Genesis Systems Group, LLC

Testing the Limits

By Harlon Neumann, and Darl Osborne

In today's fierce competition for market share, manufacturing companies are continually looking for ways to produce their products faster, cheaper and better. One solution for both large and small manufacturers is the installation of robotic welding systems.

Robotic welding offers companies a variety of benefits from direct cost savings through a reduction in labor costs, superior precision, the elimination of human error, consistent quality welds, and the ability to perform multiple welds on both simple and complex parts. Many people have the misconception that robotic welding takes away jobs when in actuality, it gives manufacturing companies an option to keep the work in the United States by reducing the labor costs and educating welders for higher paying positions. In addition, robotic welding has proven to increase productivity, maximize efficiency, increase quality, and minimize downtime. The saying "automate or evaporate" has never been truer.

During 2003, North American manufacturing companies ordered 19% more robots from North American robotics suppliers than they did during 2002 (according to figures released by Robotic Industries Association). A total of 12,367 robots valued at $876.5 million were ordered, the industry's best mark since the year 2000. As more companies integrate robotic welding into their manufacturing process, manufacturers are forced to find ways to push their operating systems even further in order to stay competitive. They are looking for ways to maximize their robotic systems enabling them to weld even faster and produce parts that require less post weld finishing.

Genesis Systems Group, the largest builder of robotic arc welding systems in North America, says the rules have changed. In an interview, Terry O'Connell, Genesis VP of Sales & Marketing notes: "In the 90's many companies purchased their first robotic welding systems. Having a robot welding system or systems distinguished you as a progressive manufacturing company." Mr. O'Connell observes: "Today robot welding systems are table stakes. It's the way you weld if you want to compete." Expanding further he states: "Today you have to take the robot system and get more good parts faster." To do this, companies need to focus on Design for Manufacturabilty (DFM), carry this through part holding and then apply the latest weld process technology for quality and speed.

The Task at Hand: Genesis Systems Group was asked to conduct tests to see how fast their systems could weld a thin material stainless steel exhaust component. Along with faster welding the part needed great appearance – little or no weld spatter would be allowed.

Step I: Choosing the Right Combination:

To obtain optimal results, engineers at Genesis Systems Group had to consider multiple factors and analyze several components. The Versa 3M robotic welding workcell was chosen for the tests. This system is designed for medium sized parts that do not require repositioning for welding. The system features a high speed 180-degree indexing, two-station turntable positioner to exchange unwelded piece parts/subassemblies and finished weldments between the robot and the operator. The workcell is excellent in high volume production environments where the 3M high-speed exchange axis (2 to 3 sec.) boosts productivity and the weld fixture load/unload time approaches the process time. The 3M System provides competitive advantages with the fastest exchange time, largest payload and table diameter in its class.

Of critical importance was selection of technologically advanced weld process equipment from Lincoln Electric Company and FANUC Robotics. The Fanuc ArcMate 100I robot is seamlessly married to the Powerwave 455/STT power supply that includes the special Surface Tension Transfer (STT) feature that made the difference in speed and quality for this application.

The exhaust component parts tested were a light gauge 400 series stainless steel, making the PowerWave 455/STT a great choice for this process. In addition, the 455/STT provides reliability of arc starting and arc stability while reducing spatter and smoke. The 455/STT provides the customer with the opportunity to control distortion better while minimizing burn-thru, cold lap welds, and post process finish or rework. These qualities are controlled with previously mentioned Surface Tension Transfer (STT) process mode providing optimal performance on thin gauge and stainless steel applications.

Step 2: Testing for Optimal Speed

By increasing the speed of the robot, obvious benefits occur: more parts are produced per shift resulting in more products at the end of the day. To accomplish the optimal speed for the specified application, the FANUC Fastart feature utilizing ArcLink was chosen. The FANUC Lincoln communication protocal, ArcLink, provided the system with consistent information transfer allowing for faster speeds in controlling the welding process. It does this by allowing the system to start the arc welding process as the robot reaches the arc start position, resulting in a reduction in cycle time per arc start and arc end. By utilizing ArcLink, Genesis' engineers were able to adjust parameters and timing to make the system as efficient as possible while providing the arc characteristics and quality the customer was looking to achieve. Fastart allowed the Genesis' weld engineers to control the timing of the weld start signal relative to motion termination. With Fastart, they were able to overlay the small delays in starting the wire feeder with the robot motion to the Arc Start position. Also, with Fastart, they were able to begin craterfill just before the torch reached the Arc End position.

In addition to features provided through ArcLink and Fastart, Fanuc acceleration/deceleration features were utilized to decrease cycle time. The process continued to be refined as Genesis' engineers worked to identify the right combination of welding wire and shielding gas to produce the desired outcome. While .045 wire was recommended in the original specifications for the test, Genesis' engineers determined that .035 wire produced better results. The use of a shielding gas purge function at the start of each weld improved arc-starting stability and helped prevent porosity. Engineers placed the part in a standing position to allow for vertical down welding, allowing gravity to work with them to increase the speed of the weld. Weld speeds over 100" per minute were obtained. Throughout the testing, the robotic teach pendant was programmed to monitor and record welding times.

The optimized system was able to consistently perform a specified 20-weld test at speeds faster than the time required by the customer – thus exceeding the project requirements.

Step 3: Completing the Spatter Test

Some degree of spatter is produced when metal is welded together. Depending on the part and the finishing processes, spatter typically has to be completely removed prior to finishing the part. By decreasing the amount of spatter produced, manufacturers can save time and money by eliminating the need for extensive spatter removal.

To test the amount of spatter produced by the robotic welding system, Genesis was asked to place a white sheet of paper under the system to show the spatter pattern that appeared. (Please note that a fire extinguisher should always be close at hand when conducting similar tests.) The spatter produced by the arc welding process was allowed to fall directly onto the paper. When each spatter ball contacted the paper it would produce a brown discoloration or burn mark in the paper. If the spatter balls were large enough they would burn a hole completely through the paper. The size, quantity and placement of the discoloration's were the indications measured and compared between each change made to the welding process. Most of the weld debris produced was a fine dust with very little burn through on the paper.

To complete the spatter test, multiple variables were tested to reach the desired outcome established by the customer. Variables included the torch angles, tip to work distance, welding power supply pulse waveforms, trim value, welding position, shielding gas flow rates and robot travel speed.

In addition, the process was videotaped. This allowed the engineers and the customer the ability to visually examine the glow from the spatter balls, the sounds produced by the arc and the visible stability of the arc.

Outcomes:

Genesis engineers proved successful in accomplishing the tests set forth and were able to program the robotic welding system to produce parts at a maximizing speed while minimizing spatter and increasing the arc stability. Overall, the systems were able to perform a specific 20-weld test in a time frame that exceeded customer expectations and goals of the project. In addition, the required spatter test sheets were kept as a baseline document that can be used for future project comparisons.

Although the processes used in performing these tests were not new to the engineers at Genesis Systems Group, it was the process of testing the limits and capabilities of the equipment working together to find the exact sequences, timing and parameters that produced optimal results from the robotic system. As automation continues to emerge in manufacturing facilities, robotic welding techniques such as those used in these tests will be increasingly important to both large and small manufacturing companies as they look to find a new competitive edge.

About the authors:

Harlon Neumann *is the Director of Application Engineering at Genesis Systems Group. He has over 15 years of experience with robotic are welding. He received a B.S. in Welding Engineering Technology from Ferris State University, Big Rapids, MI. Throughout his career; he has given several presentations to organizations such as the Canadian Welding Association, The National Trailer Manufacturers Association and the AWS. He is a current member of the AWS A9.4 committee covering Network Specifications for Weld Cell Integration.*

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Genesis Systems Group is an industry leader in the design, manufacture, and building of robotic systems for welding and cutting applications. Founded in 1983, Genesis is the largest robotic arc welding workcell integrator in North America. The company has installed more than 2,000 robotic welding systems in more than 36 states and 7 countries. For further information on Genesis Systems Group or the processes involved in these tests, visit www.genesis-systems.com or contact us at robots@genesis-systems.com