New lightweight robots are faster, energy-efficient, and more user-friendly than ever.

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Robots have joined the lightweighting craze. The newer lightweight designs and materials of many robots, and their end-of-arm tooling, are helping manufacturers boost production times as robots pick up their pace, all while lowering energy costs. Robots of many sizes and payload ranges are swapping out iron for lighter-weight materials such as aluminum and composites when appropriate considering rigidity needs and the application.

In some cases, lighter-weight robots, or so-called cobots, equipped with vision capabilities and force-sensing features, are considered safe enough to work alongside humans. Many of these robotic automation innovations will be on display at the upcoming Automate show March 23–26 at McCormick Place in Chicago.

One example of the lightweighting going on in robotics is automation integrator Schuler Inc. (Canton, MI,
and Gemmingen, Germany). Last year, it unveiled a new lighter, faster version of its Crossbar Robot aimed at automotive press stamping applications. The Crossbar Robot 4.0, the fourth generation of the system, uses a modified drive system with two motors and a new transmission to significantly shed weight, coming in under half the previous weight, while making the robotic arm more dynamic and improving energy efficiency by 50%.

Schuler uses an overhead-mounted six-axis robot that the company integrates from a robotic OEM, said Thomas Schmider, automotive account executive, Schuler Inc. The robot gets two additional axes from its horizontal drive and from the hand of the robot arm, and it conveys up to 15 parts per minute in the automotive press application.

“We take the robot and enhance it to make it a Schuler product. The application that we are targeting is to automate tandem press lines,” said Schmider. “From our perspective, this is quite simple. The lighter this system is, the more dynamic it is and the more efficient.”

The Schuler Crossbar robot itself weighs about 800 kg (1778 lb), Schmider added, and the payload including tooling is rated at 90 kg (200 lb), the same as the prior model. The Crossbar can move at 15 fpm (4.6 m/min), he noted, and the new system’s lower weight results in its arm being 20% more dynamic, making it much more effective in its automotive press applications. “You constantly move this robot around,” Schmider said. “You’re able to accelerate faster. It translates into speed or output.”

While virtually any size industrial robot can reap some benefit from downsizing weight, there can be trade-offs with less rigidity and limits on reach capability. That has some robotics companies moving more cautiously into the area.

“Generally for the larger robots, you would use nodular or ductile iron, just because of its properties,” said Nick Hunt, manager, Automotive Technology and Support, ABB Robotics North America (Auburn Hills, MI). “It’s extremely durable, and since it’s ductile, it can conform without cracking.”

Still, for smaller robots, either anodized aluminum or composites can be a good choice. “Composites are very expensive, but it’s very temperature-stable,” Hunt said. “On a rigid robot, you want to use the iron. Aluminum can be
rigid, but the stability of the temperature is a big deal. Some of these aluminum robots, if the temperature changes drastically, you could have problems with repeatability. Iron is still very much the method.”

One example of a lighter-weight ABB robot is the IRB 1600ID, an arc-welding robot that gained speed advantages with less mass. The IRB 1600ID robot features high accuracy with position repeatability of ±0.05 mm and it is among the fastest in its class.

But even in industrial robotics where iron remains a top choice, lighter-weight designs are being used. “You can certainly see where some of these tubular metal-type arms are starting to come into the fray,” Hunt said.

Small, Fast and Flexible Robotics

For many material handling, machine tending and parts assembly applications, smaller, lightweight robots that take up less space are the ticket. Last year, ABB’s new IRB 1200 robots debuted with a 15% smaller footprint and 10% shorter cycle times over comparable small robots. The IRB 1200 models come in two standard variants: a 700-mm reach model with a 7-kg payload and a longer-reach 900-mm model with a 5-kg payload. Either variant can be mounted at any angle, and each comes with an IP 40 protection standard, and an IP 67 protection as an available option.

The ABB 1200 models help improve productivity with better energy efficiency of about 15% less usage, noted Hunt, and an improved maintenance schedule. “We really went after the total cost of ownership. We made it easier to maintain and more modular, even improving the precision, stiffening,” he said. “There’s benefits all over in making it lighter. In general, smaller machines go faster, and speed is king.”

One of the most effective ways to lightweight robots is by taking weight out of end-of-arm tooling. “It’s probably more important to take away weight from the gripping, the grippers and end effectors,” said Chris Blanchette, national account manager, aerospace and assembly, FANUC Robotics America (Rochester Hills, MI). “There are a lot of limitations on how much weight you can have [at the end of the arm].

“If you can take that weight out the tool, you can go a lot faster,” Blanchette noted, particularly for fast pick-and-place applications where there is a high priority on speed. “You can go faster with the same energy. It also could be used for putting higher payloads on the end of a robot. I guess a third one would be to make it easy for a robot to be collaborative,”
Some lightweighting of robots can entail changing the castings and making the arm hollow. “All have an evolution toward lighter robots, and one reason is that we’re always trying to be better than the others,” Blanchette said. “They may be faster and lighter, but how do you make it better?”

In some cases, robot OEMs are using carbon fiber for the robot links and joints.

In its lightweighting efforts, FANUC has tried to hollow out the design and use smaller, more efficient motors, Blanchette said. “It typically is more the smaller robots, such as our LR Mate,” he said. “It’s smaller, and it’s gotten to be a lot faster.”

FANUC also began selling a spider-type Delta robot a couple of years ago, with its M-1iA, M-2iA and M-3iA models, for lab and medical applications. “They’re primarily used in applications where real high speed is required,” Blanchette said. “A Delta robot is the fastest.”

Slimming Down the Tooling

For lightweighting tooling, automation integrator De-Sta-Co (Auburn Hills, MI) offers its Acceler-
ate Collection of lightweight tooling as a standard product line for automated pressroom stamping dies in automotive. The company works with all of the auto OEMs and is a partner with Schuler as well on press automation applications, said Rob Pitera, global product director, End Effectors, De-Sta-Co.

“Companies like Schuler have a different approach. The Crossbar Robot 4.0 is mounted upside down, and I know they’ve done a lot of work to reduce the weight of the robot, particularly the end of the arm of the robot,” Pitera said.

Reducing the weight at the end of robot arms has been a trend over the past few years, he said. “We are now trying to push a lot of the limits,” Pitera said. “Nowadays customers are looking to go faster than ever. The existing tooling we had was too heavy.” The goal is to also reduce end-of-arm vibration, Pitera noted. “There are ways to get that vibration out of the system, and lowering the weight is one.”

With the Accelerate tooling, De-Sta-Co aimed for about a 25-30% increase in speed. The company’s tooling fits any OEM robots, he said, and the most common end effector is a vacuum cup tool. “Our goal to reduce weight is 30%,” Pitera said. “The primary aim of that tooling is automotive press and stamping. We use either a suction cup or sheetmetal grippers, and also magnets. But our first choice is suction cups—the magnets can sometimes pick up shavings and if that gets into certain areas, it can cause problems.”

Automotive press lines need lighter tooling to speed up operations to produce more parts on assembly lines. “Most of the car manufacturers are now having to put more jobs down a press line,” Pitera said. “Say currently you just run doors down a line, and you need to add another product. The big problem with that is die change-over time.” The result is automakers have to run quicker batches, he said.

“The key is if I can go faster, I can change quicker, and do more production in less time,” Pitera said. “Everybody’s talking about lighter weight.”
At the Automate show, De-Sta-Co will show the latest offerings in its Accelerate automotive press tooling with a FANUC robot, Pitera said. FANUC also plans to be at Automate, where it will show its new Universal Bin Picker gripper. “It’s very lightweight, and it’s also very flexible, so you can adjust the maximum open and close on it,” Blanchette said. “It’s capable of holding with a force of 6 kg. It’s flexible, with two fingers, and it’s better than a suction cup.”

**Lightweight Collaborative Robots**

Collaborative robots have garnered a lot of attention recently, but FANUC is one automation provider that is taking a conservative approach on that class. At IMTS 2014, FANUC showed a prototype of its soft-clad collaborative robot which is scheduled to make its official debut during the second quarter of 2015. The robot has a large arm covered in soft green rubber that has force sensors and a 35-kg payload.

Because a lot of applications do not require full collaborative systems, FANUC has focused its development in this area on its Dual Check Safety option for fenceless operations, said Blanchette. “We use sensing options, and soft cushions to soften the blow,” Blanchette said. “That’s where we see the majority of collaborative robots.”

Fenceless robot applications can be where a person has to interact with a robot by introducing a part to a cell, he said, and such a robot will use FANUC’s Dual Check Safety for precaution. FANUC has had the capabilities to do fenceless robotics since about 2006, Blanchette said, when the company came out with the R-30iA controller.

Perhaps the ultimate in lightweight co-bots is the KUKA LBR iiwa line of robots. The iiwa, or intelligent industry work assistant, robot is aimed at light-duty production lines and as a service robot for applications such as a kitchen assistant, for loading and unloading food trays to and from delivery carts.

“The current KUKA LBR iiwa is actually a fifth-generation version in the development of this robot that uses FEA-designed lightweight aluminum castings,” said Mike Beaupre, sales director, New Markets & Global En-
Early research on lightweight robots that later evolved into the KUKA iiwa robots was performed by the DLR, the German equivalent of NASA, noted Beaupre. Lightweight robotics has made a lot of progress since KUKA acquired the rights to that work in the mid-2000s. “A few examples of emerging applications for lightweight robotics are small assembly tasks—like for consumer electronics, machine tending, or even service applications,” Beaupre said. “The major differentiator with these smaller new robots will be in their ability to meet the new safety requirements for human-robot collaboration.

“This is now a game-changer in the development of new robotic applications where humans and robots can safely work together on a common task and in a common workspace,” he said. “The KUKA LBR iiwa is very well-suited to these new HRC [Human-Robot Collaboration] tasks due to its seven-axes configuration that offers more dexterity and reach than is possible with a standard six-axes configuration, plus it includes force sensors in each of its joints providing the best possible sensitivity and safety for sharing the same workspace with any human co-workers.”

Beaupre noted the main advantages of these smaller systems is that small-size manufacturers will now be able to install automation that is flexible, easier to use, and that can be moved around the shop for shorter production runs. “These systems not only take up minimum space, but in HRC applications may not require physical barriers with interlock equipment, making them more practical and affordable.”

The Automate show will be KUKA’s official introduction of the LBR iiwa sensitive robots into the GI (general industries) market for North America, Beaupre said. “We also expect to see new smaller robots recently announced by other major ro-
bot and peripheral manufacturers," he said. “There should also be products from some relatively new players to the industry that have developed products specifically for this emerging new market, which is now demanding smaller and lighter robots with features to meet the requirements for HRC applications.

“I believe that once the new ISO standard TS 15066 is released it will include more specifics about safety requirements for HRC applications, and it will separate which of these new robots is truly capable for safely working collaboratively with people," Beaupre said. “Rarely are any two process or applications requirements identical, so this will definitely put more focus on making sure a comprehensive risk assessment is completed for each application, and it not only involves safety of the robot, but also the process, end-effectors, part-holding tooling and any other peripheral devices which impact safety of the overall system.”

ABB also is readying its dual-arm collaborative robot for formal commercial launch in April, although it has shown prototypes of the robot at trade shows. The ABB YuMi robot is designed for small-assembly operations, Hunt said, and it will have force sensing and built-in vision algorithms.

“ABB has taken a very conservative approach to these collaborative robots,” Hunt said. “Ours is actually soft. We take the approach that we know it’s going to make contact with you. It’s not going to be a super-high-speed robot. But with the dexterity of the robot, it can fit nicely into a small-parts assembly.”

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