the robot to integrate with conveyors and processing equipment.

"Another key step would be to determine whether a collaborative robot or a traditional 6-axis robot are more feasible for the application to be automated. Cobots are ideally suited for applications that require an operator to frequently interact with the robot—like in the case of high mix, low volume production runs," Zhang said.

The reduced time it takes for an operator to enter the collaborative robot cell, whether behind a fence or not, makes changeovers far quicker and less disruptive. Also, for tasks that require a lot of path programming, a cobot solution can be a good fit due to simplified programming methods.

Though cobot reach and payload capacities have grown and are expected to continue to, there are still limiting factors that would eliminate a cobot from consideration.

"Traditional industrial robots are better suited for very complex operations or processes requiring high speeds to achieve the necessary throughput and handling heavy objects," Zhang added.

Benefits to Gear Shops

In addition to price, a cobot's primary benefit to small and medium-sized shops is its ease of programming and simple interface.

"Someone without robotic expertise can perform a basic setup and go in and change code. To redeploy a cobot, you can just change a couple of touch points so the cobot can do everything as before with a new starting point. That would be more difficult with an industrial robot," said Ryan.

An industrial robot has more features that provide more opportunity, and shops should also consider the extra speed and throughput an industrial robot provides.

"In many cases, an industrial robot with an area scanner, light curtain or other safety-rated stop mode might be better. When humans are not in the area, an industrial robot can run at ten times the speed of a cobot, but the complexity of deployment makes it tougher. It's a trade-off—industrial robots offer more options and productivity but require a deeper knowledge of the system to set up properly," Ryan added.

Cobots offer many of the advantages of traditional industrial robots along with easier use, more intuitive programming and, most notably, greater flexibility.

"Smaller, lighter and inherently more portable than industrial robots, cobots are easy to install and move freely around a factory whenever and wherever they're needed. They're designed with agility and ease of use firmly in mind, capable of being programmed and operated without requiring specialist robotic or software knowledge," Zhang said.

When you automate with an industrial robot, you must automate 100 percent of the task, but with collaborative robots you can automate only the difficult or dangerous tasks for a human operator and the human can do the rest.

"Another type of flexibility comes with a cobot's capacity to be reconfigured, either for changes that come along for their assigned job, or for repurposing for an entirely new task. In some instances, lighter weight cobots are mounted on mobile carts that can be easily moved between different workstations to perform different functions. This reconfigurability, i.e., the ability to be quickly and easily re-programmed to meet changing market requirements, makes manufacturers more efficient and significantly nimbler," Zhang said.

In gear manufacturing, cobots can be implemented most effectively by focusing on tasks that benefit from consistency and precision. Machine tending is a prime example, according to Savoia.

"They excel at loading and unloading CNC machines, allowing for continuous operation and freeing up workers for more complex tasks. Quality inspection is another area where cobots shine. Equipped with vision systems, they can perform consistent, tireless inspections, ensuring high quality standards. Packaging and palletizing are also great applications for cobots in gear shops. They can handle the repetitive work of preparing finished products for shipping, reducing strain on human workers. Assembly operations, particularly for smaller gears or components, can also be effectively automated," he said.

The key is to identify tasks that are repetitive while allowing your skilled workers to focus on more complex, value-added activities that require human expertise and decision-making.

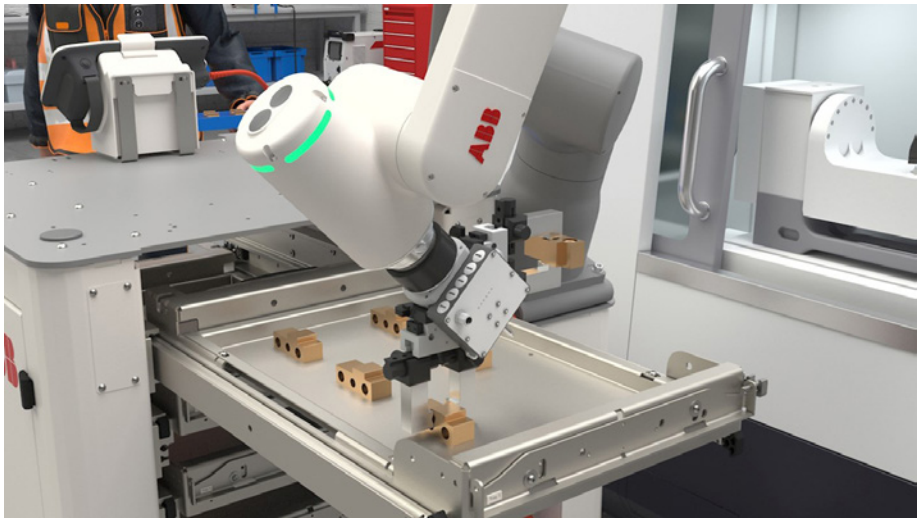


ABB focuses on cobot solutions providing quick installation and operational efficiency.

A Cobot Checklist

What should a gear manufacturer look for when shopping for collaborative or industrial robot solutions?

"A track record of successful cobot installations in the gear manufacturing industry and the type of cobots in their portfolio that are compatible with the specific automated tasks. This includes ensuring the OEM has automation equipment that withstands the rigors of a gear manufacturing environment," Zhang said. "A service and support network for the full lifespan of the robot installation, from system design, through installation, commissioning and ongoing service. Many robot OEMs have a roster of system integrators with specific expertise in applications like gear manufacturing. In many instances the availability of a system integrator is a key consideration."

Finally, Zhang said to consider user-friendly programming interfaces such as teach pendants, graphical programming and offline programming options. "This allows even non-specialists to quickly automate their applications by manipulating simple graphical command blocks rather than writing complex programming code," Zhang added.

When choosing a cobot manufacturer, Savoia at UR said several factors should be considered. "First and foremost is quality. Second, safety features and certifications are paramount. Lastly, look at the manufacturer's customer support and training resources. It's important to think about safety from the moment you start—not at the end," Savoia said. "Moreover, the workflow and movement patterns of human workers around the cobot need to be carefully considered. Even though our cobots have built-in safety features like force limiting, the overall layout of the workspace and the nature of human-robot collaboration in your specific application can introduce risks that need to be addressed.

With its integrated torque sensors, the KUKA LBR iiwa enables the automation of delicate assembly tasks for force-controlled joining operations and process monitoring.

Another critical factor is the integration with other machinery. "In gear manufacturing, cobots often work in conjunction with CNC machines, conveyor systems or other automated equipment. It's important to tie safety systems together. For example, make sure all e-stop buttons work to shut down all equipment in the work cell," Savoia said.

If you're only deploying cobots for one or two applications, then simplicity of programming and operations are the prime considerations.

"However, if the cobots are being integrated into a more complex system using larger industrial robots for heavy lifting, transporting and packaging, shops will need a full solutions provider such as KUKA or another supplier with a full robotic portfolio," Ryan said. "You should not deal with more than one robot provider in a single shop if it can be avoided. As for risk assessments, in addition to the cobot's travel, speed and potential impact force, its tooling must be a prime concern. Tooling should be neither sharp nor pointed, there should be no pinch point or hotspots, and the system should be examined holistically for safe human/machine interaction.

Trending Topics in Collaborative Robots

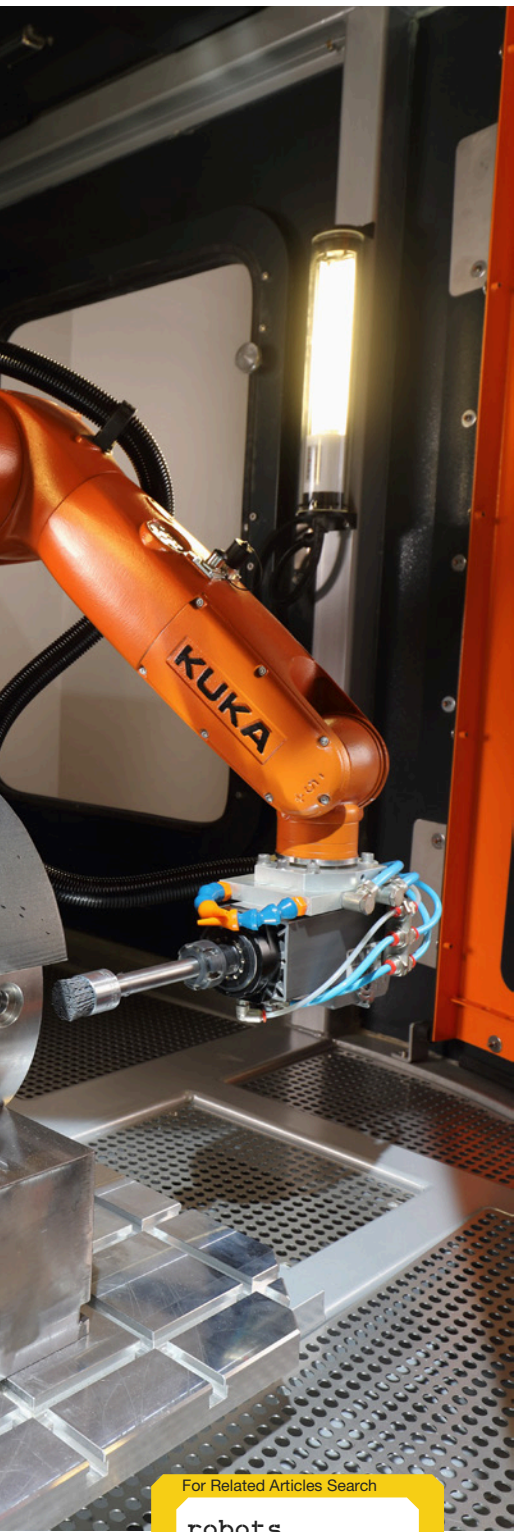
The collaborative robot market has seen significant evolution in recent years, according to all our subject experts.

"In 2025, we're seeing more intuitive programming interfaces that make it easier than ever for non-experts to program cobots. One of our key innovations in this area is our new programming platform, PolyScope X. PolyScope X is specifically designed to enhance flexibility in high-mix, low-volume production environments, which are common in gear manufacturing. This platform allows machine shop operators to achieve changeover times of less than ten minutes, far below what was previously possible. This means

The KUKA KR Agilus is used to deburr a gear housing.

gear shops can run more batches in a day and operate in a more strategic and flexible way, adapting quickly to diverse orders," Savoia said.

The quality of cobots has drastically improved with a variety of available options at different price points in recent years.



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"The introduction of block programming, rather than writing code textually, is a very big part of what makes cobots useful to shops. Advances in force control technology have made them even more deployable, but perceptions have also changed. Initially, people would not accept a robot being able to operate without a fence, but now attitudes have changed 100 percent on that," Ryan said.

Zhang said the advent of collaborative robots provided an innovative robotic option that could work safely alongside humans but was suitable for only the lightest duties; restricted to working in relatively clean production environments such as light assembly, material handling and product testing."

"Over the last few years cobots have become faster, stronger, easier to program, and better able to withstand the rigors of industrial settings. As a result, cobots are now a viable alternative to standard industrial robots for many applications. The trend is going from small part, lighter payload processing, to heavier part applications like CNC machine tending, where the smaller footprint and greater flexibility of cobots is a major benefit."

The Future: Innovation and Accessibility

Looking ahead, our subject experts see an exciting future for cobots in the gear manufacturing industry.

"We'll likely see even greater AI integration, leading to more autonomous operation. Our cobots will be able to make more complex decisions independently, adapting to new tasks with minimal human input. This is an extension of the work we're already doing with our UR AI Accelerator and our collaboration with NVIDIA on physical AI capabilities," Savoia said.

"I anticipate significant advancements in human-robot collaboration. Improved sensing technologies and more natural interfaces will allow our cobots to work alongside humans even more seamlessly. They'll be better at interpreting human gestures and intentions, making collaboration more intuitive.

This focus on human-scale automation, however, will likely place some limits on how much further we increase our cobots' payload capacity. While we've successfully expanded our range, we don't anticipate dramatically increasing payloads far beyond the 30 kg mark of the UR30. Our philosophy is centered on creating robots that can work safely alongside humans without the need for safety guarding, and significantly larger payloads could compromise this core principle," he added.

Instead of pushing for larger payloads, UR is focusing on enhancing the intelligence and versatility of cobots within the human-scale range. This might include improvements in precision, speed, and the ability to handle more complex tasks within the existing payload limits.

"I also foresee an expansion into new industries and applications. As our cobots become more versatile and easier to use, we'll see them adopted in sectors beyond traditional manufacturing," Savoia said. "In the gear industry specifically, this might mean cobots taking on more specialized tasks in gear design, prototyping, or even in areas like customer service and logistics."

Zhang said the payloads and working ranges (i.e. arm reach) of collaborative robots will continue to get bigger and longer, allowing them to handle a greater variety of applications. They will also get tougher, allowing them to be installed in the most challenging environments. Some pundits predict that in ten years, virtually all industrial robots will be collaborative.

"Despite all the recent advancements in cobots, one area that has lagged is accuracy. Cobots were just not as accurate or precise as traditional industrial robots. This has begun to change," Zhang said.

"Looking forward, I think competition is going to be the biggest change in the cobot space over the next few years. Shops can't get enough people to work, and they are looking at all sorts of ways to use cobots—food production, farming, etc.—and these cobot applications will continue to grow into the future," Ryan said.