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Robotics

White Paper: Force Control–The Key to Successful Robotic Deburring

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Integrating automation into any industry brings challenges. For the metal fabrication and finishing field, automating an application like deburring has its own unique set of considerations.

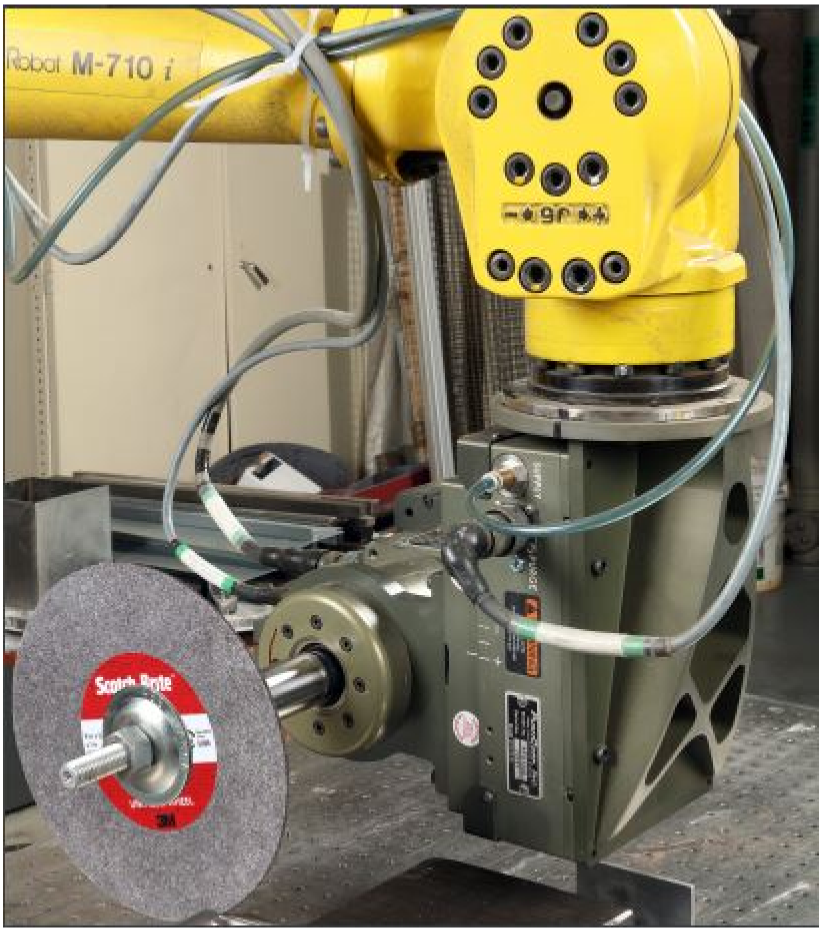
Deburring is not an application that always looks and functions the same. It's ambiguous, nuanced and often perceived as requiring the human touch of an operator. Sometimes, deburring is conducted on hulking objects like a ship hull, while other situations call for the deburring of small parts like orthopedic implants or turbine blades.

Addressing the Challenges of Robotic Deburring

At its most basic function, a robot is designed simply to reach a point in space. We see this in factory automation where repetitive motions like placing an object on a fixed-speed belt is performed by a robot arm that pivots and repeatedly bends over. It moves objects based on pre-determined coordinates, throughout a generally static process.

The challenges that come with integrating robots for applications like deburring include an abrasive's tendency to wear down and change in size and performance over time. Robots that have highly fixed, programmatic movements cannot adjust to the wear of the abrasive—and, in most cases, robots cannot understand pressure or contact like operators who are trained to "feel" the job and adjust force as they go. Robotic integrators, however, are able to add devices with force control and feedback to robotic cells that are designed to compensate for these sensory shortcomings. So, the challenges facing automated deburring are not unsolvable.

When setting up robotic controls for a material removal abrasive process, 3M looks at several factors, including pressure. Ultimately, they've found the key to successful robotic deburring is to design robots with the ability to change their pressure throughout—because, controlled force yields consistent results.



How to Implement Force Control

The term “deburring” refers to a wide variety of applications, including: removing flash from castings, eliminating heavy slag following flame cut, refining very fine edges of turbine blades, radiusing soft substrates like aluminum and plastics, among others. As such, it is necessary to use different force control devices for different applications. Here are two common ways that 3M integrates force control on robotic systems:

1. *Mount the force control device between the robot wrist and tool*

This method is ideal for situations where the robot is taking a tool with an abrasive to a fixed part. It allows the robot to apply a consistent force as it articulates around the item being deburred; this is used in cases when a part is too large or awkward to bring to an abrasive on a fixed piece of equipment.

1. *Build the force control device into the supporting equipment of the robotic cell*

This implementation is used when the robot presents the part to the abrasive that is run on a separate piece of equipment, such as a floating head back stand or pedestal grinder. The force control device is used with parts that are small enough to be picked up by the robot—such as small turbine blades, orthopedic implants, automotive suspension parts, firearm components, and more. For this kind of system, presenting consistent parts is the key to achieving consistent results.

While some types of equipment have compliance built into them, others (like a basic bench grinder) can be mounted to a force control table or to a pivoting/sliding assembly with a force control device behind it.

Importance of Abrasive Speed and Quality

Whether you've migrated to, or are still just considering robotics, there are other variables that should be considered in addition to force control devices. These include equipment speed, product characteristics and part consistency.

3M recommends investing in equipment that allows you to alter speed as you move through the life of an abrasive. This is particularly important when using abrasive wheels, which change diameter with use. As a convolute deburring wheel decreases in size, for example, its surface speed (Surface Feet Per Minute or Meters per Second) and cut rate also decrease. Variable speed allows you to increase the RPM of a wheel, to maintain performance even as the wheel diameter changes.

*Download a **PDF** of this white paper to continue reading it in its entirety.*

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