

# Chamfering/Deburring Still a Player – Now More than Ever

Jack McGuinn, Senior Editor

**Chamfering and deburring have been described as “unloved,” a “necessary evil” and, in fact — “dead.”**

After all, *manual* deburring is still common in many shops. Meanwhile, this is one of *three* articles in this issue of *Gear Technology* dedicated to chamfering and deburring. Invoking Mark Twain, it is fair to say that any thought of its demise is not only premature, but misinformed. Indeed, chamfering and deburring are vital steps in making gears for aerospace, automotive, medical devices and robotics, to cite just a handful. And while smaller module gears are still a sweet spot, larger gears are now being improved by the chamfer-deburr process. Chamfering-deburring is indeed a “necessary evil” in that it can add additional cost and time to the final part. But it also adds something that in today’s manufacturing trumps pricing — *quality*. That quality is why chamfered-and-deburred gears are typically required by many industries.

When speaking of technology, it is useful to understand just where chamfering-deburring has upgraded over recent years. What constitutes state-of-the-art chamfering-deburring? And what, for example, are the cutting-edge applications that require gear chamfering/deburring? Chamfering-deburring is not cookie-cutter; it depends on the manufacturer. Some do both, some do one.

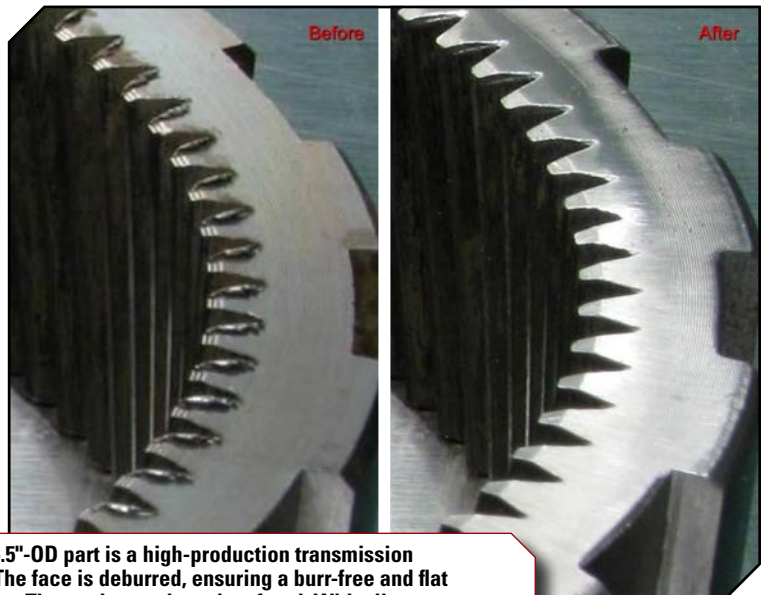
“Since 1980, Abtex has focused on one business, brush deburring,” says Jason Saner, Abtex Corp. president. “For Abtex customers in three major industries — automotive, aerospace, and medical-device — “state-of-the-art” has become the new normal. Technology is advancing so rapidly that our customers are under continual demands from *their* customers to use technology to improve quality and reduce cost. Our primary mission is to support them by designing deburring systems and brushes specifically for their (“exacting”) needs. Recently, a manufacturer wanted a machine that could deburr three gear forms that were roughly similar in geometry. Today’s customer doesn’t want any specific machine that isn’t flexible to the changing demands and uncertain horizon of customer demand.”

At James Engineering Corp. James Richards, president, enthuses over their “patented top-to-bottom MAX system. (This) is a real revolution in chamfering and deburring. The economic benefits, quality of work with zero recall for existing programs, offers customers real financial savings that show up in increased production numbers at reduced operating cost.” He adds that, “Aerospace spells out the size and specific specifications of chamfer/deburring more than any other application.”

And at Cleveland Deburring Machine Company (CDMC), co-owner Adam M. Mutschler says that “I would suspect that (state-of-the-art) is different for each manufacturer. For CDMC, we have been

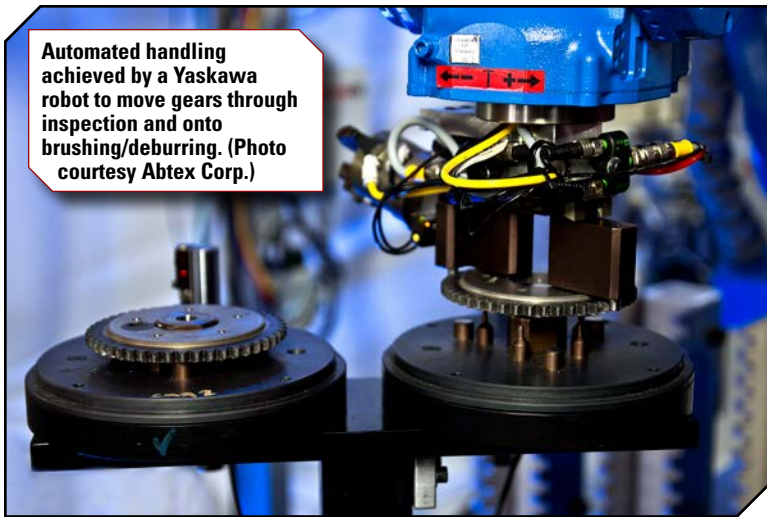
utilizing robot systems more and more frequently for a variety of reasons. The robot controls allow us to program ‘recipes’ for each different part type/size/style/etc. Since the biggest challenge with chamfering and deburring is often setup and consistency, this is a great solution for companies that have moderate-to-frequent part changeovers. Another new development is our single-flank chamfering feature. This combines a servo work-piece spindle and a tooth-detection sensor (that) allows us to chamfer only the areas of the teeth that are necessary. There are several benefits to this feature, and it’s very straightforward to set up and to use.”

Ken Bagdasarian, United Surface Solutions LLC president, points out that, “To date, most manufacturers deburr parts manually, which requires a skilled operator with years of experience. Unfortunately, even that is not enough to consistently produce parts that meet specifications. The problem with manual deburring is that the operator cannot control the amount of material removed and the angle of removal like machines can. These issues are eliminated when using a centrifugal barrel finishing (CBF) systems like ours. Once a process has been developed and part dimensions are set, the units will yield 99% consistency. The CBFs generate upwards of 30Gs, which reduces the deburring and chamfering process down to minutes. The edges are radiused to precise dimensions without inconsistencies. The other advantage to the CBF method is the surface finish; not only does it deburr and chamfer, it refines and polishes the surface as though the parts were plated. The biggest advantage to this method is that the cost of processing them is a



**This 5.5"-OD part is a high-production transmission part. The face is deburred, ensuring a burr-free and flat surface. The tooth was then chamfered. With all costs considered, including the equipment cost, cost-per-part was approximately .02 cents. (Photo courtesy James Engineering.)**

Automated handling achieved by a Yaskawa robot to move gears through inspection and onto brushing/deburring. (Photo courtesy Abtex Corp.)



fraction of the cost when manually deburring.”

Revisiting where chamfering-deburring is most prevalent, at least for James Engineering it's aerospace.” But at Abtex, says Saner, “The vast majority of brushes and systems that we have developed and built in the last five years are all for the automotive industry. We have experienced an increase in demand as a result of the more precise edge finish requirements being driven by the end customers.” CDMC's Mutschler makes claim to “customers in a large variety of fields. Some of these include automotive, heavy equipment and fluid power, as well as several industrial manufacturing companies that produce things such as gear motors, sprockets, aerospace assemblies, etc.

Why, for example, is chamfering-deburring so important in the making of certain automotive-related gears?

“Transmissions in the automotive and off-road industries are becoming ever more efficient and smaller in size,” Richards explains. “As that happens, they need to become more like their aerospace counterparts. This means that we have been seeing the automotive industries, generally speaking, adopt chamfer, deburring, and finish requirements that are much like (with aerospace). This is allowing the components to be stronger, quieter, faster, and more efficient, while reducing failures from things like hanging burrs that fall off (into a transmission, for example) through operation.” Abtex's Saner says that “With rapidly changing competition, constant technological changes, increased safety considerations, and evolving regulatory requirements, it's become very clear that deburring plays a more important role than

ever in helping manufacturers maintain rigorous quality and safety standards. Many of our customers' parts go into transmissions and steering and braking systems in cars and trucks as well as off-road equipment, so the need for precise deburring is pretty much universal.”

At CDMC, Mutschler says they approach chamfering-deburring “as two completely different processes. Deburring is most commonly a functionality issue, where a burr being present could cause issues with assembly, mating surfaces, meshing issues, etc. There is also a safety concern for both handling as well as once the gear is put into the field. In most cases, a

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loose burr being introduced into a working assembly can cause catastrophic failure. Chamfering (when not used specifically for deburring) is beneficial to eliminate and reduce stress points for many applications. A sharp corner will fail before a chamfered corner will fail. Chamfering can also simplify the assembly process in certain applications or allow for smoother operation of an assembly by providing necessary clearance.” United Surface Solutions’ Bagdasarian adds that “All manufactured and machined parts require some sort of deburring. With the addition of surface refinement, the friction on parts is reduced, allowing for smoother operation, increased load capabilities, and increased life cycle.

We asked our contributors what they thought about chamfering/deburring being sometimes considered an afterthought? At Abtex, they turn that around and make lemons into lemonade. “For years, Abtex CEO Mark Fultz has (like perhaps his customers) called deburring a ‘necessary evil’ that’s becoming more necessary all the time,” says Saner. James’ Richards points out that, “In the past it was an afterthought, but now it is engineered into the part. What is still often an afterthought is other areas of parts like snap ring grooves that have sharp edges that need deburring or edge breaking to allow assembly, and were not seen or anticipated

**United’s centrifugal barrel finishing (CBF) systems will yield 99% consistency once a process has been developed and part dimensions are set. The CBFs generate upwards of 30Gs, which reduces the deburring and chamfering process down to minutes. The edges are radiused to precise dimensions without inconsistencies (Photo courtesy United Surface Technologies).**



prior to manufacturing.”

“Absolutely (it’s an afterthought), but it’s getting better all the time,” says Mutschler. “Manufacturers are starting to realize the need for deburring at the beginning of the project as opposed to making it an afterthought. Due to the number of variables involved, a burr can sometimes be hard to predict and even harder to quantify or define.” “Most manufacturers are

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conscious of the need to chamfer and deburr, says Bagdasarian. “However, they are not aware that such high standards can be reached by CBFs, (which) causes them to avoid taking on certain manufacturing jobs and leaves a void in the industry.”

Meanwhile, given robotics’ increasing prevalence in manufacturing, chamfering-deburring has made strides to keep up in one area or another. “Chamfering and deburring is about positioning the tools in a specific 3-dimensional envelope in relation to the part being chamfered and deburred, which is what robots do very well,” says James’ Richards. “The correct question (regarding robotics) is what differentiates a robot from a MAX? Robots have great strengths, but showing what they are great at and why our machines’ address a void in the market is a standalone article by itself.” Abtex’s Saner flips the question: “I’m not sure about deburring’s role in robotics, but robotics’ role in deburring is becoming more common all the time as manufacturers seek greater efficiency. When we bought Nihmble (a robotics company) in 2015, it was with the idea that automation would play a greater role in deburring, and that prediction has definitely come true. Our customers are now looking to automate deburring operations just as they do other manufacturing operations, and we’ve been able to develop robotic handling systems that help — especially by turning parts that have multiple surfaces to be deburred.”

Is there an effective alternative to chamfering-deburring? If so, what?

Richards states that “Every alternative to grinding chamfers and brushing edges, to date, have had their own issues that

manifest into cost-restraints-per-part, or absolutely huge initial cost, and have not become effective alternatives.” Bagdasarian believes that “Robotics may be an alternative to manual deburring; however, even robots have limitations. The tools used by robots cannot reach into tight areas with small recessed sections. CBFs can utilize abrasives as small as 1,000 grit, which can effectively deburr the smallest recesses.” CDMC’s Mutschler’s take: “I do not believe so — at least not yet. There are many steps taken in today’s manufacturing world to reduce or eliminate burrs, or to ensure that if a burr is present that it will not cause a functionality issue (e.g., burr traps in powder metal components). While these are effective at reducing and eliminating *some* burrs *some* of the time, if material is being removed or changed in manufacturing there will be a burr present at some level.”

Not yet mentioned in this discussion — powder metal (PM) and plastic gears. Is chamfering-deburring a player? If so, how big?

“Huge,” Richards flatly states. “Plastic and powder metal parts have one thing in common — they both have multi-part dies. The interaction of these moving parts, which opens the die letting the part out then reclosing and either pressing or allowing high pressure plastic to be forced into the die, causes the edges of the die parts to, over time, regress and allows material to form “flash” on the edges of the part. This process needs to be dealt with in a deburring or chamfering process. Traditionally this has been addressed by mass finishing processes. But when it comes to PM gears the mass finishing degrades the operation tooth face to the point that many PM gear manufacturers are

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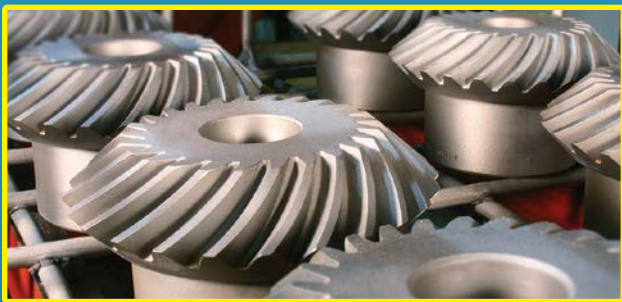
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looking for alternate methods, hence traditional gear chamfering and deburring.”

“PM is a huge part of our business and one of our primary focuses,” affirms Abtex’s Saner. “PM companies continue to push the envelope in geometry and form and we work hand-in-hand with some of the best in the world to develop an appropriate deburring solution.”

Also of interest, how if at all, has the arrival in recent years of especially high-grade steels and other metals affected the chamfer-deburr process? On one hand, Richards says, “Generally, not at all. We have seen the toughest of materials in the aerospace industry forever.”

But at CDMC, “The cost associated with scrapping a part that is made from these materials is much more significant. (On the other hand), these materials are also very well-suited to ceramic abrasive grain, which has become extremely popular in abrasive brushes over the last few years. The ceramic is slowly taking the place of silicon carbide abrasive grain, as it has a higher cut rate and material removal rate. This is especially true when the material is an exotic alloy or a very hard material.”

“In recent years,” says United Surface Solutions’ Bagdasarian, “more exotic materials have been introduced in the industry. These materials are harder, creating a huge issue for the industry. Standard deburring methods no longer work on these materials as they destroy deburring tools. CBFs are un-phased by these materials; on the contrary, they seem to work even better on such materials.”

And what of ISO and AGMA standards. What or how big a role do they play regarding specifications?

Not tipping his cards, Richards says, “I won’t select any organization specifically, but specifications over the years, and what can actually be done, have traditionally had a disconnect. I have had countless conversations with aerospace engineers in particular who have acknowledged the specification on the drawings was not technically possible to perform by technologies at the time. We would joke that the specification-writing engineers needed to actually talk with the engineers that are trying to create machines to perform their specification requirements. The MAX is the first and only machine I know of that can perform the more elaborate aerospace requirements fully in one cycle. This process will be debuted later this year. Sayner’s simple take on it is that, “We are held to the edge callout on the print. It is different for everyone.”

CDMC’s Mutschler says “Absolutely,” to the ISO/AGMA relevance. “Several years ago, we saw many applications for deburring gears that had been shaved. While many gears are still being made this way today, we have seen many gears that are now being ground. This both changes the requirement and increases the need for deburring. Since the grinding process is typically done after heat treatment, a burr could cause excessive wear on the grinding wheels (very expensive). We have also seen a more defined and precise requirement for the size and angle of the chamfer to be applied.”

So where does this leave things? Is there a long-range future for chamfering and deburring?

Richards, James Engineering: “As automotive and trucking remove weight from drivetrains to improve efficiencies requiring smaller, higher-strength gearing, chamfering, deburring,

and *surface finishing* will become mandatory in these industries — just like aerospace. With aerospace adding gear reductions, as Pratt & Whitney has for the large primary fans, that has had a significant energy savings so far. Soon, all will follow — which means a lot more aerospace gears needing processing. Electric car companies — especially Formula E — are only now realizing gear transmissions improve the efficiencies of their product. So hold on... more gears coming.”

Saner, Abtex: “As manufacturers become more creative in machine and part design, it’s incumbent on us to develop even more innovative solutions that will allow our customers to move quickly, efficiently, and economically. We have a unique advantage in being able to design our deburring systems in direct partnership with customers’ engineers. As soon as they know what they need from us, we jump in to design the solution that will best meet — and often surpass — their needs. We need to excel by continuing to innovate even more effective brush designs and even more efficient parts-handling technologies. Fortunately, we’re playing to our strength in both of those areas.”

Mutschler, CDMC: “I think that there are new things being developed all the time. The future will likely continue heading toward more automation, less operator involvement and higher production rates. This has always been the case, and things have continued to evolve accordingly. Every day there is a new program launched for production, and there is an older program that is phased out of production. As we watch these changes occur, it’s important to note the different technology being used in gear manufacturing in today’s world. The future of gear deburring and chamfering will be directly dictated by the future technology used in gear manufacturing. After all, we are in the business of removing what this equipment creates. I once heard a customer say the following: ‘Just like any other process that this part goes through, unless the part is properly deburred, it’s still a scrap part.’ This gives me hope that the last step in manufacturing is beginning to get the respect that it deserves.”

Bagdasarian, United Surface Solutions: “(We have) been on the forefront of innovation for decades. We are constantly challenged to develop processes to reduce costs and increase throughput. United has been designing and engineering the most advanced and automated systems available anywhere. All of United’s machines are proudly designed and manufactured in the USA.”

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