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REDEFINING ROBOTICS

A new development in robotic laser cutting is delivering big gains for cutting 3-D automotive components

Material processing in the automotive industry, specifically in laser cutting processes, has come a long way in the past 30 years. The market requirements for improved strength, weight savings and lower costs drive the need for manufacturers to use materials such as high-strength steel and aluminum. Hot press hardened steels (PHS), generalized as high strength, include many different trade names. The key aspect to gaining toughness for all of them is through heating of the material in the stamping press, forming the part and then quenching to achieve hardening of the steel while forming the stamped shape.

In traditional automotive stamping, a part goes through various stages of die forming with a final trimming die to form the metal to the net shape. However, PHS parts are hard and nearly impossible to trim in a die and require a machining process to create the correct net shape. Therefore, the most effective and popular choice for trimming PHS parts is through laser cutting.

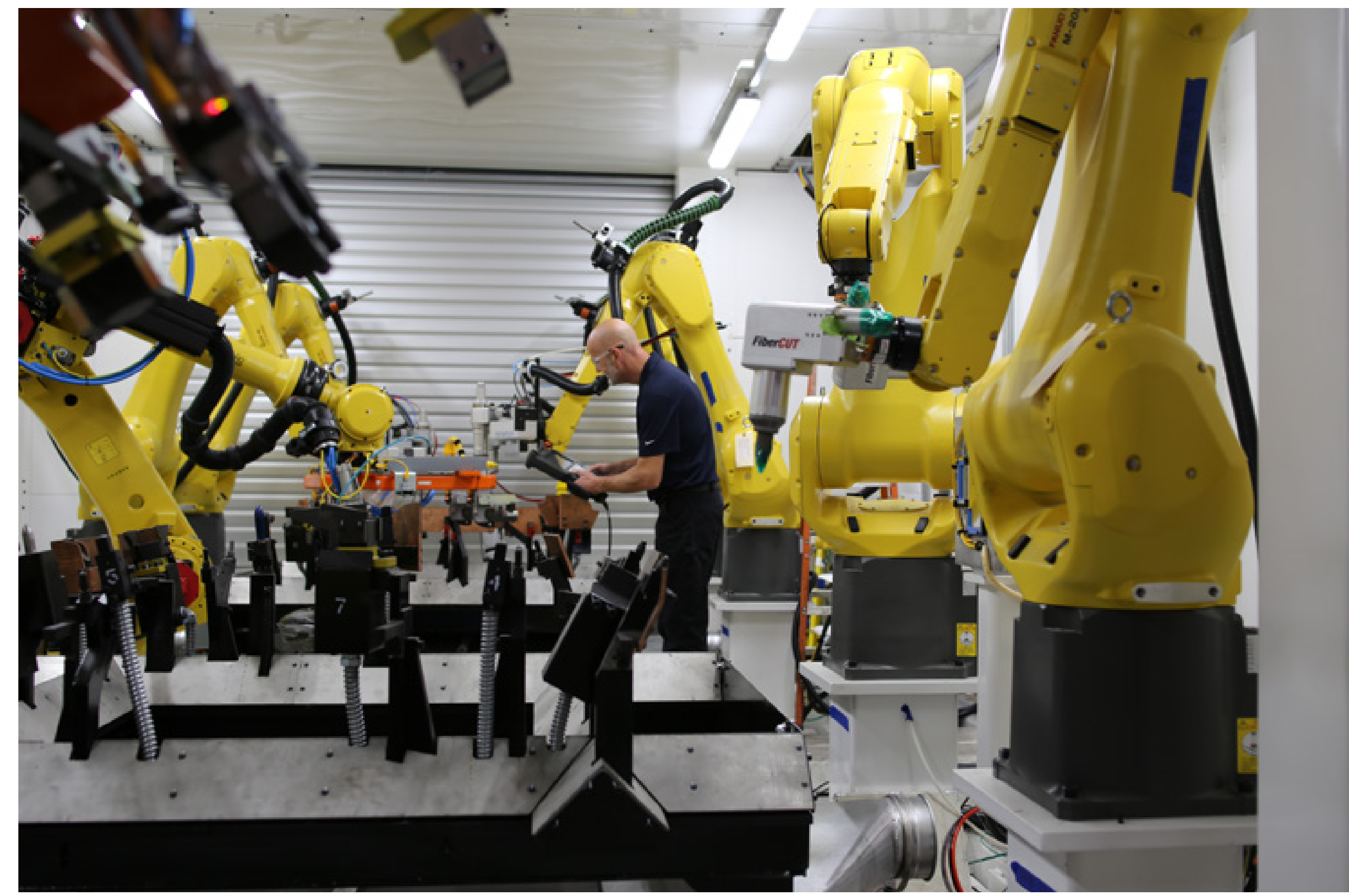
Closing the gap

There are two primary means of laser cutting including robotic and traditional CNC. Robotic cutting has evolved with improved robotic motion performance by accurate mathematical models of the robot mechanism and improvements in the controller's servo performance and path planning. This has allowed robotic laser workcells to offer a competitive cost-per-interchange part (improving the time for presentation of the completed part out and the part to be processed in) when compared to a CNC cutting operation. This is especially true when processing automotive components that have varied shapes and require five-plus axes of motion to process the 3-D parts as compared to traditional CNCs used for sheet or plate processing.

While 6-axis robots, such as the Fanuc M-20iB/25, offer the best robotic accuracy and speeds, they do not have the accuracy of a purpose-built CNC. Therefore, manufacturers need to consider the tradeoffs of slightly less accuracy with a robot than a CNC but much greater throughput.

Robotic laser cutting capabilities offer improved density of the laser processing and the number of laser cutting heads that can be applied to the part simultaneously.

However, new developments in robotic cutting continue to close the gap on path accuracy with speed, taking robotic cutting to CNC accuracy levels and with higher throughput. The latest improvement in robotic laser cutting performance comes from Shape Process Automation (formerly DRS Robotics). Shape collaborated with Laser Mechanisms and Fanuc America to develop the Newton robotic laser cutting head. →



The Newton robotic laser cutting head is controlled directly from the robot teach pendant. Robot users can easily transition to the Newton head because the programming is familiar and easy to use.

Press hard

Press hardened steel (PHS) involves a hot stamping process used to form boron steel parts at high temperatures (900 degrees C) in a stamping press and then quenched for strength. PHS is a general term for these materials that start as low-tensile steel and then are converted to high-strength components. PHS is used to add strength to a vehicle structure or to allow for a thinner gauge steel, saving vehicle mass. The material becomes so tough that stamping trim dies are ineffective at producing a new shape and, therefore, require some type of machining. Fiber lasers are well suited for trimming these PHS components into usable net shapes.

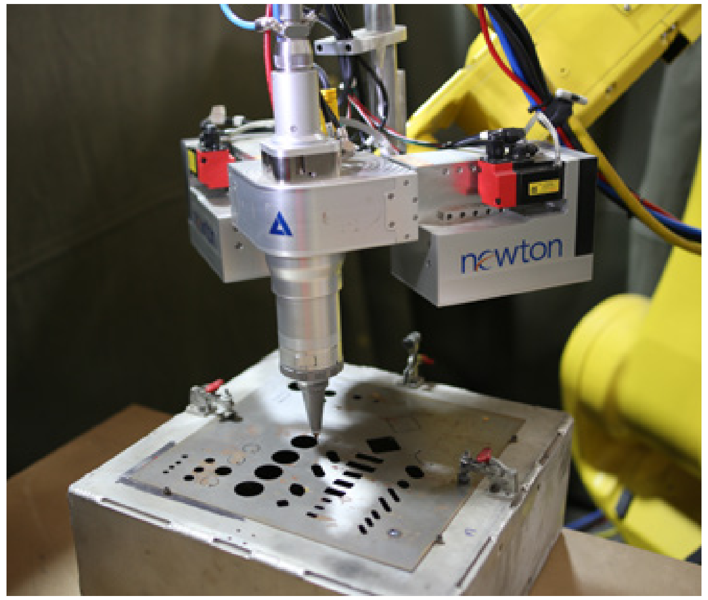
The Newton head is a robot-mounted, 2-axis shape-cutting device that offers path accuracy up to ±0.05 mm within a 30-mm operating range. The device is also capable of fast laser hole cutting speeds at 0.3 sec. for common size features. The Fanuc M-20iB/25 robot already has impressive path performance and together with the Newton head, they provide capabilities that nearly eliminate the benefit of CNC laser cutting over robotic for 3-D automotive components.

The Newton patent-pending device is inertial balanced and controlled directly from the robot teach pendant. The operation is simple with pre-canned motion planning for common shapes including circles, slots, squares, hexagons and others in the robot's library. For users, it's as simple as moving the robot head to the feature and then selecting the cutting shape from the library. The shape attributes are easy to modify to make quick programming. Robot users can easily transition to the Newton head because the programming is familiar and easy to use. Newton can reduce the cycle time over a typical 6-axis cutting robot by as much as 70 percent.

Increased flexibility

Operational efficiency is the name of the game. With the Newton head, robotic laser cutting systems perform well in a workcell or linear arrangement. When reviewing the processing layout for cutting PHS components, it is the manufacturer's choice of how to develop the best layout based on material flow. For example, a station type robotic workcell may mimic the CNC cellular approach while a series of robots in a line offers higher throughput capacities.

Workcells may offer improved capabilities for changeout of the tooling and part mix while a series production line offers higher throughput due to the dedicated tooling, high laser density, increased arc-on time and overall increased productivity. The layout depends on the part mix or variety and the production volume required. →



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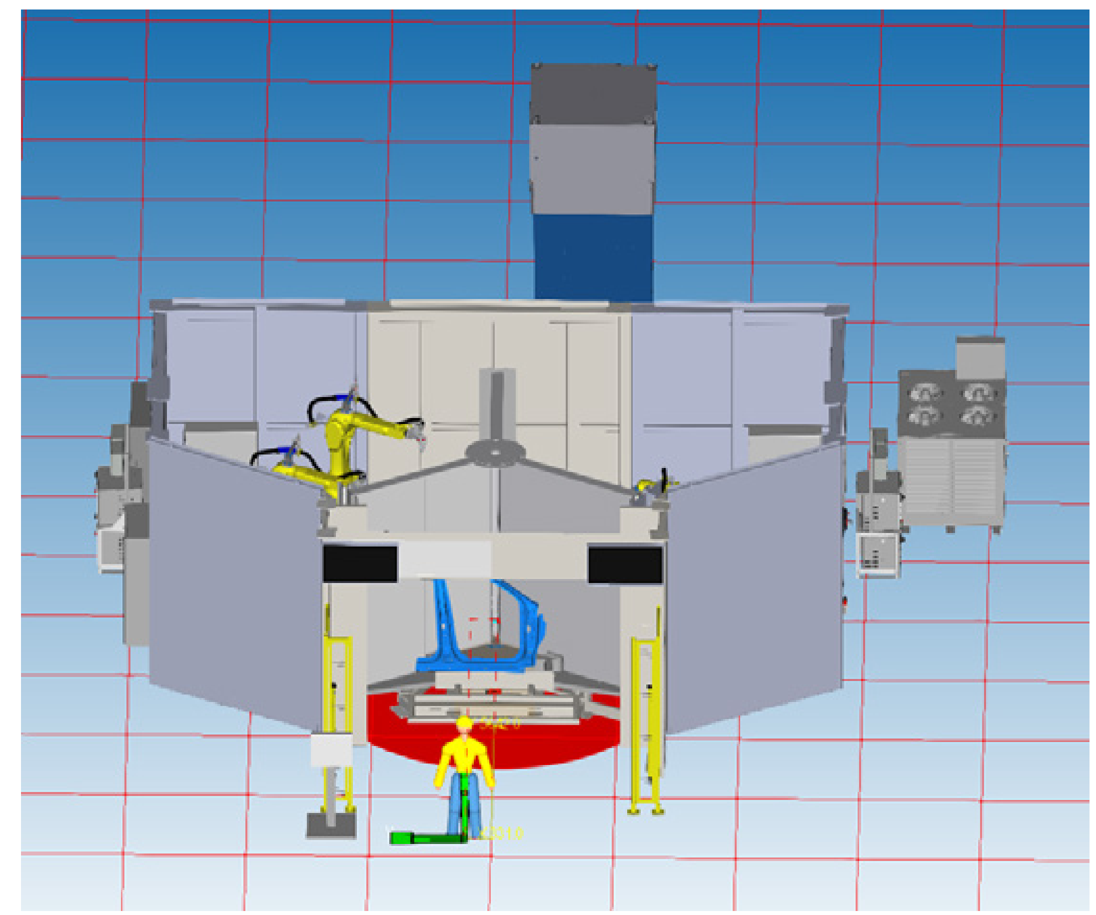
The Newton head is an enabler for workcells and line processing and has many advantages for 3-D laser processing. A robot can process a variety of parts and part shapes because the serial link arm construction enables more robot arms on a part fixture. More arms mean more laser processing heads and increased throughput per unit area. The CNC design is rectilinear, where the motion device consists of a horizontal bridge structure with a single laser head within the working area of the enclosure.

Part processing cycle time also needs consideration when reviewing the laser cutting application. The CNC may only have one laser head on the part at a time and if the total cut time is less than 30 sec., it makes an operator imbalance. In other words, the operator cannot load or unload the material fast enough for a single part cycle of less than 30 sec.

If they take the same cycle time and double the part, then the cost for tooling doubles and the area of the laser workcell doubles, too, while the part processing time per head is still the same. Some of these issues may be resolved with robotic load and →



A flexible robotic workcell manages material flow through a turntable axis, often referred to as an interchange axis. These types of robotic workcells provide the user with a balanced load and unload time within the laser processing cycle.

unload of the CNC, but the number of processing heads per part is still one to one and the floor space becomes larger.

A robotic laser cutting setup, on the other hand, adds up to more laser heads per part, and allows better on-time production. A side benefit to fewer fixtures or tools per part type is improvement in process capability (Cpk). The proportion of cycle time and the number of heads per part needs to have balance and match the material flow requirements.

Material flow

The capital costs and space savings become more apparent when a flexible workcell manages material flow through a turntable axes, often referred to as an interchange axes. These types of robotic workcells provide the user with a balanced load and unload time within the laser processing cycle. Cells with a single turntable offer increased flexibility allowing dynamic part fixture or tooling swaps for other model parts. Two-sided turntable cells allow continuous operation, realizing simultaneous planned tool changeout for one side while the other is in production.

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This workcell is sometimes referred to as a dual-wall cell with turntable axes, with walls on each side of the cell to provide a safe light-tight operation. An additional concept uses the same method but with a three-station wall axes or tri-wing turntable that rotates the part and tooling into the laser cell with three positions at 120 degrees each on one table. The tri-wing design of the triple station can achieve higher production rates while offering the capability to do part changeover during production. The dual-wall and tri-wing designs are further accentuated by the high speed and accuracy of the Newton laser cutting head.

Overall, the capability of the Newton head enables robots to overcome the cycle time and accuracy penalties from their predecessors. This new technology has capabilities that allow for series or cellular production without penalty. The flexibility of adding more laser heads per part saves on tooling costs and helps balance the operation cycle time while improving Cpk. Newton is a key enabler to keep robotic laser cutting at the forefront of manufacturing. This unique inertia balanced design and control through the Fanuc equipment will usher in a new era, redefining robotic laser cutting. ●

Fanuc America Corp. →