



Whitepaper

Modern Concepts for Implementing Robotic Arc Welding Automation

The Future of Automation



Working to develop solutions for the unique challenges of robotic welding.

In this discussion we will address the many reasons to automate by outlining modern techniques, common mistakes, applications of sensor technologies, vendor selection criteria, and keys to success for robotic welding automation in your operation.

We will also take on some of the many challenging process applications and discuss how companies have worked to overcome them. This process often involves an in-depth collaboration between integrators and manufacturers working together to develop clever solutions for the unique challenges of robotic welding not found in other automated processes.

A few of the many reasons for manufacturers to consider implementing welding automation include:

- New products or product mix
- Increased productivity
- Quality improvement and traceability
- Ergonomics / safety / job quality
- Increased throughput with reduced labor content
- Lack of experienced / trained welders

Sustainability

Economically speaking, there are a number of reasons American companies are bringing manufacturing back to the United States and automation is the great enabler of this trend. As compared to many other highly industrialized countries, we place a high value on safety, human rights, and environmental well-being. The lure of cheap, globalized manufacturing is highly attractive for the manufacturers' bottom line and subsequently, the cost to consumers; however, we are fooling ourselves if we say we are completely satisfied with the quality of most foreign products when compared to those made proudly in America.

As we continue to automate more and more manufacturing processes, we are developing our sustainability both locally and abroad by reducing the cost of manufacturing, improving quality, and creating long-term employment with better jobs.

Adopting the Technology

At a recent AWS meeting in Denver, Dr. Jesse Grantham, Forensic Expert on weld inspection and weld qualifications, asked the audience, "what would you say if your company says they will be introducing welding robots into the operation?"

The diverse audience was comprised of production welders, high school students, local manufacturing leaders, welding suppliers, welding inspectors, and automation integrators to name a few. A couple of the youngest in attendance piped up and shouted phrases such as, "No Way!" or "They take our jobs away!" Dr. Grantham promptly informed them about the benefits and sustainability of welding automation.

Unfortunately, the anti-technology mindset is still alive and well in this country, but the condition is improving. The simple truth of the matter is that a good deal of U.S. manufacturing disappeared because cheaper manufacturing abroad became a competitor to our own capability to produce products locally. Over the past 15 years or so, I have witnessed several cost control initiatives that have reduced large American manufacturers to assembly plants first-hand. Small manufacturers often disappear altogether

Additionally, there are many hidden costs due to the lower quality of cheap replacement components we receive from abroad. These are typically inferior to the domestically produced parts that were formally manufactured locally. Often times, the initial cost of these components (including shipping) was much lower; however, the additional rework due to poor fit-up, increased use of welding consumables, part handling, and extra robot programming time required to cope with inconsistent subcomponents outweighed the overall cost of manufacturing. I believe “the only people satisfied with the quality of cheaper components are the people in purchasing roles”. Manufacturers are quickly becoming more knowledgeable about these hidden costs and as a result of this are developing a better understanding of the importance of automating with more technology than ever before.



Integrator Selection Criteria

Selecting the right integrator for providing the automation solution is the most important contributing factor for the success of any automation project. Robotic automated welding is clearly on the rise; however, the number of qualified integrators is not necessarily keeping up with manufacturers' desire to automate. They may also misrepresent the technology or fall short with process knowledge.

Operations dictate the production requirements of the manufacturing operation and rely on engineering and purchasing to provide solutions capable of coping with the demands of production; therefore, manufacturing operations must be aligned with corporate goals and objectives for both the current and future outlook of the company. Manufacturing Engineers are often at the forefront of the vendor selection process and must be able to determine what areas of manufacturing (if not all) can be automated.

Purchasing & Engineering Process

Corporate buyers are expected to make sound spending decisions and, therefore, are well trained and equipped to compare proposals from multiple vendors. Buyers and Engineers work together to generate the integrator bid package outlining project scope, specifications, terms and conditions, content, capacity, schedule, cycle-time and many other elements they feel are necessary to describe the system deliverables.

Buyers may phase out custom or value-added content and are expected to reduce proposals to common content in order to simplify the buying decision. Once the lowest priced vendor is determined, it can be difficult for Project Engineers to convince management of their decision to purchase from their preferred vendor choice if the lowest cost solution is not what they feel is the most reliable solution for their application.

Purchasing personnel often work from a list of preferred vendors that may or may not be completely equipped or experienced enough to provide a successful solution. Implementing factory automation is not necessarily an every-day occurrence and will require a significant effort from Engineering and Purchasing working together to discover, learn, and understand current technology relevant to their automation opportunity. Due to the fact Plant Engineers are the most familiar with the daily challenges of production, they are generally well equipped to qualify and specify solutions to cope with manufacturing and process improvements. Process Engineers also benefit from multiple proposals because they can compare the strengths and weaknesses of various system concepts provided by each integrator.

Often times, manufactures don't have exact figures for budgets, are unsure when they will be able to spend capital, and don't know how much space or demand from the facility will be required for automation. Keep in mind that manufacturers don't implement automation solutions every day. However, they generally welcome the assistance from qualified integrators to help them with the process of determining good candidates for automation, budget expectations, and realistic timeframes to integrate automation solutions. Depending on the complexity of the solution, integrators may even assist the manufacturer through the process of developing a request for quote.

The request for quote or RFQ generally contains the basic elements that describe the part(s) to be processed, throughput requirements, equipment specification, process specification, floor space availability, warranty, purchasing schedule, and installation schedule in the form of a bid package. It is up to each integrator to work with Engineering and Purchasing to clarify each of the elements detailed in the RFQ so as to clarify any items they don't fully understand or to expose any initial shortcomings of the RFQ itself.

Many companies are unsure of exactly what it will cost to automate elements of their operation and seek a budgetary proposal that can be used as a tool to inform management of the financial impact to the operation. Management will analyze production throughput requirements, cost saving goals, labor reduction, quality impact, safety and other factors to determine the return on investment. If it is determined the project is a good fit for the company goals and directives, a firm bid is generally requested from the top two or three integrators and significantly more time will be invested in the details of the project.



Several factors play into the automation buying decision:

Competitive Manufacturing Capabilities

- Cost
- Quality
- Delivery performance
- Flexibility

Investment Decisions for Strategic Manufacturing

- Process Technology
- Capacity
- Quality system
- Production and Inventory Control
- Workforce Management
- Manufacturing Organization
- Management
- Operations
- Purchasing
- Engineering
- Production



Identifying the Right Integrator for your Solution

Process Engineers and Purchasing staff are charged with the responsibility of finding the most qualified and experienced integrator for their applications that can provide the proper technology at the best value. Be wary of smooth-talking sales personnel set on leading the buyer into a cheaper solution that sounds great on paper, but won't be completely successful in the end. Also, it is not a good practice to stretch an integrator's capabilities in hope it will all work out when the equipment hits the floor. Remember, if the automation solution is not successful, no one is successful, including the manufacturer and the integrator. This can be avoided by selecting an integrator that has experience and expertise in the exact solution for the manufacturing operation(s).

There are many qualified integrators in the industry, but there are also plenty of hungry integrators that would love the opportunity for business in which they are not capable of supporting through the life cycle of an automation solution. This includes not only hardware and software, but extensive process knowledge, which is the key to any integrator's sustainability in the manufacturing world.

During the integrator qualification process you are certain the equipment supplier is equipped with the minimum capabilities, skills, and experience:

- Design and build capability for robot transport units (RTUs) and multi-axis work-piece positioners
- Familiarity and experience with relevant robot and process technology, i.e. robot capability, flexibility, welding process equipment, peripherals, controls, and safety
- Off-line programming expertise starting with full configuration to part programming
- Most importantly, the integrator must have a staff of highly trained and experienced robot and welding process experts for your specific application!

Ill equipped integrators can be exposed in the bid process if they don't ask the right questions, ask irrelevant questions to the operation, or provide concepts that are difficult to describe or understand. Your experienced process engineers should be able to smoke them out, so make sure the integrator speaks the language, understands your pain, and provide a solution to solve the problem. Selecting a project for automation is a task that often requires significant process knowledge and an understanding of manufacturing techniques.

Keys to Success

Research

Allow ample time for your Process Engineers to develop an understanding of current and emerging technologies related to the desired solution then listen to your Engineers' recommendations!

Develop Internal Robotic & Process Knowledge

By far, the most successful users of automation, especially automation that encompasses difficult processes such as welding, are those users that embrace the technology. Having been involved in the conception, design, implementation, and integration of hundreds of complex automation systems, I can assure you the period between final system debug and production launch is the most important, yet it is a commonly neglected aspect of the entire process. It is recommended during this phase of the project that the integrator and customer collaborate and learn the unique challenges that span from the upstream fabrication operations through to the completed weldments. The upstream processes may involve outdated technology, manual processes, and significant variability that all culminates at the robotic welding station where the expectation is that the automation will cope with the same level of variability as a human, but with improved quality output, this is a common rookie mistake.

In a perfect scenario, the integrator will learn the production process from the manufacturing experts and the manufacturer gains automation experience and knowledge from the integrator. In many cases, however, the integrator is relied upon to process the parts, perform the programming and process development, and run the system off with hopes that the customer's expectations have been met. This approach results in diminished sustainability of the process.

Take the extreme example of a company that does not understand the large-scale benefits of automating their operation; the "Anti-Technology" manufacturers that are afraid of automation taking jobs away only to maximize the profits of the corporation elites. Adopting the technology is the only path to sustainability.

High Mix, Low Volume

In the traditional sense, automation was only commonly applied to repetitive work and high-volume applications. As we continue to refine product designs, manufacturing techniques, and develop clever part handling/holding solutions we have created a new outlook on what automated solutions are capable of.

Automation systems including the flexibility of producing High Mix, Low Volume, and quick changeover are enabling manufacturers to fully realize the “made to order” concept. However, this concept requires significant work on the part of product engineering, flexible tooling, and highly experienced integrators. In many cases, existing product design and manufacturing techniques will need to be modified to accommodate a large variety of shapes, sizes, and options to be manufactured on a common platform.

Modern Techniques for Robotic Welding

Process Application Toolbox

- Offline package
- Process component capability and flexibility
- Design and build capability
- Heavy welding package (when applicable) - Root pass memorization, multi-pass, adaptive tracking
- Sensor technology - seam tracking, touch sensing, spot laser, vision



Offline Programming

Most robot OEMs offer offline programming software that can be used for just about any application however, robotic welding is an application that becomes extremely useful over other applications for several reasons. First of all, robot programmer safety is significantly improved, especially for large systems and components as the programmer is no longer required to spend long hours holding a teach pendant while hanging off ladders, man-lifts, or platforms to access the weld paths. Programming can be done prior to system delivery during the integration process and concurrent to ongoing production. Integrators with strong process knowledge also incorporate proven welding procedures directly into the offline program as they generally work directly from the weld drawings when programming in order to make sure the welds are the correct length, size, and location on the part.

Sensor technology is used in many forms to enable the robot system to weld under variable conditions that a human takes for granted. Part variation, fit-up, thermal distortion during welding are just a few factors that sensor technology can be used to overcome variability either prior to welding or during welding. Tactile sensing with the welding electrode or gas cup and laser spot sensors are often used to displace the program path prior to welding where through the arc seam tracking and optical profiling sensors can be used to maintain the proper tool center point to weld seam relationship during the weld. Vision is generally used in robotic welding for small weld joints that cannot be tracked with conventional through arc techniques or in heavy welding where tracking, multi-pass, adaptive volumetric fill of groove joints is necessary.



Wrapping Things Up

Rely on your integrator to recommend the best robot brand and combination of sensors for the application. Just about every robot brand can be used for single pass welding but in the case of heavy welding, offline programming, and sensor integration capability, not all robot brands are equipped to accommodate the unique demands required for multi-pass, heavy deposition applications. The top contenders are outfitted with simple instruction sets and user interface that allow the programmer to easily select, setup, and employ any of the adaptive technology required to cope with heavy deposition.

In this piece we addressed the fact that sourcing relevant technology, process capability, and automation expertise can be a daunting task. Hopefully we have provided some insight on finding find the right automation partner to assist you with the entire process.

About Midwest Engineered Systems

MWES has been integrating welding system and many other forms of state-of-the-art automation equipment for manufacturers over the last 25 years. Our philosophy is to design an integrated system that meets a customer's current needs while accommodating future capabilities and growth. Our extensive industry experience, broad range of product knowledge, and customer-focused approach make Midwest Engineered Systems Inc. a leading supplier with a solid reputation for quality, service, and value.

Need more information regarding your welding application? Contact MWES to review your specific requirements, help you determine what equipment would be the most successful, and get a custom quote.

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