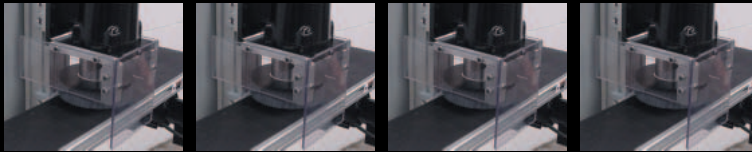


ADVANCES IN TOOLS AND TECHNIQUES HAVE PUT AN END TO THE DAYS OF HAND DEBURRING, WITH NEW AUTOMATED SYSTEMS THAT CAN HELP MANUFACTURERS SAVE TIME AND—MOST IMPORTANTLY—MONEY.

Today's marketplace offers a wide spectrum of needs for all types of manufacturers: from the job shops needing quick and easy changeovers for a wide variety of parts, to those who manufacture the same parts day after day. These parts can be almost anything manufactured, but very common in the mix are gears. All types of gears—from spiral bevel rings and pinions, to parallel axis gears, to internals and worms, among others—are being manufactured. Each presents a different need to complete their deburring process, and it is difficult to incorporate the deburring process into a "one size fits all" machine.

In the job shop arena, more emphasis is put on flexibility. In the high volume production market, more emphasis is placed on hands-off operation and internal machine controls to monitor and adjust machines. This, too, is a reflection of a machine designer's need to compete in a changing world. Gone, or going, are the days of a separate deburring department. Today the part is deburred as the primary machine is producing the next part. With escalating injury claims, operator training issues, and increasing quality awareness, hand deburring is no longer a good option. The only real way we can compete with the low cost labor to the south and the east is by having no labor, thus automation with single operators running multiple machines. That puts a spotlight on the deburring machine—once viewed only as the lowly machine in the dirty corner of the shop—and places it right out in the open, sitting proudly next to the primary machines and an integral part of the day to day

production. In a cell, it is as important as any of the other machines. That type of position



the **BASiCS** of brush deburring

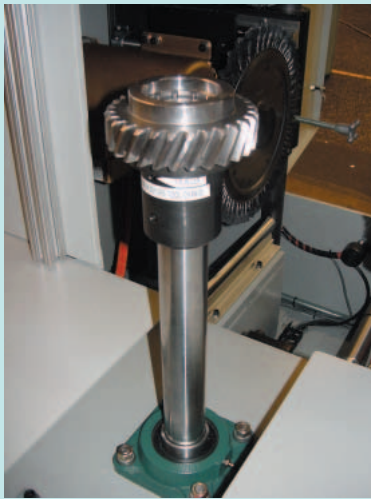
by Eric Mutschler and Marvin Nicholson



places different parameters on us, the machine builders, to meet those needs by providing more self-sufficient, self-adjusting, and simple to use machines without entering the primary machine costs. This is a challenge, indeed, and one involving how to find a way to incorporate an age-old, proven technology of brushing into a piece of equipment with operator friendly set-ups to address today's needs.

Who really plans for burrs? They are typically the last item on the manufacturing list, often not considered until they arrive, and normally minimized. The importance of deburring is only an issue when it causes problems. So the normal channels that a manufacturing engineer may take are to contact a brush company, gather information, and test their parts in the brush company's facility. When a solution is offered, many times there is no feasible way to pull the process into a machine, so something is cobbled together, or the local special machine shop puts together a version of their best shot. As simple a tool as a brush seems to be, however, it is quite complex in its ability to succeed or fail on a given project. Misapplication of either the product or the placement/function of the brush are the typical causes of failure. And today, when cost is so critical, how does the local machine shop know how to properly monitor and adjust the brushes as the process is operating? The ultimate goal of "lower cost per piece" has many facets. Here are a few:

- 1) Proper brush selection
- 2) Proper speeds and feed
- 3) Use of coolant
- 4) Proper placement of the brush relative to the part
- 5) Engagement control/load monitoring
- 6) Keeping it consistent
- 7) Dual Process/use of skiving tools
- 8) Deburring is different from chamfering.
- 9) Easy set-ups
- 10) Zero set-up



Deburring Definitions

What is a burr?: (noun) a rough edge from a machined item. In basic terms, but with so much more variable, one man's burr is another man's extension of the base material.

What does *deburr* mean?: (transient verb) to remove rough edges from machined material. To deburr is an action-taking place to remove the burr.

What does *chamfer* mean?: (noun) shallow angled cut, edge, or groove, usually at an angle of 45 degrees. In other words, the result.

Why are they different?: The two definitions are as different as drilling and hobbing. They represent two completely different intents, yet the expectation is to achieve both with a single process. You would not expect to get gear teeth from a drill press, so why expect the same from a brush? In some cases it can be done, but consider this: a burr is a variable that changes. The changes are a result of many things, including tool sharpness and material variation, let alone speeds and feed and process methods.

These changes affect the chamfer. If the same process is applied to a part with a sharp cutter, a certain result is achieved. Apply the same process to a part cut with a dull cutter and your chamfer is going to change. To work on the worst case will result in excess use of the tool and, therefore, more cost. Many times two steps are used, where a deburring tool removes the heavy and variable burr presenting a common sharp edge to the bush that can produce consistent results time and time again.

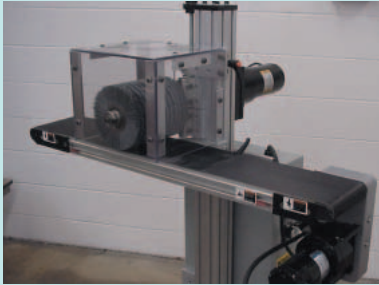
Keep in mind that if the parts are prone to being chamfered properly as they are being deburred, someone did their homework.



Case Studies

Diamet: this manufacturer of P/M components and pump parts used brush deburring to finish their parts. Cost per part was \$.04. They made the following changes:

- Larger diameter brush/same brush material
- Auto Amp Compensation for brush wear
- Pass-through type machine, reduced tooling needs/set-up times.



- Deburred and chamfered top and bottom on a through-feed basis
- Applied coolant
- Variable-speed brush motors

Cost was reduced eight parts for \$.01.—a 3200-percent savings. The major cost savings were in brush life, which allowed for the operator to have no involvement in making brush adjustments.

Hawk Allegheny: a manufacturer of P/M components. Prior to sintering, the parts have a mold line or a burr on the tops of the parts causing sharp and rough edges. These are removed using vibratory machines. Problems include rust, damage from parts contacting, and slow cycle times. Single-part processing is not possible, as this is a batch process. Over-deburring or under-deburring is also a concern. They made the following changes:

- Installed small through-feed machines at each press
- Green parts travel past a slow rotating brush, eliminating the burr
- No additional handling is required
- Brushes last 1,000,000-plus parts due to the green application
- Total elimination of an entire process and associated concerns

Martin Sprocket: manufacturer of sprockets in high volumes. Method was manual, using a grinder to remove the burr and a brush to smooth out the sharp corners. Dirty, hot, and inconsistent at best. Many injuries and part-quality issues. Plant bottleneck area. They made the following changes:

- Installed a machine to dual-step the sprocket
- Rotate the part in an enclosure

- Apply a sanding station for heavy burr removal
- Apply a large bush for slight edge break
- Tools lasted longer as they were controlled
- Quality, productivity, and injury record was improved
- Eliminated the bottleneck

John Deere: manufacturer of off-road machinery and gear-ing. The concern was the large variety of deburring methods and machines in the plant. There was a large learning curve, and lots of spares to keep. Many of the same types of gears were deburred in many different ways. Cellular concepts were introduced, and a solution had to be found. They made the following changes:

- Installed machines that allowed manual or robot loading
- The machines eliminate the subjectivity and variables
- Part is placed on the spindle and is completely deburred with no flipping
- Set-up is a five minute procedure. Zero set-up makes it a one-button step
- Brushes are monitored and adjusted, with actual loads being the data collected. Brush life is into the tens of thousands of parts
- Rugged proven longevity and easy maintenance

The results are a dozen machines using common parts and set-up procedure replacing a wide variety of all types of machines. The cost savings are impossible to calculate.

Tailored Tools

The greatest challenge a builder has is to provide the user with a feasible solution. Many times when a brush is mentioned as a solution, the user has already tried them and it

didn't work. The builder must then qualify the needs of the user and determine what the best method is to achieve the goals. There are several goals to consider:

- 1) Process: it must work
- 2) Price: it must be affordable
- 3) Cycle time: it must make enough parts
- 4) Fit: it must make sense to the user

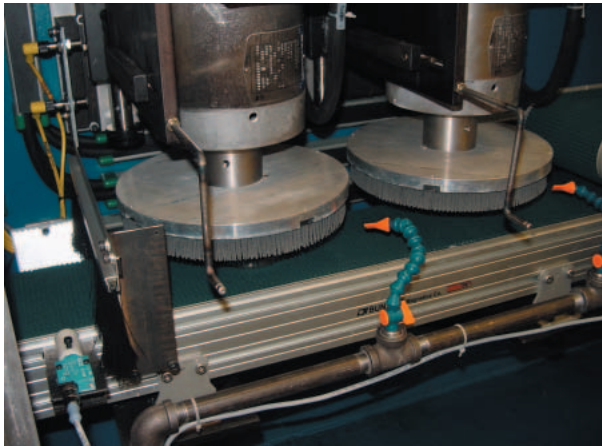
All things begin with the proper brush being applied to the part, resulting in a favorable outcome. This is the critical step and must be demonstrated so the user has confidence in the process. Seeing is believing. Once the best solution is found, the next challenge is to package it properly. It must fit into the scheme of the user's plant and needs.

The largest benefit of brushing as a means of deburring is likely to be in the training aspect. Since the set-ups are typically very straightforward and


designated, no real subjective positions can be achieved. This protects the process and makes the operator more productive overall. The typical learning curve is hours versus days, as in some other operations.

Replacement Brushing

Many brushing machines are in use from the early days. These are typically large and heavy units still in operation after 40 or 50 years. The downside to these older machines has to do with the control capacity and the efficiencies of operation. Today's motors operate on much less electricity, and the use of variable-frequency drives allows the brush to be easily tuned in to optimum speed for best performance. This task was achieved only by the use of pulley changes, resulting in hours of time. The adjustments were all manual, and little consistency was offered. Some of the machines had brush wear adjusters, but were based on cycles and were



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not accurate. Most were open and unshielded, as the use of deburring departments was popular. And, as time passes, many older machines become obsolete as the parts supply vanishes.

These users are aware of the brush process and how it is used. The benefits of new technology are endless, but some stand out as high points:

- Same rugged frames and mechanical features as the older machines
- Auto Amp Compensation for unattended brush wear compensation using actual loads
- Small enclosed machine for safety
- Large access opening for set-up, brush change, maintenance
- Dust collectors integrated into the machine
- Coolant contained within the machine enclosures
- Automation allowing all types of possibilities
- Control packages to suit everyone

For the builder, it is a benefit to work with customers who are familiar with

brushes, since they already have a working knowledge of their use.

A Sample Scenario

Imagine this scenario: sample parts arrive at the builder's facility with worst-case burrs. These are preferred by the builder. A finished sample of what is acceptable by customer requirements is usually enclosed as well as a "target" of what to accomplish. The part is evaluated in several ways, ranging from burr severity, finish requirements, and available media to achieve the results. The part is then tested using what is determined to be a good starting point. This starting point considers all of the customer's goals so that the test can be converted into a machine.

Several samples are then developed and submitted to the user for review. Comments are made and, depending on the results, a machine form is conceptualized. The user approves the final design. It considers that brushing is not a clear-cut science, and it therefore

allows for everything that can be variable to be so. These variables include:

- Part rotation speed or through-put speed
- Brush speed
- Brush direction
- Part direction
- Brush engagement
- Length of time the brush spends on the part
- Brush type allowing varieties to be used
- Coolant flow

The final design is then placed into a package that becomes the user's machine. A lot of specificity is considered in the end result. Any of the stated variables that remain fixed can be the difference between failure and success.

Recent Developments

The Zero Set-Up Gear Deburring Machine: The elimination of variables is the key goal in this technology, and by making the machine accountable for proper positioning of the brushes



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to the part, all set-up is eliminated. Using four 14" diameter steel wire brushes simultaneously, the work is done very quickly with a single loading. There are three components to set-up with this type of machine:

- 1) Part stop position
- 2) Brush horizontal position
- 3) Brush engagement

Since the set-up of the brush is somewhat forgiving, plus or minus 1/8" in position is normally acceptable. The brushes and the table are positioned using 90 vdc linear actuators. These actuators move the brushes horizontally on the slides so they can be placed as required. Each brush operates independently. The part slide also has the same device setting the location of the part centerline relative to the brushes. Once the proper alignment is achieved, it is recorded as a part number and stored in a database. Also, the quick screen can be accessed and part diameter entered as a bypass to saving a new part. Simply enter the part diameter and the machine adjusts automatically.

The last component to zero set-up is the use of OLS Auto Amp Compensation. This system controls the engagement amount of the brushes as they are working. Feedback is gathered and compared to a preset value. If the chamfer is too small, the number is increased and the engagement of the brush is greater, resulting in heavier edge breaks. The system monitors constantly for change and adjusts the brush as it wears. When the brushes wear out, the brush is changed and

the "new brush" button is pressed. The brush retracts to the "home" position to assure clearance and then begins to rotate. It moves toward the part until contact is made and the desired load is achieved. Once in place, the brush remains there and continues to be monitored each cycle.

Auto Amp Compensation has been proven to double the brush life, or to increase it by 20 percent at a minimum. It works in a continuous and close resolution arena, constantly making small adjustments as needed. This is something that no operator has time to continuously monitor.

Magnetic Belt Through Feed Deburring Machines: Top and bottom face deburring of all types of parts is the goal of this machine. Zero Set-Up and OLS Auto Amp Compensation are both key components on this machine as well. Normally parts that are double disc ground, or milled or turned on both faces, work well. Hydraulic components and pump parts especially work well.

Parts are placed onto a magnetic conveyor and enter the enclosed wet machine. The part is detected and is stopped. A 10" disc brush (cup style) lowers until it makes contact with the part and achieves the preset engagement amount. Once in proper position, the part moves to a second brush station. This is an identical station, with the brush rotation being opposite. The part stops again and the second brush is applied. Once in position, the part moves again. It transfers to an overhead conveyor and is captured with the bottom exposed. Two additional brushes are in place, facing upward



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and contacting the bottom of the part as it hangs and travels past the third and fourth brushes. Once brushed, the part travels through a de-mag station and is finished.

Key elements here are the lack of tooling required, the wide variety of parts capability, and the ease of set-up.

Alternatives


A lot of time has been spent on brushing as a means of deburring gears. There are many other methods to consider based on specific needs:

- Grinding wheel type machines
- Carbide rotary file machines
- Pointing type machines using either round tools or fly cutters
- Clipping type machines
- Thermal deburring
- Electrochemical deburring
- Mass finishing/vibratory deburring
- Drag finishing

- High-volume material displacement machines
- High-pressure water
- Abrasive media honing using high pressure
- Manual

All have pros and cons. All have a place for a certain type of part. All have proven success. The general difference between brushes and all of the other methods described are simple:

- Flexibility
- Ease of set-up
- Simple and safe operation
- Value in capital expense and cost of consumables

To summarize, brushing is a simple process, made so by people who have experience with brush types and machine layouts. We recommend working with a specialty house to develop the proper brushes and the means of presenting the brush to the part, and having a full understanding of the environment which the brush creates will help make your project a success. 

About the authors:

Eric Mutschler is president of On-Line Services, Inc. He can be reached at (216) 472-0200, or via e-mail at eric@olsmachine.com. Marvin Nicholson is sales coordinator and can be reached at (330) 421-0420 or marvinn@olsmachine.com. Visit the company's Web site at [www.olsmachine.com].



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