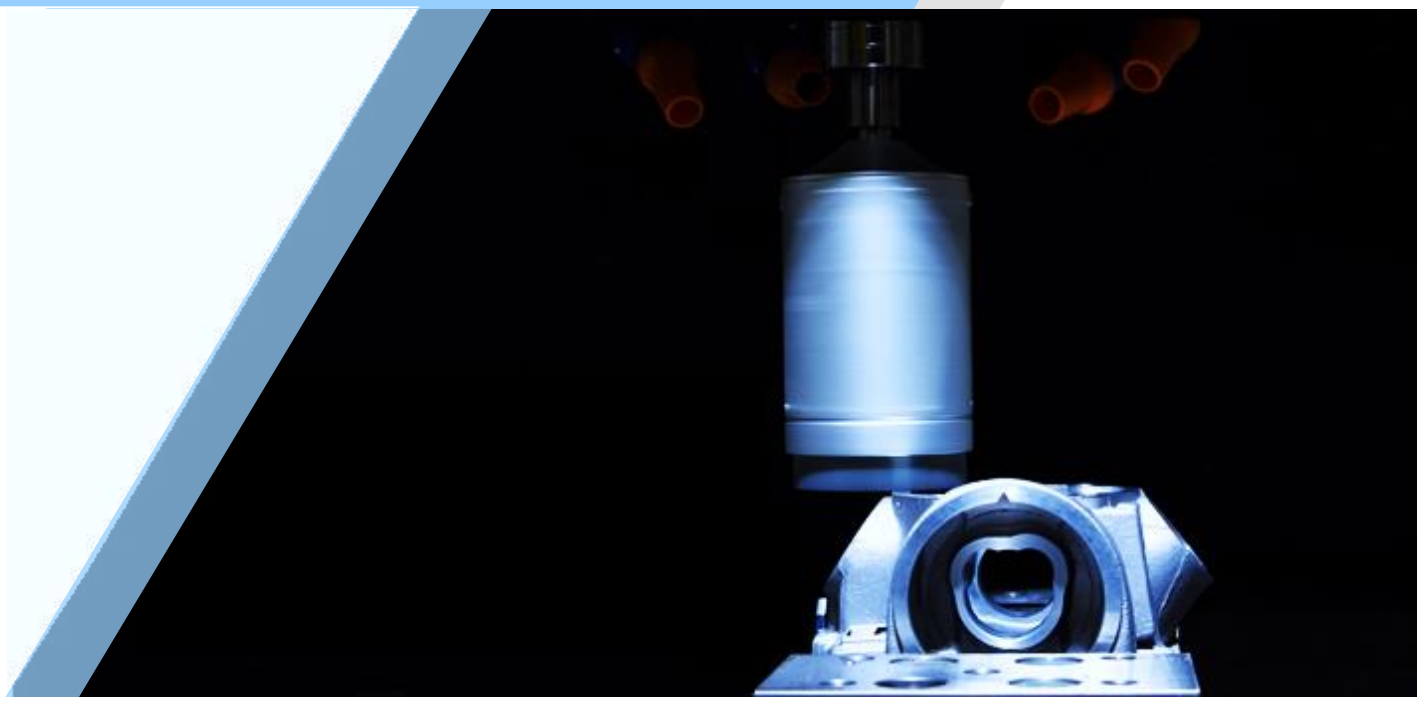
Reliabotics

Automated Surface Finishing

The Evolution of Robot Based Deburring



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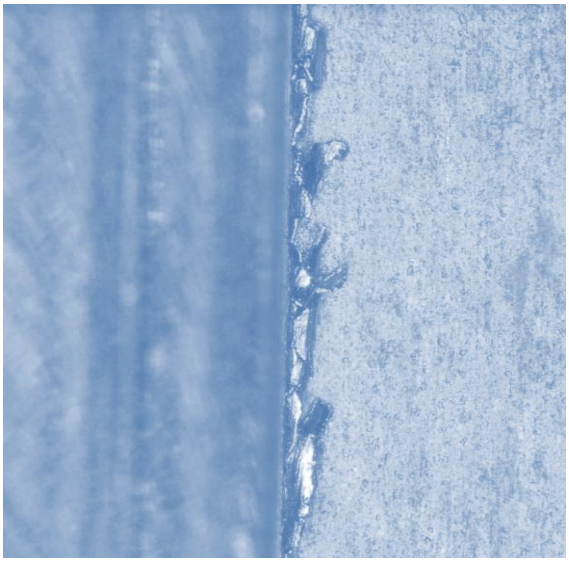
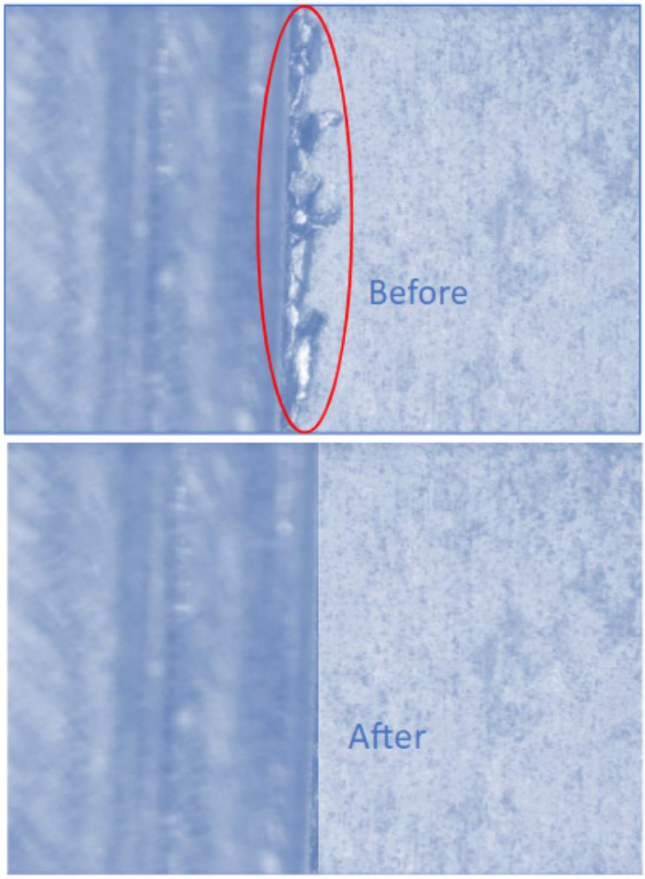
RELIABOTICS

DEBURRING

Most metals will exhibit some form of superplastic deformation during machining, so it's virtually impossible to cut or machine metals without producing a burr. There are numerous types of burrs but most commonly there are two types, one known as entrance burr and the other as exit burr. The entrance burr is where material in the machining process is displaced in the direction of the cut, outward and away from the incoming teeth of the cutter. The exit burr is the type of burr that forms as the tool exits the workpiece. There are others as well, a rollover burrs in sheet metals from stamping, shearing or punching, tear burr, and breakout burr from turning operations. Depending on the size of the mill or cutter, its speeds and feeds or sharpness, these burrs may vary in size from a few millimeters, to several hundred millimeters. While larger burrs may require additional machining or cutting with a carbide burr (a hardened steel, or carbide tool having many spiral flutes) smaller burrs may be deburred by simply brushing the surface with a small pick, file or stone, an abrasive brush or emery cloth. The most common hand tool for deburring is a whirligig, a tool description that describes the free rotation of its knife. This handheld tool has a sharp carbide hook shaped tool that, with practice, will naturally follow the contours of an edge. It's guided by hand and cuts or shaves the edge of the burr as it's cut away into shape. In this process rookie mistakes are common and it's very easy to be over aggressive in terms of pressure and bite angle causing too much material to be removed. An edge that has been improperly deburred with a whirligig style deburring tool will appear bitten or chewed.



Burrs can affect tolerances of fitted parts. Burrs can create risk for human operators who can be scraped or cut on these ragged sharp edges while handling. Burrs can change the way a part can be perceived or performed, and larger burrs can even change the very dimensions of machined surfaces. Deburring is a necessary quality step. Deburring adds value because without it, product quality suffers. Burrs can be found on machined metal parts, stamped parts, flame laser and plasma cut parts and even some machined or molded plastic parts in the form of flash. What is: The need for deburring? What is the overall best deburring method? For discussions, a look back on tool makers and past and modern deburring methods is a good place to start.



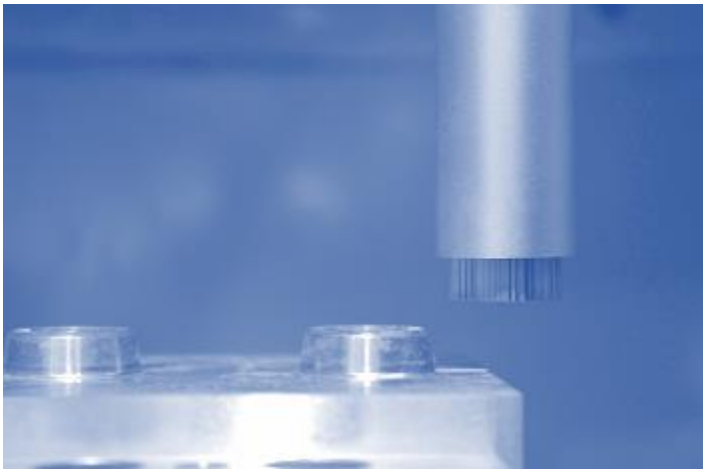
What is the best deburring method?

Most often, the simple answer is, removing burrs by whatever means works best. While this may sound broad, the fact is that any process which removes burrs efficiently for you is a good one. An efficient deburring method can be as simple as scraping off the burr with a knife or file or stone, to very sophisticated methods such as thermal, water jet or even laser. On some parts deburring is very easy by abrasive media tumbling or vibratory methods due to the low standard of finished work, other parts such as high tolerance machined parts need a finer touch and finesse of the human hand and eye.

So, what's needed in today's modern machine shops is a longer-term strategy to recognize potential shortcomings of manual deburring before they become a crisis and develop a long-term automation policy that can supplement your production with methods including automation. A properly executed automation strategy can make a job easier for the operator or replaces them altogether allowing employers to redeploy workers to other areas of production.

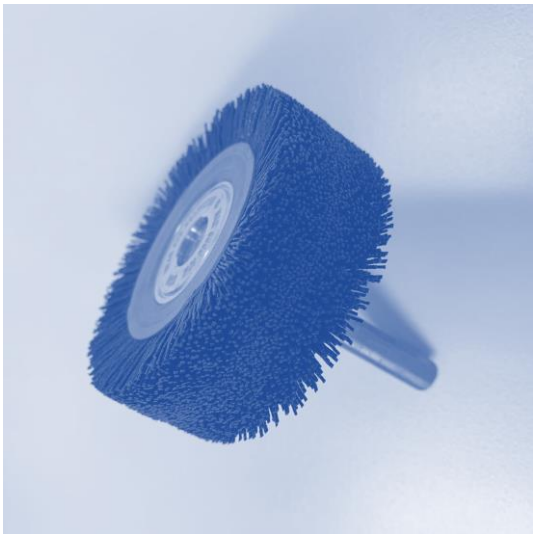
What is the best deburring method?

Burrs can be large or micro-sized, but in most machine-shops need to be removed by hand for proper form, fit, quality and cosmetic purposes. In years past, off-line and manual deburring and finishing was only a small part of the overall cost. However, once CNC automation became well adopted, it follows that the process of deburring has become more of a hardship, and while deburring is still essential for finishing parts, keeping tolerance and maintaining quality or a certain cosmetic appeal, there's no escaping the fact that manual deburring is tedious, dull, laborious or unrewarding work. One customer of ours described deburring as the job nobody wants to do and in one case, told us that the deburring was used in their shop as a punishment for the employees who clocked in late! There is no escaping the fact that workers worldwide have become less interested in doing these kinds of jobs.



Most shops are facing challenges paying higher salaries and finding willing, capable and qualified low-cost workers for these jobs. The only exception we've seen is for areas where higher valued components and deburring work is critical, mandatory and rewarded. It's usually in these higher ends where we can address robotic automated deburring first. Payback for deburring can be particularly attractive, because these parts are done by hand. The trouble with manual deburring is a technique and method driven issue. Methods include automating various tools and techniques that have been learned from decades of experience and on the job training. The arsenal of the precision deburring technician includes, rotary motor driven grinding and abrasive wheels and points, files, stones and knives and other devices. Sometimes the tools may be as simple as a piece of sandpaper or an orange wood stick.

You really can't talk about automated robotic deburring without first exploring your own deburring processes in some detail. There are numerous ways to automate deburring, but the most effective up to date is using abrasive brushes. Although using Nylon bristle brushes for light deburring goes back decades, the newer deburring brush technology is made up of plastic brush bristles that have an embedded abrasive. These style brushes are designed to be used with rotary tools such as angle grinders. It's not an exaggeration to say that newer designs, including those which go in the tool changers of CNC machines have revolutionized machine deburring and granted a level of control that was previously impossible with other techniques. The drawback

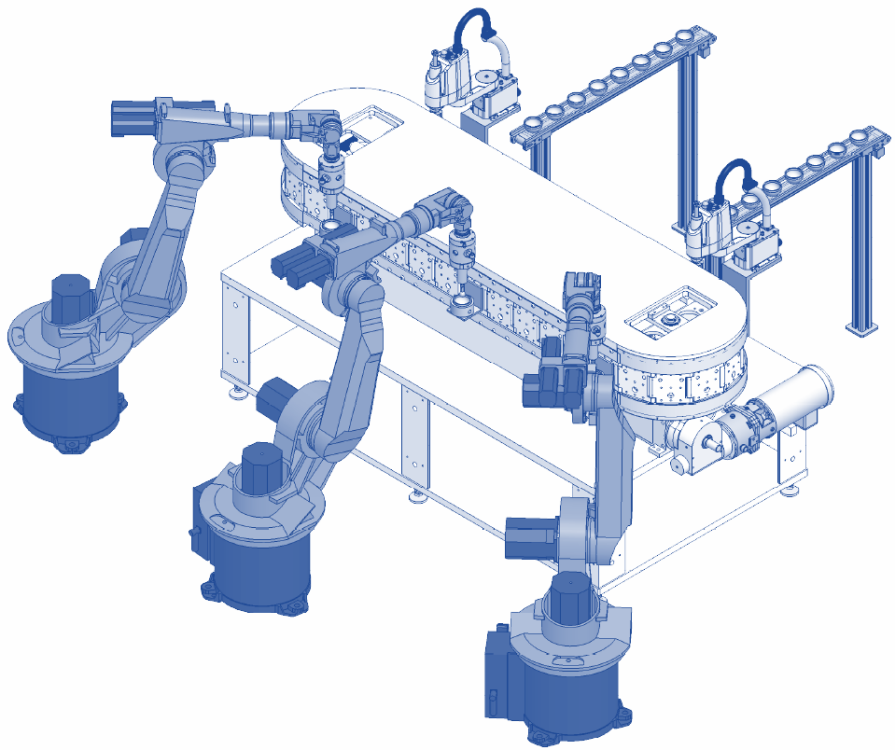


to these brushes is that they are extruded from nylon and other forms of thermal-melt polymers. When used without coolants, excessive speeds and feeds can cause the brushes to melt or otherwise lose their shape.

Modern Day Innovation in Abrasive Brushes

Abrasive brushes have been around for over 60 years, within the last decade, abrasive brushes have found their way into CNC machines as a deburring tool. The form factor of a brush with their stiff thermoplastic bristles impregnated with abrasive is a rather attractive deburring method for robots, but nylon bushes tend to deform if pressed to hard and speeds and feeds can suffer even with the use of coolant. A more recent development is the **ceramic fiber brush** which is molded or pultruded from with continuous fiber. The added advantage of this technology is the ability to customize abrasive grits and grain size. Recently we tested these brushes and found that the particle distribution was so consistent that an automated approach using brushes of this type had the ability to outperform all others. Soon we learned of an additional manufacturer who had an even larger assortment of brushes. The product has a long life and is resistant to heat. That company is Sowa Kasei of Japan. Their product will be marketed in North America trademarked as Stonebrush by Sowa. In Japan, SOWA enjoys a leadership position and their product has been standardized as deburring automation systems by the Japanese and Korean automotive markets. The simplicity of their design allows for a simple spindle-based solution. The brushes are available in sizes from just a few mm up to 100mm or more. Although smaller robots typically use brushes below 25mm.

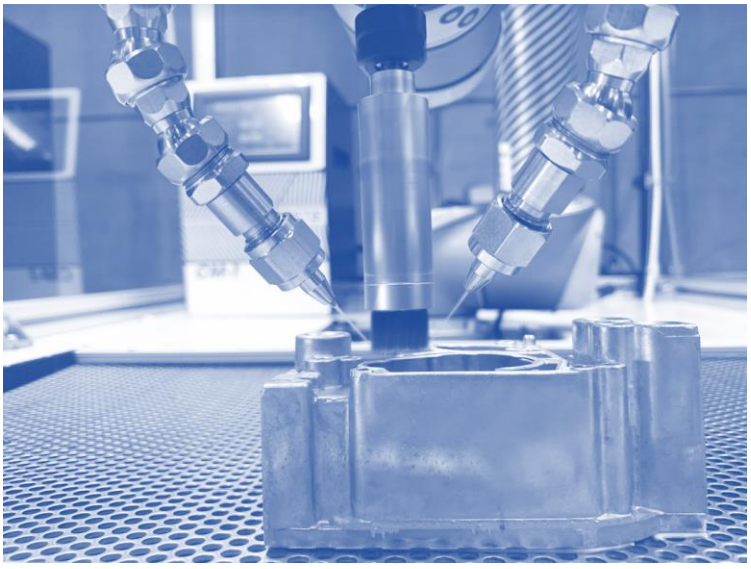
New approaches can also be fortified with old ideas and practices which require a new way of thinking. Getting a customer to think in terms of what can be automated and how, can have its own challenges. A good machine designer is always thinking about payback. How much does it cost to do the operation manually now and how much will it cost in the future? If the customer doesn't automate it today. Will labor costs be rising, will labor still be available? Will unforeseen events such as geopolitical instability, pandemics, political changes affect the possibility of being unable to complete this operation? These are all things to be considered.



The reasons to automate are just as many as the reasons not to automate. A good designer understands that "not everything can be automated should necessarily be automated". In other words, don't buy automation for the sake of automation. A better approach would be to look at the current process, explore the pain points with management and ask questions. A good outline for this would be to start with, how much does the process cost me now? What are the long-term risks if I don't automate? Some of the answers may be obvious. If I don't automate and my competition does first, will my costs lose a competitive advantage?

Humans are generally more sensitive to process expertise and nuances of production, robots and cells have evolved with numerous new technologies designed to help the automation approximate human motion, touch sensitivity and even vision feedback. High competition due to lower labor cost areas like southeast Asia has taken its toll on volume manufacturing in the USA. The type of work that is still being done domestically, for example, is either dwindling, lower volume production work, or the dreaded “high mix-low volume” type of production that makes automation even harder to justify. How many times have we heard, “I don’t make enough of these to find ROI automation?” And while it’s true that without high volumes of parts it's harder to achieve a payback, this doesn’t mean that automation should be eschewed altogether. Lower volume parts manufacturing may require more flexible automation, a better design to help accommodate part setup and changeover, but it can be done. Fortunately, technology is keeping pace and smart manufacturing cells and lines are being developed which can detect when a part is changed, and the line can be reconfigured on the fly to adapt to new parts.

Experts agree, deburring and parts finishing is an area ripe for automation. While modern CNC production machines abound in the average shop and have reduced labor, finishing and deburring are still being done by hand. It’s not unusual to see, even in small shops with several machining centers, 2-4 people sitting at benches deburring and finishing parts.



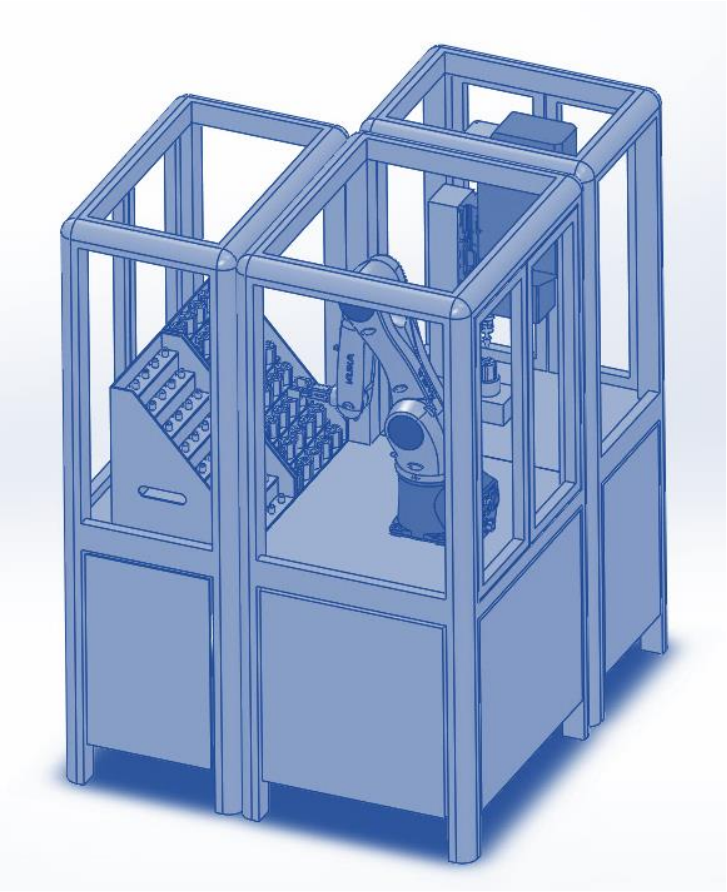
Robot deburring is not new, but it is expensive and rare. For the last 4-5 years it has been hoped that once smart robot automated systems are invented that could take advantage of smaller agile robots and COBOT’ s perhaps everyone could afford

automated deburring. New software and user interfaces are being developed to help eliminate the traditional interdependence on manufacturers and their essential relationship with robot programmers and machine processes. Gone are the days where a customer has an experienced staff of engineers, programmers and technicians dedicated to keeping equipment up, maintained and operational. What's replaced it is machines designed with an emphasis on simplicity of operation and a common skill set. In the past, a customer may have had a team of engineers internal whose job it was to program PLC's, but today we see touch screen interfaces and with big button displays, intuitive pictures, and drop-down menus that simplify the process and make the machine owner less reliant on the integrator except for initial training, total redesign or

reprogramming. Methods, time and motion, the classic industrial engineering terms of yesteryear have been replaced with new terms like "agile manufacturing" and "industry 4.0" Finding deburring automation methods that were easy to automate was elusive at best. Do we outfit the robot with a whirligig, a knife, a deburring tool, a blast nozzle or all three?

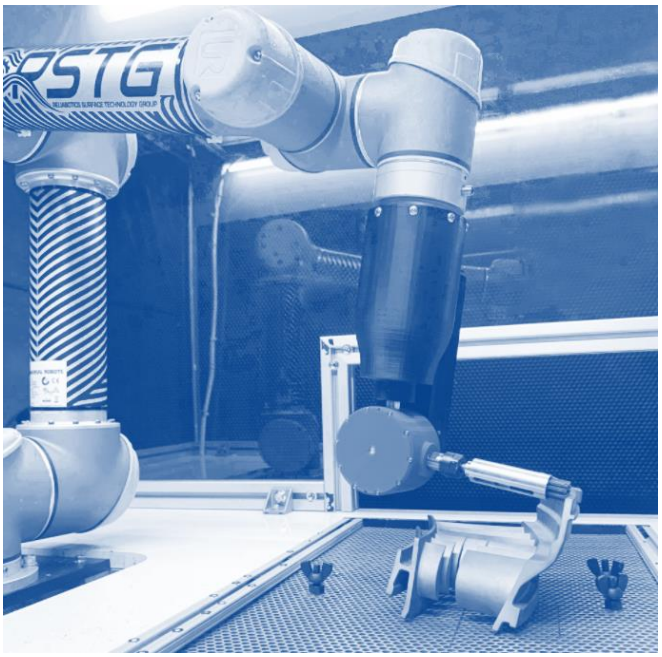
The task we have taken on has become to build a line of flexible Robot Cells designed for today's modern machine shop production. User interface, control panels and software are driven to embrace Industry 4.0 and ease of use. Most importantly we have designed the key components to be easily redesigned for changeover of parts. Flexibility is provided for by changing tools and nests and reprogramming the multi-axis robots. New parts can be reprogrammed within days or sometimes even hours. We also recognize that a well-designed, flexible deburring system needs to consist of more than an enclosure combined with an agile multi-axis robot. What's even more important is deployment flexibility. The agile flexibility to adapt to new parts in the future, added flexibility to carry and bring the new product into and out of the cell. Naturally, appropriately designed feeders, trays, conveyors and tooling all play a role in this. Therefore, most integrators are providing their customers standard robot platforms and enclosures which can back up against each other in an in-line pass-thru configuration.

Today's better designed deburring systems are modular and have been designed to evolve with your production. For example, an early manual system may operate semi-automatically with a simple hand loaded station, but in the future can be outfitted with higher production or automated features such as in-line conveyors, pallet handling, return carousels and the like. The key component of any system is the main process station, whether loaded by hand or by automation, once a part is properly presented to a robot, the work can begin. In the Reliabotics Roboroom family of deburring cells our spindle with a Stonebrush is guided around the edges of the part and the abrasive fibers sweep the



burrs off using their cutting edge. While each product is unique, and many process steps can be added to the program to generate all the motion paths required to finish the work.

With smaller robots and COBOT's hand teaching and off-line programming options make the task of generating new paths off solid models a reality and simple paths for deburring can be generated offline for testing before the parts are even available. In the case of larger parts, the robot cell may be built to carry parts to the abrasives, not the part to the brush. In this case, grippers are developed which can grip and carry the parts to the appropriate stations where finishing is accomplished



Decades ago, the emphasis is was on throughput and speed, but today the emphasis is more commonly on system flexibility. Out of all other deburring tools that can be automated, we have found that these new and innovative Stonebrushes offer the most flexibility and quickest ROI with highest speeds and feeds.