Hypertherm®

Offline robot programming software: the differentiator in robotic thermal spraying

White paper

Abstract

The use of robotic automation paves a path towards increasing productivity and output quality, while reducing costs and time to market. However, the adoption of offline programming software, allowing manufacturers to get the most out of their robotic investment, is the differentiator.

Article

Background

According to the Modor Intelligence report, the global thermal spray market was valued at just over 9.8 million USD in 2020 and is expected to grow over 2% by 2026. This growth is expected to be driven in part by an increased usage of thermal spray coatings in the aerospace and oil and gas industries.

It comes to no surprise that these two industries dominate the thermal spraying space. This process is commonly used to enhance a component's performance by improving wear resistance, corrosion resistance, or enhancing its thermal resistance properties. By leveraging different coatings, the longevity of components is increased and allows them to better withstand the environments and forces they are exposed to. Thermal spray coatings are not just used as part of the production process of new components, but this process is also extensively used to repair old components.

Although in recent years, the aerospace industry has taken an economic hit, an increase in demand is expected for commercial airplanes as the economy bounces back as business and leisure travel returns. This rebound is continuing to drive the production of aerospace components, including the need for thermal spraying.

Similarly, the oil and gas industry is seeing a rebound as the COVID-19 pandemic has accelerated the pivot to new energy sources. The exploration of unconventional gas resources requiring new technological advancements in the equipment used in this industry is a driver of growth while also making it a very competitive marketplace.

As growth in the use of thermal spraying is expected to continue, manufacturing organizations are looking for a way to increase the quality of their components, reduce costs, and increase efficiencies, all while reducing the time to market and keeping up with market demands. The use of automation and robotics paves a path towards those goals, however, the adoption of offline programming software that allows manufacturers to get the most out of their robotic investment is a major differentiator.

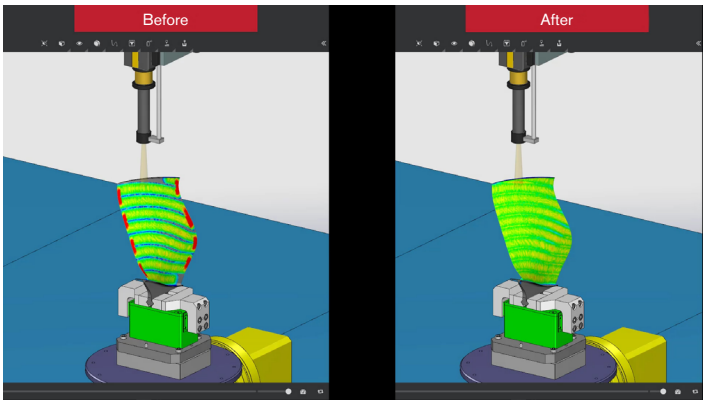
Quality

In the oil and gas and aerospace industries, especially, the quality and accuracy of components are of utmost importance. Achieving a consistent coating when thermal spraying is a critical requirement, and can be a challenge depending on how the robot is programmed.

When programming a robot manually, the user needs to maintain a consistent distance between the spray gun and the part, ensure the step overs (amount of spray overlap between passes) are consistent, and, even more challenging, maintain the spray gun at an angle that will eliminate bounce-back which is extremely difficult to do by eye.

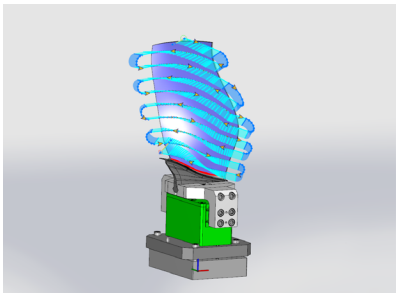
Robot programming software is available in the market to eliminate the challenges that come with manual programing; however, not all of them can take process-specific parameters and apply them to the generated robot program. With offline programming software, like Robotmaster®, users can define process-specific parameters such as deposition speed, flow rates, step overs, stand offs, and spray angle based off the CAD model of the part to achieve the desired coating thickness consistently over the entirety of the component. Intelligent and powerful programming software is also capable of demonstrating a simulation of the process prior to running the program in the real-world cell. This is a powerful validation tool for the user to see where the software predicts there will be a lack of coverage and corrections can be made.

Robotmaster®



Robotmaster spray simulation visualizes the process output allowing for adjustments before production.

Another challenge when it comes to component consistency is the variability in finish that is output from varying manufacturing locations. Each location might output different coating qualities or finishes as a result of varying robot programmers. A flexible robot programming software is able to take the same program and adjust it based on varying robot cell layouts. The result is the program is created just once, and then shared with the different locations to use in their facilities to achieve consistency and reduce the amount of programming time required.



Visualization of the spraying toolpath within Robotmaster.

Manufacturers, like McStarlite, who produce some of the largest, most complex sheet metal components for the aerospace industry, leverage an offline programming software solution to program their industrial robot arms to achieve consistent and accurate finishes.

"Automation is something we had been wanting to do for over a decade, it's a lot of planning and CAPEX, however, automation and the use of an offline programming software standardizes the finish, the consistency, and improves our cycle time."

Saravanan Rajaram,
Mechanical Engineering – Quality Assurance,
McStarlite

Using a high-quality offline programming software is a differentiator when it comes to the quality achieved with thermal spraying. Process-specific parameters can be defined and input into the software along with the CAD model of the part, the process simulated to ensure the desired results are achieved, and optimized, error-free, and ready-to-run robotic code is generated.

Cost

The cost of scrap, rework, robot downtime, and long programming times are some of the operating costs that surface as a result of manual programming that can be easily eliminated or reduced by adopting an alternative method of programming.

The increase in cost of material is impacting manufacturers in all sectors. This increase either impacts revenue, as it cuts into sales margins, or results in an increase in price. The additional pressure to keep material costs at a minimum highlights the importance of running production with minimal waste.

Additional rework not only slows down production, as an additional process step is needed, but also requires additional machinery, labor wages, and consumables. This is another area of opportunity for a reduction of costs.

Robot downtime is one of the most impactful operating (or should we say lack of operating) costs a manufacturer can incur. Robot downtime is the period of time during which a robot is idle when it could be in production. This most commonly occurs when robots are programmed manually, using a teach pendant method. When using a teach pendant to program industrial robots, the robot is required to be taken off production and to be taught the program point by point. This can be extremely time consuming – taking up hours or even days to do, during which time the robot is not performing any productive function.

Finally, manual programming can be a very tedious and time-consuming process. The more complex the part the more challenging and time-consuming the programming process is which means the more time your (already limited) skilled labor force has to spend programming. Rather than incurring additional monetary costs, this is an "opportunity cost" created by your programmer's inability to work on other tasks during the time it takes to program the robot.

These operating costs can be reduced through the use of an offline programming software such as Robotmaster. Scrap and rework are minimized as the process parameters are set within the software to achieve the desired coating. The process is visualized and simulated prior to loading the program onto the robot, allowing the user to resolve any errors and inconsistent finishes prior to running the process in the real-world environment. Robot downtime is essentially eliminated as the program is completed entirely within the software. Once the program is created and validated, it is ready for production. The robot remains in production, generating revenue, rather than sitting idle with traditional teach pendant programming methods. Programming time can be cut from days to minutes allowing your robot programmer to focus on other tasks or start programming the next part.

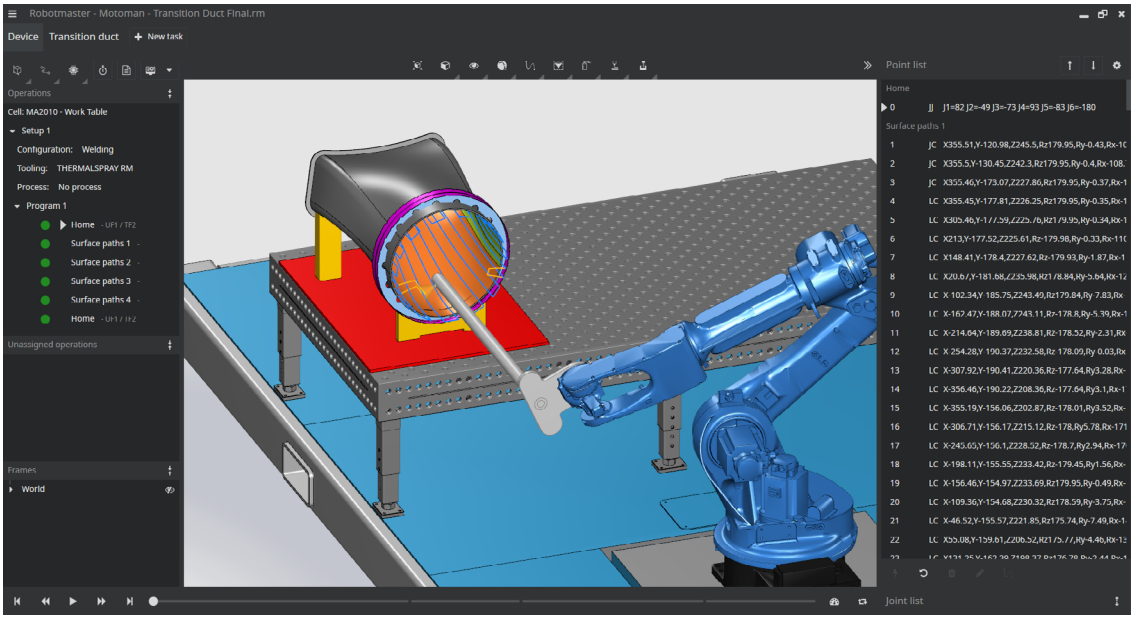
Market demands

Industrial automation delivers the promise of producing more, yielding higher-quality parts, in a fraction of the time. With the mass adoption of automation, the market has shifted to demand smaller batches and a higher mix of part complexities. These opposing needs cannot be fulfilled with manual programming, and thus the increase in adoption of offline programming software, unlocking profitability for high-mix, low-volume production runs.

The mass reduction in programming time, the ease of use of good offline programming software, and the elimination of robot downtime enable manufacturers to meet these market demands. Companies that make this investment are able to differentiate and keep up with the growing demand for more consistent coatings and higher throughput rates while reducing operating costs.

Recent economic pressures have caused a pivot to reshoring. Manufacturers are seeing the need to perform additional processes in-house. There are many offline programming software solutions in the market, however, one that can program all robot brands (ABB, FANUC, KUKA, Motoman, Staubli, Cloos, UR) for all applications is the ideal solution, as it allows for flexibility when adding additional robot brands and manufacturing processes, while eliminating the cost of multiple software solutions and training.

Embracing automation and leveraging software to program industrial robots can transform a straightforward coating shop into a center of excellence for market-ready industrial parts. By using an offline programming solution on top of robotic investments, manufacturers are able to maximize their robotic capabilities. The potential isn't limited to thermal spraying; Smart manufacturing is available from the start of the manufacturing process to the end, with the implementation of offline programming software that can easily take CAD models of the component, generate robotic paths for machining, deburring, grinding, polishing, and spraying applications, visualize the process within the simulation environment, and output optimized and error-free robotic code – all without removing active robots from production.



Robotmaster used to program a Motoman robot to perform thermal spraying on a transition duct.

Conclusion

The use of thermal spray coatings has been around for over 100 years. Over the years this technology has evolved with the invention of plasma spray, detonation gun, and high-velocity oxyfuel (HVOF) coating technology. Until recently, this process was extremely labor intensive when done by hand. Not much before the turn of the century was it that thermal spray robots began to be used in the industry. The next technological advancement in this space comes with digital transformation.

The adoption of high-quality and powerful software technology to program thermal spray robots is crucial to manufacturers who are looking for a way to increase the quality of their components, reduce costs, increase efficiencies, all while reducing the time to market and keeping up with market demands.

The use of automation and robotics paves a path towards those goals, however, the adoption of offline programming software that allows manufacturers to get the most out of their robotic investment is the differentiator.

For more information, visit:
www.robotmaster.com

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