Best Practices to Improve Results in Gear Deburring

Rick Sawyer, OEM & technical business development manager, Weiler Abrasives

All cutting and machining operations produce some type of burr or leave sharp edges on metal components.

These unwanted by-products are especially troublesome when producing precision components such as gears. The burrs can loosen from the gear — either during assembly or later when the gear is in operation — and damage components or lead to critical part failure.

Burr removal and edge prep are important processes performed during the manufacture of gears. These processes improve the quality, performance and reliability of the gears.

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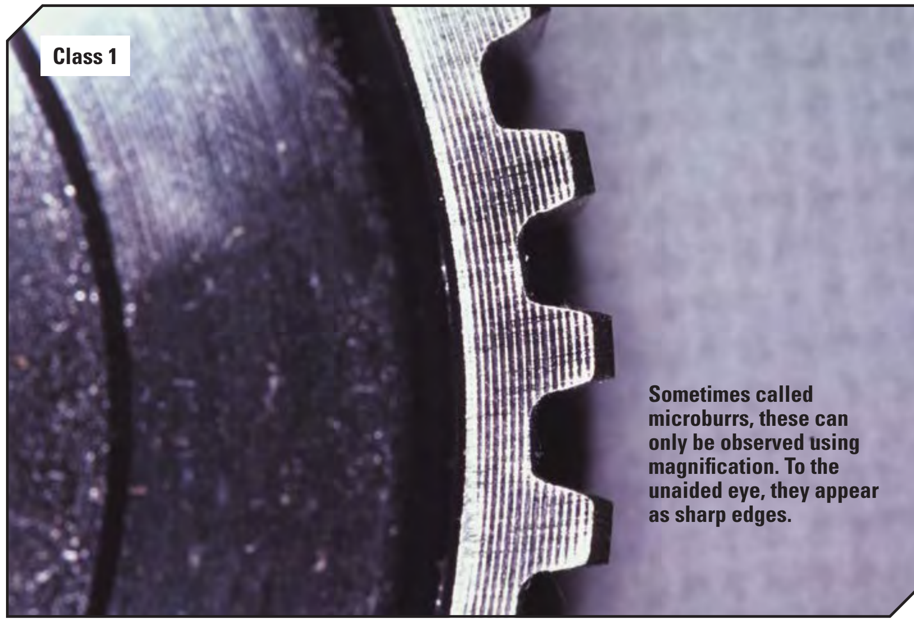

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Why is gear deburring important?

Gear deburring is very prevalent in the automotive industry — especially for large trucks — as well as in the production of agricultural equipment, construction equipment and aerospace components.

Under operating conditions, sharp edges become areas where internal stresses concentrate and failures become more likely. If corners are left very sharp or there's any sort of crack or nick, it will promote failure.

Deburring and radiusing eliminate edge defects, minimize stress risers and contribute to better mesh and lower operating noise between individual components.

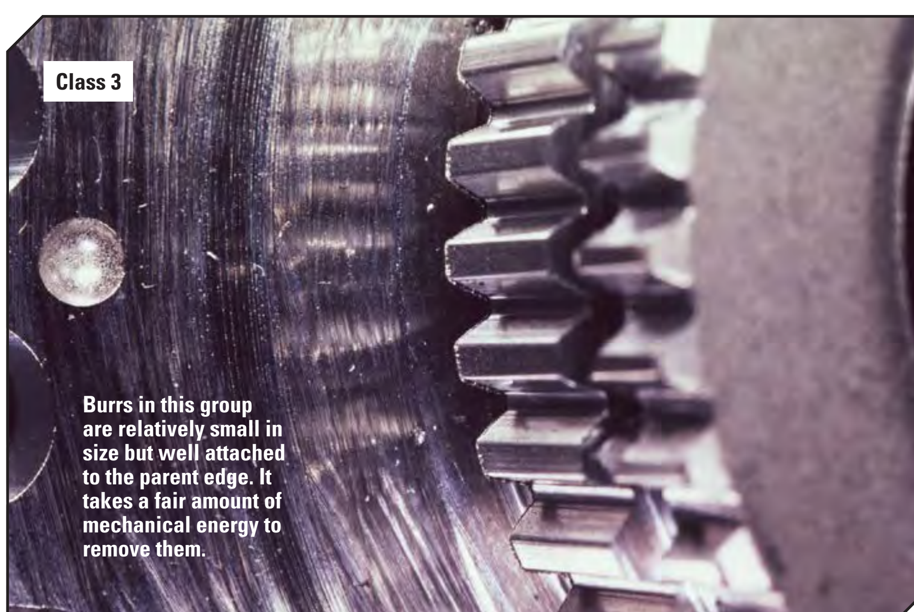
Failure to remove burrs can result in quality issues or potential breakdowns later — often at great expense.

These feather burrs are readily visible without magnification and characterized by extremely thin roots. They can be easily removed.

5 burr classifications

Understanding the size, shape and orientation of burrs to be removed can help in choosing the right equipment and media for the process. Burr classifications produced by common metalworking processes are:

- **Class 1:** Sometimes called microburrs, these can only be observed using magnification. To the unaided eye, they appear as sharp edges. Grinding operations are a common source of this type of burr. Grinding operations are capable of holding tight tolerances while providing very good surface finishes.
- **Class 2:** These feather burrs are readily visible without magnification and characterized by extremely thin roots. They can be easily removed.
- **Class 3:** Burrs in this group are relatively small in size but well attached to the parent edge. It takes a fair amount



Burrs in this group are relatively small in size but well attached to the parent edge. It takes a fair amount of mechanical energy to remove them.

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- **Class 4:** Like Class 3 burrs, these burrs are also well attached. The primary differences are size and root thickness. Because of this, a significant amount of mechanical energy must be applied to remove them.
- **Class 5:** These burrs are very large with thick, rigid roots. Burrs in this class are different than conventional burrs because they are comprised of displaced base material that is still fully-attached to the parent part. Stock removal operations such as grinding or machining are required for complete removal.

The burr's root thickness and how well attached it is to the part are key factors in determining what type of media can be used for removal. The thicker the root (attachment to the part), the more energy it will take to remove the burr.

If an operation is consistently seeing larger Class 5 burrs, it's likely a sign that something should be adjusted upstream in the process.

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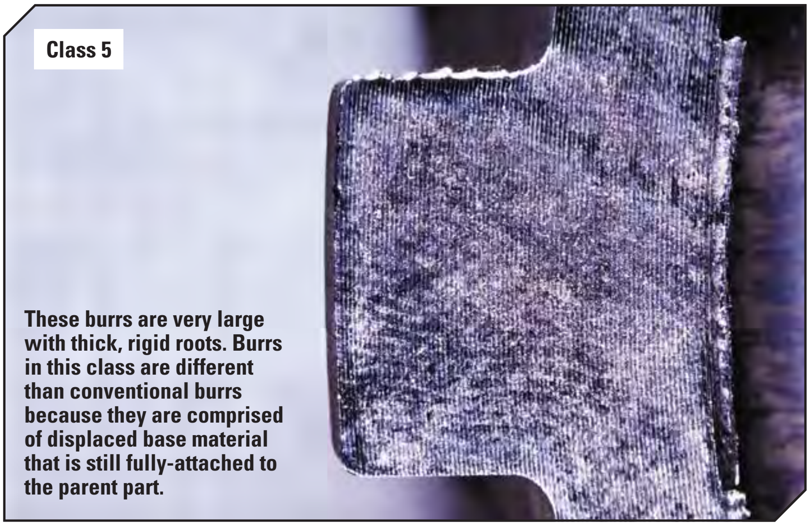

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Filament selection for deburring

Brushes are well suited for removing many types of burrs, as they can be used in semi-automated and fully automated deburring processes.

Brushes offer greater conformability than most media types and don't alter part geometry. The moving filaments of a brush concentrate their collective kinetic energy on the edges of the part. They can remove the burr and unwanted edge defects while blending the edge and maintaining the shape of the gear. Compare that to using a cutoff wheel or grinding wheel, both of which will generate a secondary burr.

To optimize the process, the most important factor is to use the right media for the spindle rpm range and horsepower of the system. In order from least aggressive to most aggressive, the three brush configurations commonly used for gear deburring are:

- **Nylon abrasive filament brushes:** Think of these brushes as a collection of flexible files. Each nylon filament contains thousands of abrasive grains that act as little cutters. Although these filaments contain the same grain types as other abrasive products, the flexible nylon carrier does not forcefully apply them to flat surfaces. However, when they encounter an edge, these abrasive grains act like the teeth on a file, removing burrs and generating small edge radii.
  Due to the flexibility of the nylon bristles, the aggression of abrasive filament brushes can be somewhat limited. Different abrasive grain types and grit sizes, as well as brush media featuring different filament sizes, fill densities and trim lengths, are all variables that can be used to tailor the brushing action to the requirements of the application. Nylon abrasive filament brushes can be used to remove Class 1 and 2 burrs, and sometimes Class 3.
- **Crimped wire brushes:** These brushes use an impact-driven process similar to grit blasting. The focused velocity of millions of sharp wire tips striking an edge within a short period of time strips away burrs and peens sharp edges. Brushes with crimped wire offer a more compliant brushing action than knotted wire. Because wire brushes can focus a great deal of mechanical energy on an edge, they are best suited for removing large Class 3 and some Class 4 burrs. The crimp design is more capable of absorbing geometry changes than the knotted design. One limitation of these brushes is they will likely change surface finish.
- **Knot wire brushes:** These brushes work similarly to crimped wire brushes, but knot wire brushes are not as compliant. The twisted wire strands maximize the impact of the wire tips on the work and can handle larger burrs with a greater root thickness. In higher volume Class 3 and 4 burrs, knotted brushes will typically provide a lower cost per part due to parts per brush and shorter cycle times.

Wire brushes leave a peened or chamfered edge configuration, while nylon abrasive brushes provide more of a radiused edge.

When removing larger burrs with nylon abrasive brushes, it may work best for the system to use coolant. This allows the brushes to be run with a greater depth of interference (DOI) and at higher rpms, both of which increase aggression. Coolant prevents nylon transfer, which can occur when the abrasive filament generates too much heat and melts the nylon to the part's surface.

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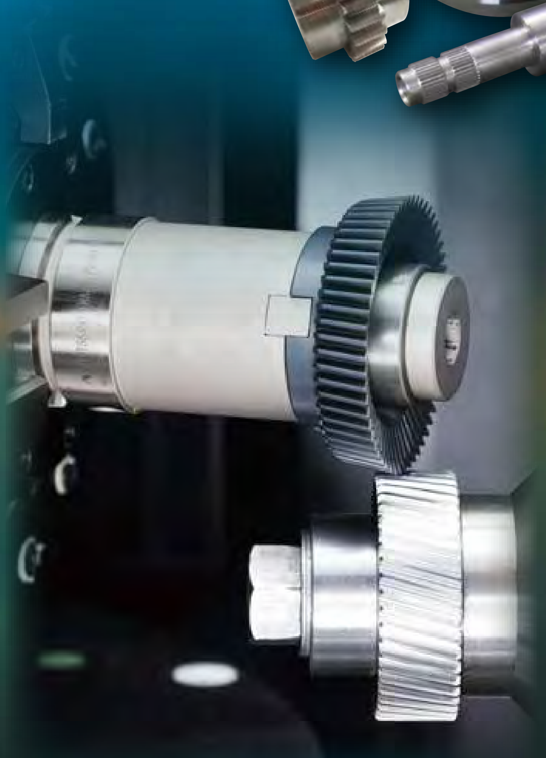

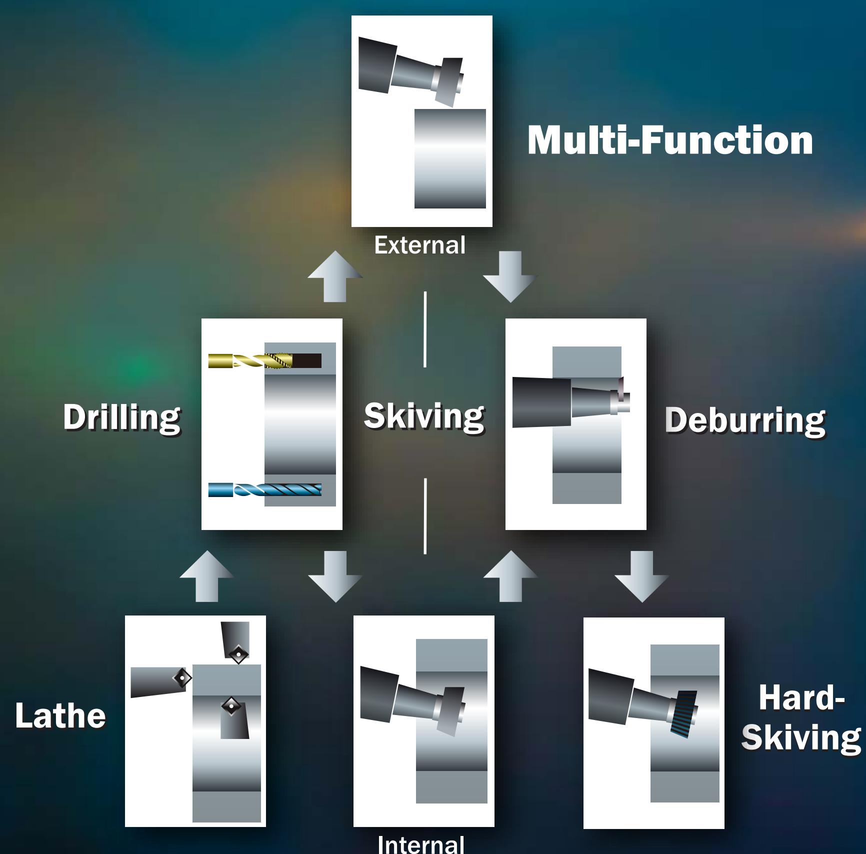

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Best practices for gear deburring

Choosing the proper media for the system and application is one of the most critical factors, but there are several other tips that can help improve results in gear deburring.

1. **Proper orientation.** Burr location determines the proper orientation of the brush to the part. The brush filaments must have direct access to the burr, and the edge must be oriented properly, relative to the direction of filament movement. The biggest factor is to have the brush be as perpendicular to the edge that is being deburred as possible — within 15 degrees plus or minus to 90 degrees for efficient performance. Brush orientation also affects product life and wear. Product life is directly dependent on the amount of penetration into the face (DOI). Minimizing brushing pressure reduces filament fatigue in wire-filled brushes and filament wear in nylon abrasive brushes.

2. **Operating parameters.** Before selecting the operating parameters for a deburring application, determine brush size, since the velocity at which the filaments strike the work is a function of spindle speed and product diameter. Typically, larger diameter brushes are preferred even when dealing with small parts, because they lower the consumable costs per part and increase production stability. A smaller brush will take longer to produce the desired results and require more frequent changeovers. Using a 3-inch brush may produce 100 parts, but operations looking to deburr thousands of parts will find a 10- or 12-inch brush more cost effective. One exception to this is when a small diameter brush is needed to access an edge due to the part geometry. Look for a chart from the brush manufacturer that shows recommended operating parameters for wheel brushes based on diameter and fill material. Wire filled brushes should be used at higher surface speeds with a minimum amount of penetration. Nylon abrasive brushes require lower surface speeds and greater amounts of penetration to allow the filaments to smoothly file across the target edges.

3. **Troubleshoot aggression.** If the recommended speeds and parameters don't work in a particular application, it may be necessary to troubleshoot and increase or decrease aggression. There are several steps that can be taken when the brush is too aggressive or not aggressive enough — both for wire brushes and for nylon abrasive brushes. These options include increasing or decreasing operating speed, changing the type of brush being used, and changing the brush trim length or fill density.

4. **Match equipment to the process.** Don't buy deburring equipment without knowing what the media can do. If the machine is the wrong speed or horsepower, it won't provide full efficiency with the tools. Make sure the process parameters are known before the equipment is purchased to ensure the proper parameters are in place from the start.

Improve performance in gear deburring

Better understanding burr classifications and what products are best suited to remove each type can help improve results and performance in gear deburring operations. Using the right media and parameters for the deburring application will extend product life and improve quality while saving time and money.

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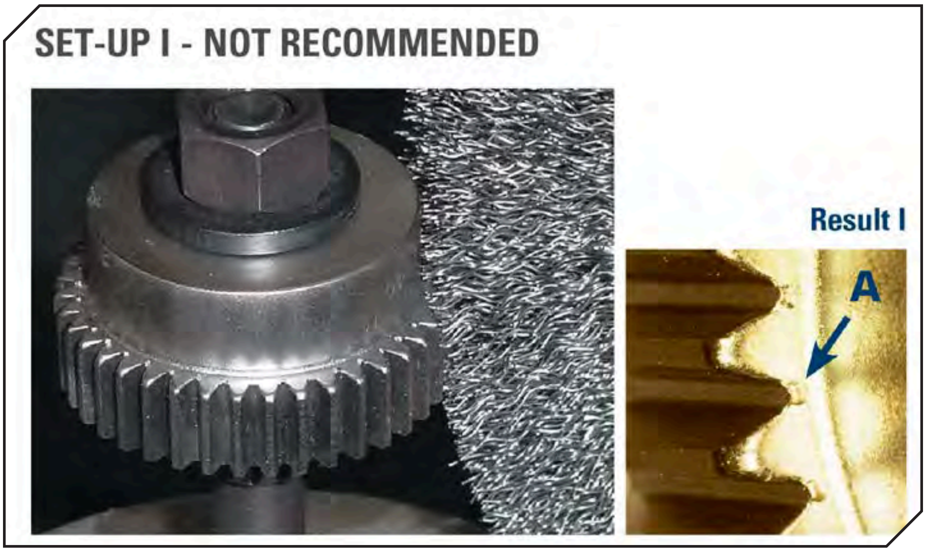

Burr location determines the proper orientation of the brush to the part. Here are examples of improper and proper setup.