FIGURE 1 *A Kuka robot with 2,200-pound payload capacity places material blanks onto the shear load table.*

A shear and a robot, together at last

Company integrates flexible automation with a guillotine shear

By Jon Creese and Wayne Swift

A guillotine shear epitomizes traditional metal fabrication. Machines and their controllers have advanced, but the motions operators go through have remained unchanged for decades. Managers at Lane Steel Co. knew this—and recognized an opportunity for improvement.

What they saw at the McKees Rocks, Pa., metal service center was a lot of repetitive, tedious, and sometimes strenuous operator movement around the shear. One or two workers, often with the help of a crane, would lift a material blank from a stack; position the blank on the shear load table; manually set the shearing parameters with either a front- or backgauge; advance the blank under the knife for shearing; and, if needed, rotate the blank if more than one side needed trimming.

Last year Mike Gedeon, co-owner and vice president of operations at Lane, visited Automated Robotic Systems (ARS), an automation integrator near Pittsburgh. He recalled glancing at one of the automated forming lines at ARS—and having a revelation. "I was watching [the company's] robots feed an automated forming machine," he said.

Why, he asked, couldn't the same concept be applied to a guillotine shear?

Relieving a Bottleneck

While robotics and metal fabrication have a long history together, integrating a robot into a front-loading guillotine shear is something new altogether. It's not that today's shearing systems and stackers aren't conducive to robotic material handling; it's just that, to the authors' knowledge, no one had thought to put the two together.

That is, until now.

The company has integrated flexible automation into its shearing operation—and for good reason. The operation, usually the last before packing and shipping, represented a bottleneck when the plant was operating at full production. Automated, coil-fed leveling and blanking lines pushed product downstream, and for customers demanding custom-sheared sizes, material blanks had to flow through manual guillotine shears.

The operation now is anything but manual. The company has an automated cell with a Standard Industrial guillotine shear and Canrack stacker from Mid Atlantic Machinery, a distributor in Harrisburg, Pa. A six-axis Kuka robot arm with a carrying capacity of 2,200 pounds picks and places material blanks from a stack to the load table in front of the shear (see **Figures 1** and **2**). The robot communicates with an external seventh axis, a servomotor on the load table. Essentially, once the robot has moved and positioned a material blank onto the table, software signals the servomotor to execute procedures, which involve pushing the material blank precisely where it needs to be under the shear's knife.

Precision "Clicks"

Central to the system are the thousands of markings, or indexes, on the table. Imagine a ruler 14 feet long with these indexes every 0.005 in.; that translates into 33,600 individual markings. The robot arm positions the material blank so it can be secured by four clamps. A PLC, operating in concert with the robot controller, signals these four clamps to open and close. The servomotor then controls the movements of the material blank into the shear (see **Figure 3**).

Assume that the program calls for the blank to be trimmed 1 in. at the leading edge and then cut into a series of 8-in.-wide finished blanks. For the 1-in. trim cut, the servo advances the blank's leading edge 200 index "clicks." The shear trims, and the 1-in.-wide remnant is scrapped. To cut the blank to an 8-in. width, the servo advances the material blank by 1,600 index clicks and stops. The shear cuts again, and the final custom blank is offloaded to the stacker. The system indexes forward another 1,600 clicks for the next cut, and so on, until all finished blanks are complete.

To cut more than one edge, the robot arm comes back into play. After the shear cuts one edge, the robot spins the blank to another orientation. The system thus can square a material blank with mill edges on up to three sides before final shearing.

When a cut piece will be scrapped, the system sends a signal to the stacker, which in turn opens a door that accepts the scrapped piece. Finished parts are stacked into a bin adjusted before the production run to match the length and width of the final blanks.

Consider a 0.125-in.-thick material blank 60 in. wide by 144 in. long. Standing by the controller, an operator selects a program, or production plan. When picking a material blank from the cart, the robot knows to orient the blank width parallel to the

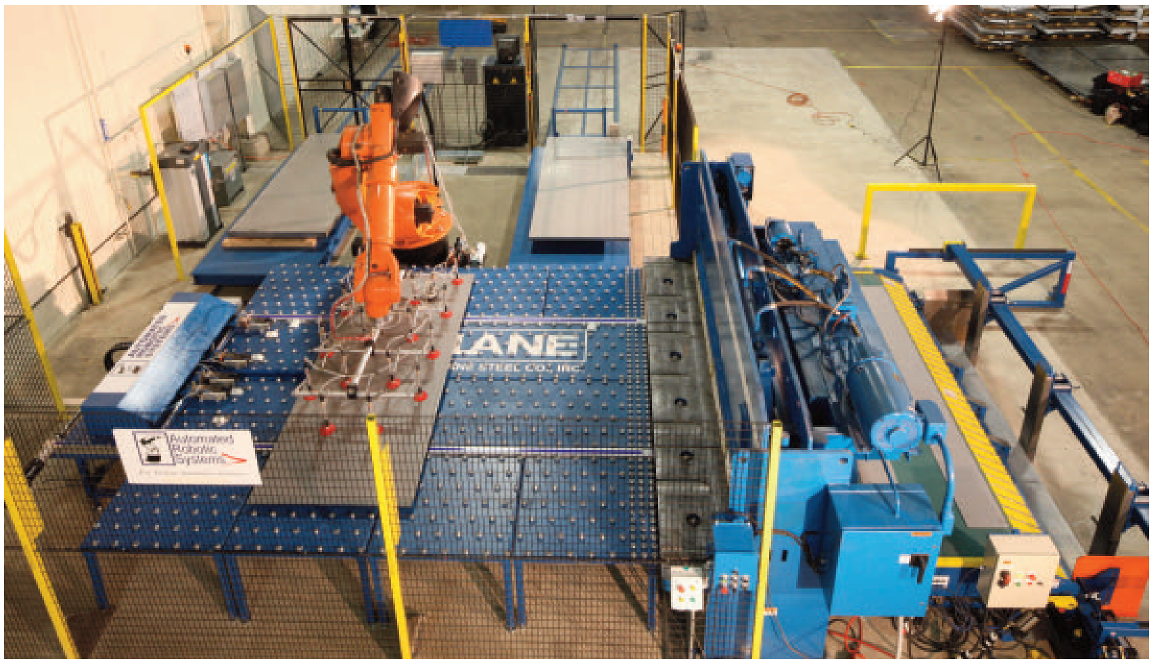

FIGURE 2 *At Lane Steel a robot arm picks and places material blanks onto a table, which has servo-driven clamps that position the sheet for shearing. Scrap and finished blanks are handled by the stacker to the right of the shear.*

The system's 12 robot-orientation programs can manipulate blanks in virtually any conceivable manner.

shear knife line. It moves the blank over the table and then, with the help of several actuated squaring pins, positions the material's trailing edge into the set of four grippers. Once proximity switches verify material alignment, the grippers gain control. Meanwhile, the robot returns to the cart to pick the next material blank.

Let's say this production plan involves a leading-edge trim-cut piece that is scrapped; a total of 33, 4.25-in.-wide parts cut to width; and a scrapped, 2.75-in.-wide trailing-edge cut piece. The servo-driven system, the shear, stacker, and robot all work in concert to perform this complex operation. The leading edge is cut, followed by 33 parts cut to width, and finally the trailing-edge cut. When complete, the robot already is at the ready with the next blank.

Throughout, the only communication that occurs between the guillotine shear and the automation is the command passed from the robot controller instructing the shear to make a cut. After cutting, the shear's controller sends a signal back indicating that it's ready for the next cut. Such simplicity has an added benefit: The automation can integrate with virtually any commercially available guillotine shear.

Overall the automaton can handle 0.024- to 0.250-in.-thick steel with starting dimensions up to 5 by 12 ft. The smallest finished blank it can produce measures 1 by 12 in. And it can hold consistently a tolerance of ±0.005 in.—a feat impossible to achieve manually.

Fast and Safe

Gedeon said it used to be challenging to keep up with customers' demands for shear work. Manual shearing was a slow process. "This [automated system] will help us get orders and deliver orders on time."

When production speeds up, safety hazards normally become a greater concern. But the robot, which operates in a safety-secured cage, eliminates many hazards. The material is handled by an automated, intelligent system from the time it comes off the floor until it is released to the stacker, reducing the need for manpower and the potential for workplace accidents. Moreover, if workers attempt to enter areas of the cell during production, they will trigger light barriers that in turn force an instant shutdown of the robot and servo drives.

First of Its Kind

"It's the first of its kind, and no one wants to be the first," Gedeon said, adding that technicians still are working out the bugs, most of which involve the robot arm and how it delivers steel to the shear table. Nevertheless, problems have been relatively minor, and early technology adoption has its benefits.

"We try to capitalize on every opportunity that enables us to take a lead," he said. "That's what sets us apart from our competitors."

Most significant, the system's 12 robot-orientation programs can manipulate blanks in virtually any conceivable manner. "It's a huge benefit that the robot can turn the steel," Gedeon said, explaining that such capability makes the automated setup as flexible as a manual operation—without straining the operator's back.

Previously a crew of three often had to work with seriously heavy material, such as a stack of 0.25-in.-thick, 5- by 12-ft. sheets—*each weighing 630 lbs.* Using manual methods, it took this crew five minutes or so to fit one sheet onto a crane and load it into a shear. Let's face it, a job requiring such heavy lifting, all day every day, isn't anyone's career aspiration. But the robot doesn't mind at all. In fact, it can execute the same operation—with greater precision—in 20 seconds. ***FAB***

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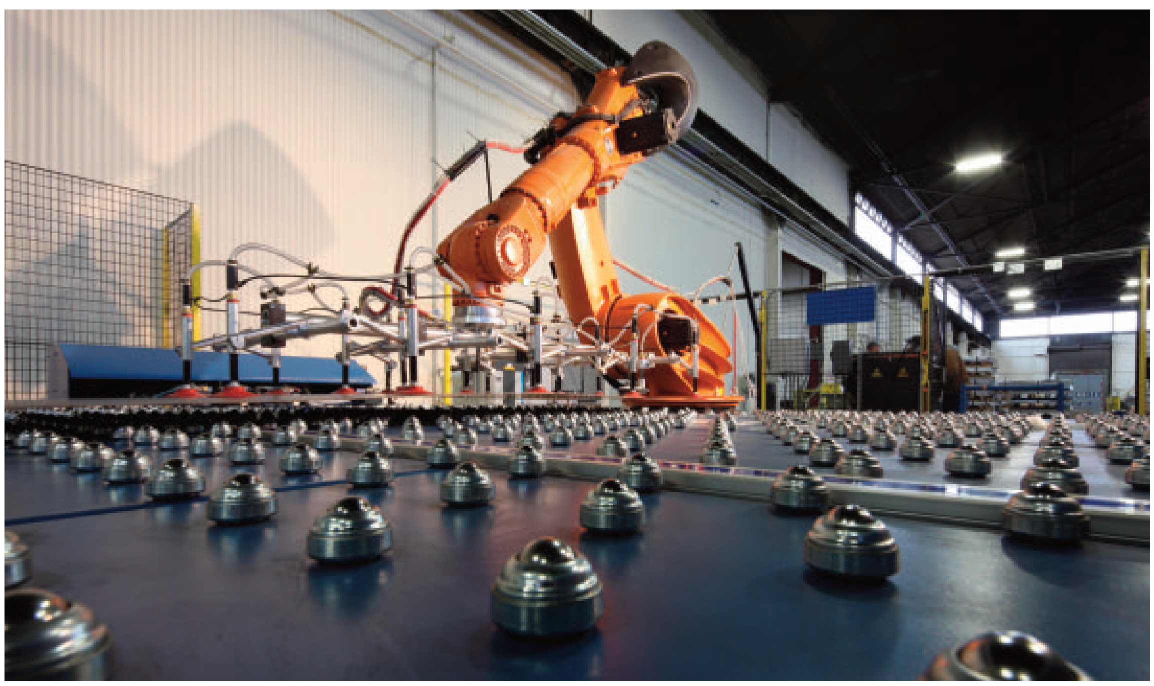

FIGURE 3 *Four servo-driven clamps at the raised blue housing, shown here immediately behind the sheet being placed onto the table, position the blank for shearing within ±0.005 in.*