

# Sturdy Exam Tables Rely on Robotic Welding

*Manufacturer banks on robotic resistance welding to provide a cost-effective, aesthetically pleasing, and strengthened cabinet assembly*



Fig. 1 — An example of Midmark's new, sturdier examination table introduced in 2005.

In 2003, the marketing team at health-care-product supplier Midmark Corp., based in Versailles, Ohio, challenged its manufacturing team to develop a cost-effective process for fabricating a newly designed pair of manual examination ta-

bles. The new tables (Fig. 1) were to replace a well-known product line in the healthcare industry since the 1970s. With an innovative table design in hand that, among other benefits, offered an increased maximum patient weight of 500

lb, compared to the 325-lb capacity of the previous model, Midmark's fabrication team went to work.

"Controlling our manufacturing cost was a big factor with this product redesign," recalled Rick Turner, Midmark's engineering manager and team leader for the project. "To optimize efficiency, we focused immediately on automating the assembly process for building the cabinets for the examination tables. Also, the cabinet design called for the forming of complex drawn metal components, which reduced part count compared to the previous table models. The new design challenged our metalforming and fabrication departments to not only develop the necessary forming tools and processes, but also to engineer a cost-effective means for assembling the cabinet components."

For cabinet assembly, Turner and his team turned to a new technology for the company — robotic resistance welding. The new robotic welding setup, developed and integrated by Motoman, Inc., makes 58 spot welds to join seven formed sheet-steel components in a 5-min production cycle.

## Fitting It into Lean Manufacturing

Midmark, with subsidiaries in Torrance, Calif., Orchard Park, N.Y., and Ernee, France, operates out of a 225,000-sq-ft plant in Versailles. Its stable of metal-fabricating equipment, which includes six press brakes to 300-ton capacity, three 4000-W laser cutting machines, and four stamping presses to 300-ton capacity,

feeds seven assembly lines, each dedicated to a specific product category. When the manufacturing plant took on the new examination table project, it was in the midst of an ambitious project to revamp its assembly lines based on Toyota production system principles.

The focus was to reduce lead times to customers by developing assembly systems that allowed one-by-one production instead of batch processing. Midmark production system (MPS) was what the company called the process it developed to let it provide the exact quantity of products exactly when the customer wanted them.

MPS focuses on identifying and eliminating seven categories of waste from manufacturing operations:

- Overproduction — producing more products than necessary, and sooner than necessary;
- Waiting — idle time that could be used more productively;
- Transporting — unnecessary transport of parts or materials;
- Inappropriate processing — operations that do not add value for the customer;
- Unnecessary or excess motion — activity by workers that does not add value to the products;
- Unnecessary inventory — exceeding one-piece flow; and
- Defects — rework or repair.

Lead times went from two to three weeks down to three days when the MPS model was implemented. The new examination table project had to make its production fit into that MPS system. A three-day shipping target was set, from receipt of order, and very few shipment dates were missed. Robotic welding to assemble the table cabinets has played a critical role in that success.

## Unitized Construction Forms a Rigid Cabinet

The new integrated robotic welding cell (Fig. 2) assembles cabinets at a cycle time of 330 s, which is the time needed to fixture seven formed metal components, create 58 spot welds and remove the 55-lb welded cabinet and load it onto a gravity-fed conveyor for delivery to a paint line. Cabinet components are primarily 18-gauge draw-quality steel.

“With the requirement to increase the weight capacity of the table compared to the previous table design,” said Art Smith, Midmark senior design engineer, “we developed a unitized cabinet construction to provide the necessary rigidity, while at the same time down-gauging our steel from what had been primarily 16-gauge on our previous table models. Also, the previous table cabinet was comprised of 16 parts and 34 fasteners. Taking that down to seven parts, all welded together, took a lot of

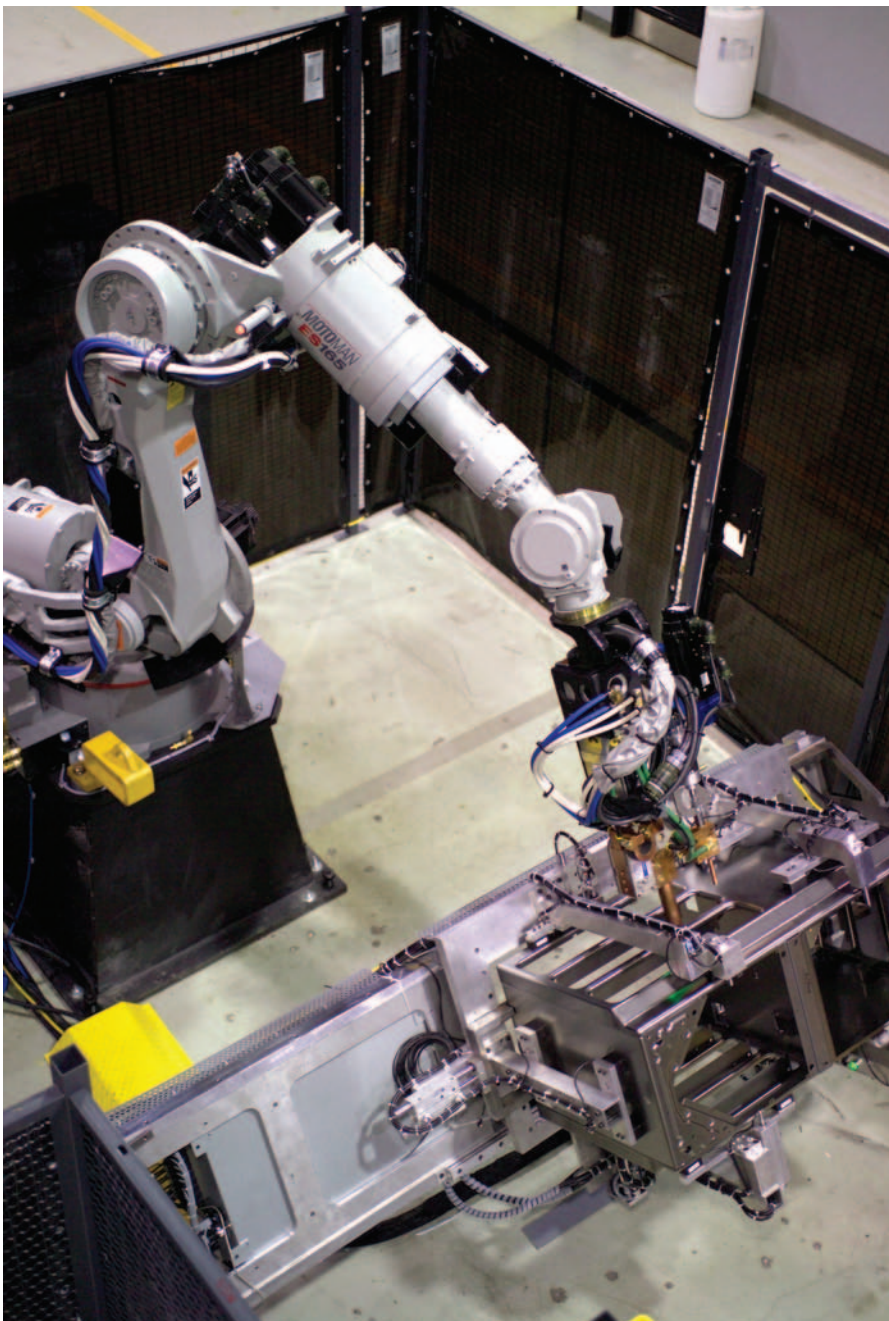


Fig. 2 — A six-axis ES165 robot deposits 58 spot welds to assemble cabinets for Midmark's new line of examination tables.

time and cost out of our process.”

Consolidating 16 parts down to 7 also demanded quite a bit from tooling and metalforming engineers. They used *AutoForm*, a simulation software, to prove out the complicated drawing operations for forming the complex shapes.

The company custom-developed blanks, proved-out by *AutoForm*, that allow draw-finished parts in one hit in the die with no need for trimming.

## Tackling Fitup Challenges

The cabinets' seven formed compo-

nents come together at the robotic welding cell. The cell operator gathers the parts from storage racks located near the cell and loads them into the cell's head-tailstock positioner — with one exception.

Automated welding can bring challenges, most notably those related to part fitup. One of the seven parts comes off of the stamping press with too much edge curl to allow proper fitup in the weld fixture. The cell operator first loads this part into a sizing fixture, located near the weld cell, where the edges are rolled and reformed to remove some of the edge curl. The development of that sizing fixture, as

well as that of the weld fixture, was done at the company and played a critical role in the success of the project.

To help bring the components together into a fairly large (20.5 × 23 × 46¼ in.) completed weldment, the firm also had to increase the number of spot welds made by the robot. The number of welds was based on what was felt was needed to hold the assembly together and carry the loads. Originally, 44 spot-weld locations were estimated. But once the actual fixturing of the parts for welding started, it was determined another 14 welds were needed to

help pull the assembly into shape and iron out some of the edge curl.

### Robot Takes Center Stage

The robotic welding cell, installed with all of the necessary safety apparatus, features a six-axis Motoman ES165 welding robot, with 165-kg (363.8-lb) payload capacity, 2651-mm (104.4-in.) reach, and a work envelope that extends behind the body, providing easy access to the weld gun for maintenance. To minimize maintenance, the robot was designed so that weld-

gun cables as well as air and water lines route through the robot's base and upper arm to the robot's wrist. This setup proved ideal for this welding application, as well as other similar weldments that require the welding gun to work over a wide range of motion to reach the spot-weld locations.

The robot was integrated with a C-style servoelectric welding gun that provides lower life-cycle costs. The servo gun allows the operator/programmer to minimize cycle time by programming the electrodes to open the shortest distance needed to clear the tooling and sheet-metal. The closure speed combines with a soft touch at impact that extends electrode life. Weld power comes from a mid-frequency DC welding transformer, an extra investment compared to traditional AC power supplies.

The DC power supply delivers a weld current of 10, 200 A to the electrodes at a low voltage. Compared to an AC unit, the power draw is probably reduced by 15%.

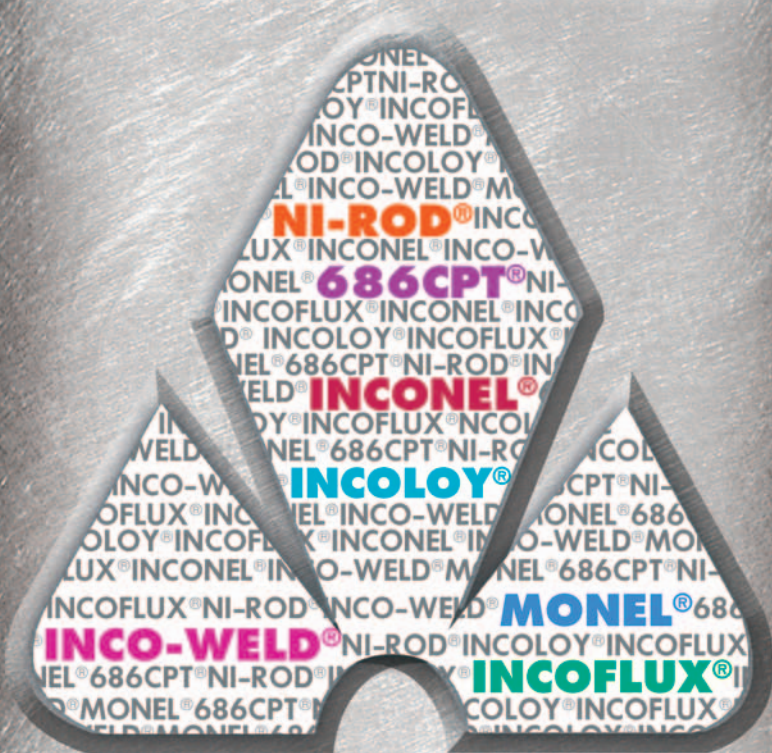
The weld schedule is 10 cycles of electrode squeeze, 15 cycles of weld current and 10 cycles of hold time, yielding spot-weld nuggets of ⅜- to ½-in. diameter. The welding electrode on the visible side of the cabinet components has a flat face, to help eliminate marking, while the opposing electrode has a tip with a 2-in. radius. The robotic welding cell runs two shifts, five days per week, with an uptime of 98%.

### Making Mark-Free Welds

Critical to the success of the welding project was the ability to make mark-free welds. Programming the robot using *MotoSim@EG* robotic simulation software, which combines 3-D graphics and cycle-time calculations, was a key factor. This was done by Motoman's programmer over a two- to three-week period. Fine tuning to the program was done once the welding cell was installed in the plant, where the welding gun angles could be assessed. Precise square-up of the tip of the welding electrode to the sheet metal at each weld location is needed to prevent any dents or marks. The servoelectric actuation of the weld gun also helped by being able to control the rate at which the electrodes close, and ramping up of the clamping force provided by the electrodes optimizes weld quality. Some additional fine tuning was done by the company's programmer who was able to reduce the production cycle by 30 s. All told, a 420-s production time when the process was launched last year, has been pared down to 330 s.

Dropping the old table line over a 30-day period and launching a new table design has been a remarkable achievement for all involved in the project. The table has done well in the marketplace.◆

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