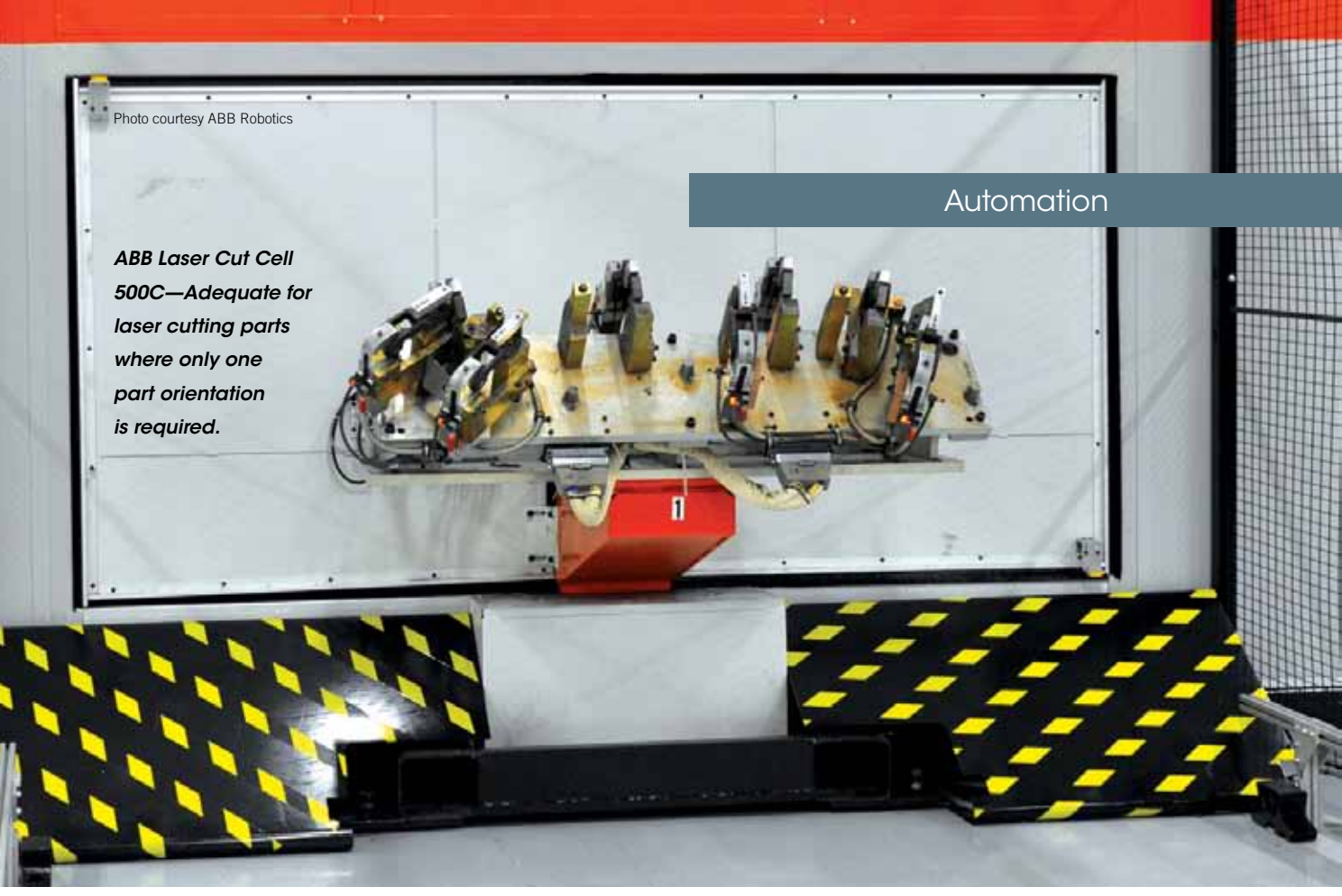

Photo courtesy ABB Robotics

ABB Laser Cut Cell 500C—Adequate for laser cutting parts where only one part orientation is required.

Robotics Cut New Path in Hot Metal Stamping

Robotic laser cutting provides balance of performance and capital flexibility, helping company enter and expand in hot stamping

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The longer term challenges facing the automobile industry are as complex as they are interrelated: Design cars that people want. Increase customer satisfaction. Reduce capital costs. Improve passenger safety. Increase fuel efficiency.

And, of course, do all of this while sustaining a business model with a reasonable profit margin.

An ongoing trend emerging in the metal composition used in the safety cage of newer vehicle designs is providing major, yet somewhat hidden momentum for this reinvention of the automobile. That is, the increasing use of lightweight, higher strength steels that reduce the overall cost and weight of the vehicle while achieving the previously unattainable dichotomy of improving both passenger safety and fuel economy.

One of the new fundamentals involving the lighter, stronger structural metal is the process of hot metal stamping—the

forming of metal, typically boron-alloyed steels, while it is very hot, and then cooling it quickly in the die. Hot metal stamping converts low-tensile strength metal into extremely high strength steel, often up to 200 kilopounds per square inch (KSI).

The result is the formation of a relatively complex, near-net shape metal part in a single-step die, with yield strengths up to four times higher than the metal prior to the forming process. Hot stamped parts weigh 30–40% less than standard metal parts of the same strength, thus cracking the code for greater gas mileage and increased passenger safety.

One major problem solved, one far lesser problem created. Once the parts are press hardened during the hot stamping process they are too hard to be trimmed using traditional steel trimming dies. The process of trimming the edges and cutting of features (holes) in hot stamped parts must be done with a laser. This may require the purchase of additional capital equipment beyond the hot stamping presses for companies embracing the technology.

Despite the dedicated equipment required, laser cutting is a noncontact process, so the laser equipment does not wear and no trim presses or trim dies are required. The laser cutting process is highly precise, and trim lines and feature sizes and locations can be easily adjusted to handle a wide variety of parts.

Companies that enter the hot stamping business have two basic choices when it comes to laser equipment: five-axis laser cutting machinery or six-axis robotic laser technology. While the performance of each option is comparable, there are some definite differences.

The five-axis machine does not have a fixed base, hovering over the part it is cutting in a linear motion, with the part being manipulated by the axes of the machine. The robot works on a part from a fixed base using its axes to access the part, which is usually affixed to an indexing positioner, often with part rotation functionality. The five-axis machine generally has up to a 35% higher throughput, but the robotic equipment can be up to 25–30% less expensive, and occupies 15–25% less floor space. The robotic equipment is also easier to maintain, with less moving parts and robotic technicians in greater supply.

The five-axis machine is typically regarded as more accurate, but the robot matches it in path repeatability. In the final analysis, the relative performances are very close and the aesthetic and functional quality of the finished parts are nearly identical.

Photo courtesy ABB Robotics

The LaserMech FiberCut Zero Degree Laser Cutting Head and the IPG YLS-3000 3kW Fiber Laser integrate seamlessly with the ABB robot to maximize the customer part quality and throughput.

GNS Automotive, a Korean company that has expanded into the US market, recently faced a decision on laser cutting equipment. GNS acquired the business and facility of a traditional stamping business in Holland, MI, with the goal of expanding into the hot stamping business as a Tier 2 supplier doing overflow work for domestic Tier 1 suppliers.

"We saw a great growth opportunity in hot stamping and knew that laser cutting was the only proven technology for cutting the hot stamped boron material," said Elie Mordovanaki, the director of engineering for GNS in the US. "Nothing else is economically viable."

Mordovanaki had to review the merits of both technologies based on numerous factors, none more important than the longer term business plan for GNS in the US, and the capital

Laser cutting of a hot-stamped B-pillar reinforcement using an ABB IRB 2400/16.

available to expand into hot stamping. A five-axis machine can be in the $900,000 to $1.2 million range, with the robotic option considerably less. With the greater throughput of the five-axis machine, however, the future volume expectations of the business must also be examined.

Mordovanaki explains, "Looking at the volume projections for the Holland operation we were confident that the robotic equipment would suit our needs. With the modular, quick set-up and space efficient nature of robots, we were also comfortable that we could easily add more robotic laser cells as our business expanded. We choose not to overbuy in the initial step and took good advantage of the capital flexibility that our decision provided."

The analysis proved to be well founded: a first laser cutting robotic cell was installed in the Holland facility in the summer of 2009, with a second installed just over a year later in the fall of 2010.

"In addition to performance, the value proposition that robots add to the equation are faster delivery times, lower initial capital investment and lower overall lifetime costs," said Joe Bowen, the global account manger of ABB Robotics who has managed the GNS projects.

The first cell is an ABB LaserCut™ 500C featuring an ABB IRB 2400 robot with a rigid arm most suitable for laser cutting. It is integrated with an IPG Photonics 3KW laser and a Laser Mech zero degree FiberCut head. It includes an indexing dial table on which an operator places a part for presentation to the robot.

The second cell is an ABB LaserCut 600R with the same equipment as the first, except the Dial table includes a 360° rotary which allows for a greater ability to put the part in the optimal angle to the laser head. This provides access to difficult-to-reach areas and allows the cell to cut both larger parts and a greater variety of shaped parts.

Both cells are programmed by ABB's proprietary laser cutting software for shape generation and laser control, and TrueMove2™ and QuickMove2™, the standard ABB robot motion software. A Bullseye® tool center point (TCP) automated calibration tool calibrates a Z-directional angle to ensure the laser head is normal to the surface, achieving repeatability of < 0.1mm and reducing downtime to almost nothing. Laser beams cannot be viewed by the naked eye so the equipment is housed in a Class 1 light-tight enclosure.

Industrial systems that involve the intricacy such as that required of laser cutting have for many years utilized some sort of CAD/CAM machine programming. Up until recently robots have primarily been taught the movements required of their operation through manual methods, not a viable option for a laser application that requires so many precise points and such complex motion. Recent simulation software innovations like ABB's RobotStudio have the CAD/CAM compatible platform that has brought the flexibility of robots to some of the most precision-oriented manufacturing applications like laser cutting.

"We looked at other manufacturers but chose ABB because the design of the robot was best suited for laser cutting, and the accompanying software was well beyond anything on the market," said Mordovanaki.

As is typical with any manufacturing process, GNS customers had to approve the robotic laser cutting of the parts before the supplier agreements were finalized, and the quality of the parts had to be certified through a rigorous testing process. The aesthetic appearance and functional quality of the parts were certified without issue.

Photo courtesy ABB Robotics

The rigid arm construction of the ABB IRB 2400/16 due to its parallel link equates to higher motion performance and stability required for laser processing and not found in other robots in its class.

Boron steel sheets, approximately 1.4-mm thick are what GNS typically hot stamps and robotically laser cuts for its automotive customers. The parts are A-pillars, roof rails, sun roof supports and other parts used in the safety cage of an emerging group of vehicles designed to achieve the maximum balance of passenger safety and fuel economy.

Once the parts have been hot stamped, the laser robots precisely trim the edges and cut circular and other shaped features into the parts.

The hot stamp dies are designed to develop as much of the trim as possible in the stamp, but the area of stamped parts a moderate distance from the edge are slightly stronger. This requires more edge to be trimmed from some peripheral areas of parts that require higher tolerances. On these parts more of the edge is trimmed to extend the stronger area closer to the edge. Because the trim areas vary widely from part to part, the advanced programming and precise path repeatability of the robotic laser are especially valuable.

The programming efficiency and precision are also critical for cutting the shaped features from the stamped parts. The shaped features are used for a variety of purposes such as clipping electrical harnesses or gauging a part during the assembly process. The shapes can be circular, rectangular and T-shaped, and vary in dimension from 4 to 12 mm. A robotic laser can cut a 6-mm circle with a high quality of roundness. Some stamped parts have two to four shaped features while others have up to 20 to 25.

"We worked very closely with the team at GNS to understand their needs and to configure a cell to meet their exact requirements," said Erwin DiMalanta, senior manager, Robots & Applications, ABB Robotics. "Much of the success on each cell we delivered is attributable to GNS' willingness to adopt and learn the technology, and the collaborative relationship throughout the entire design and construction process."

Some very good business decisions coupled with the resurgence of the domestic automobile industry and the contin-

ued growth of hot metal stamping has served GNS very well. They opened a new hot stamping facility in Canton, MI, in April 2012, complete with two additional robotic laser cutting cells. In addition to serving as a Tier 2 automotive supplier, GNS has begun to serve domestic auto OEMs directly and can now be classified as a true Tier 1 supplier.

"I estimate that approximately 10–20% of the metal parts in domestic automobiles are currently hot stamped. I believe it won't be long before that number increases to 40%, and perhaps beyond," said Mordovanaki.

Regarding the performance of the robotic laser cutting system Mordovanaki added, "The ability of the ABB system to teach itself the perfect hole is tremendous. And the ABB staff has been completely hands-on throughout the entire process."

"While the initial cell was being assembled we sent our own technician to ABB in Auburn Hills, MI, for extensive system training. Now we have our own in-house expert."

The need to meet the National Highway Traffic Safety Administration's (NHTSA) structural requirements for vehicle safety while adding as little weight as possible to the vehicle certainly expedited the emergence of hot stamping in the auto industry. Looking forward, there is great potential for hot stamping to grow beyond the auto industry.

"Industrial lasers have become even more reliable and cost effective in recent years, making them a perfect match with robots that are well-known for reliability and flexibility," said DiMalanta. "Six-axis robotic laser cutting is here to stay." **ME**

Want More Information?

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