End Mill Selection Guide

5 Mistakes That Are Costing You

ADVANCED TOOL INC
END MILL SOLUTIONS

The End Mill Geometry Experts
Customer-Specific End Mill Geometry and Grades Manufactured-on-Demand.
www.advancedtool.com

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#1 Unused Flute Length:

Stop paying for a flute length that is too long. Select a flute length ONLY as long as you need. **This is hands down one of the easiest ways to save money.**

Many times an end mill comes in standard lengths forcing you to have unused flute length. However, reducing the flute length to ONLY what you need will improve end mill rigidity and save you money. Performance is enhanced by allowing more of the end mill to remain intact. Increased core strength improves rigidity and maximizes the efficiency of the end mill, this helps to maintain a sharp edge longer.

A longer flute length costs more to manufacture. Why pay more for a flute length longer than you need?

End Mills With Short Flute Length

Application Specific Length of Cut (LOC) End Mills

#2 Not Testing Material Specific Carbide Substrates:

Not all cemented carbide is created equal

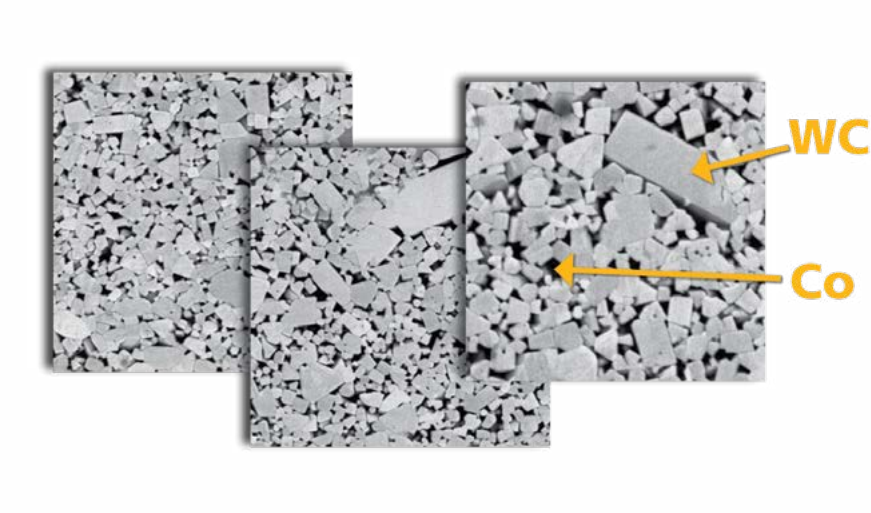
Did you know that **80% of catalog end mills are produced with standard 10% cobalt (Co) sub-micron carbide?** There are so many better options available.

Why should you care?

The cost difference between a standard 10% grade and a premium material-specific grade are minimal, yet the results can yield **up to 30% more production**. Standard material is used because catalog items are mass produced and meant to work in a range of applications.

Balancing hardness vs toughness is key:

Tungsten carbide (WC) grain size plus cobalt (Co) % determines wear resistance vs fracture resistance (image below).



Does It Really Matter?

Yes absolutely! This is where we see the biggest impact on overall cost reduction.

You are already paying for that end mill to be manufactured, why not have it made utilizing the most advanced substrates on the market? Cemented carbide manufacturers are continually enhancing their substrates with new material specific grades.

Smaller grain size / lower cobalt = wear resistant
Larger grain size / higher cobalt = tougher (breakage)

Why Are There So Many to Choose From?

Because just like with anything else, each manufacturer of carbide rod has their own recipe of ingredients, cobalt (Co) percentage, tungsten carbide (WC) grain size, transverse rupture strength (TRS), etc.

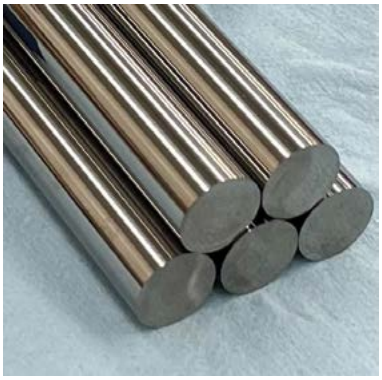
It's no different than putting four five-star chefs in a pasta sauce cook-off. They will all start with similar ingredients, but each chef will use different amounts of each ingredient. They will blend them and cook differently, resulting in 4 completely different tastes. Raw material manufacturing is no different.

Each manufacturer balances wear resistance vs fracture toughness in order to work in certain materials. One grade may avoid breakage but not wear resistance. One may work better when plunging vs side milling. One may perform better in dry machining, and another in wet. There are too many variables to say this is the only one that will work best. Fortunately, there are several options available to improve performance.

Global leaders of raw material include Ceratizit, Mitsubishi, Hyperion, Kennametal, just to name a few. Every manufacturer uses their own material to manufacture their catalog cutting tools. However, each one also has a division of their company dedicated to selling tool blanks to other cutting tool manufacturers. The benefit of using an independent cutting tool manufacturer, is they can offer you any of the above substrate options to test in your production. Whereas, the manufacturer will only offer their own material.

This is one of the reasons why, at Advanced Tool, you will see so many grades available for any one material being machined. **We won't just give you one to try, we'll have you try multiple options based on our Wear Analysis™ report and your exact machining process.**

A customer-specific tailor-made end mill will always outperform a catalog end mill. OEMs and contract manufacturers demand more and understand raw material selected for the exact application is key to better results.



12% Cobalt (Co) Sub-Micron Carbide

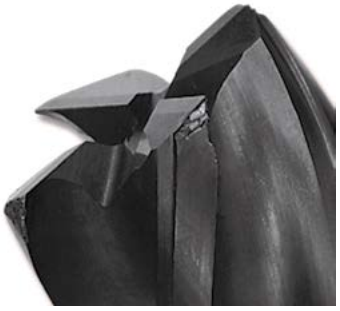
Same Geometry – Three Different Substrates
Undetectable to the Naked Eye

#3 Not Beefing Up Corner Geometry:

Corners are the weakest area of an end mill. There are many ways to improve corner strength, but the key is ensuring what you gain in corner strength is not sacrificed in edge performance for the specific material being machined.

The workpiece material, machining parameters, wet or dry machining all play a role in the options available to improve strength in the corner. If a square corner is needed, a variable helix can improve corner strength. Otherwise use the largest radius your operation will allow.

The higher the helix, the weaker the corner. However certain materials require a higher helix in order to perform. Adjusting the helix angles for the depth of cut can help. You can also adjust the gash, rake and clearance angles to get the least possible corner wear.



Damaged End Mill Corners

Corner Wear

#4 Paying for Geometry You Don't Need:

An end mill is one of the most versatile cutting tools with some of the most complex geometry. Ensuring you are not over paying for what you don't need can be difficult.

One of the most overlooked cost savings is end geometry.

If you're not plunging or end cutting, why pay for end teeth?

Ordering your end mills without end geometry can be a significant cost savings.

Other geometry you may not need:

- Extra Overall Length
- Extra Flute Length
- Neck Relief

End Mills Without End Geometry

#5 Not Using Advancements in Coating Technology:

It's easy to understand a coated tool will last longer. Tool coating adds protection and lubricity to the cutting edge. However, not every coating chamber and process is created equal.

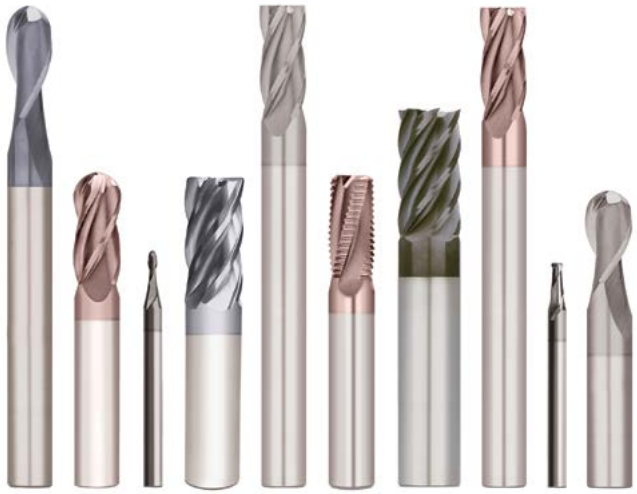
Out of the three components that make up an end mill (substrate, geometry, coating), coating technology advances the most rapidly. Not only does every coating manufacturer have its own recipe, but each has its own process.

It's logical to assume the AlTiN coating on an end mill will be the same as every other AlTiN coating, but it's just not so. There are different application technologies, different cleaning processes and various post treatments. You pay extra for a coated tool, make sure you are getting your money's worth.

Many cutting tool manufacturers with in-house coating rely on older technology. This impacts performance. At Advanced Tool Inc, we've seen the difference. We are always testing one coating manufacturer vs another in head-to-head testing. Results determine the winner. We collaborate directly with the manufacturers to craft the perfect chemistry, hardness, thickness and finish for optimum cutting performance for the application at hand.

Things to remember when selecting a tool coating:

- Try not to get obsessed with the "hardness" of a coating. The hardness of a coating is not the same as the toughness of a coating.
- A silicon (Si) doped coating has better abrasive resistance and helps deflect heat, however, silicon can also make the coating more brittle. Silicon (Si) also gets tougher (not harder) as it heats up. Toughness impacts breakage. You need RPMs here to generate heat to prevent brittleness.
- Coating thickness: it is assumed a thin (1-2 micron) coating is best for micro diameter tools (diameters under 1/8"). This is not always the case. We have found in certain applications, including general steels, a 3 micron coating can work better.



Summary: End Mill Selection Can Be Frustrating

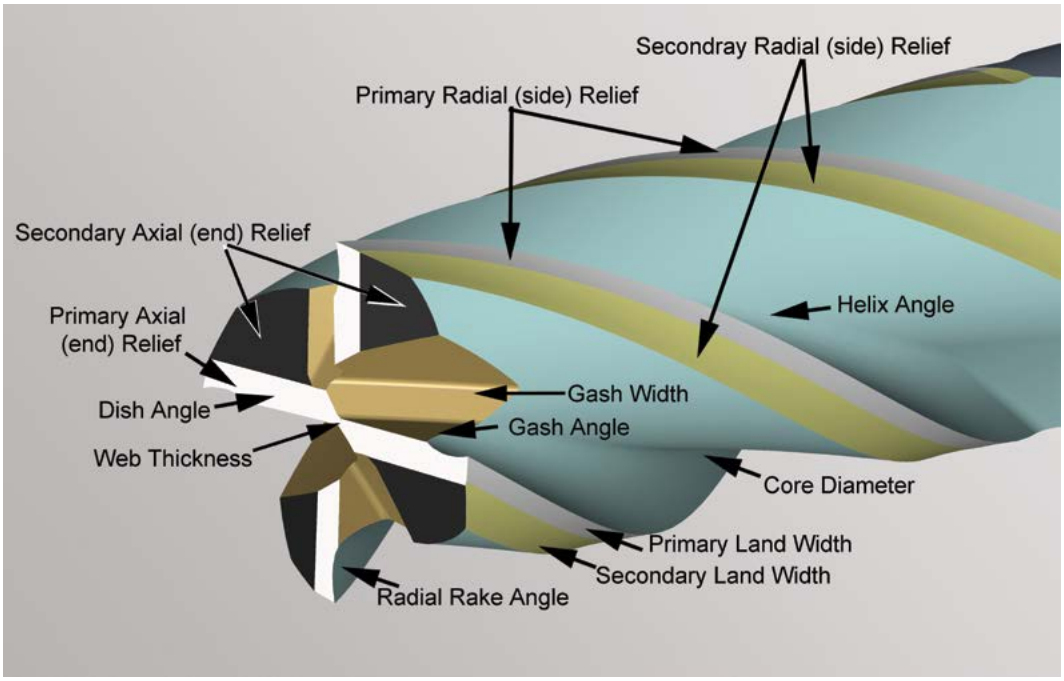
End mill geometry is complex. No two manufacturers make their geometry identically. Unfortunately, in many cases, the end-user has no control over several aspects that impact performance. These include:

- Relief / Clearance angles
- Rake angles
- Gash angles and widths
- Dish angle
- Core diameter
- Change in helix

With catalog end mills, you get what you get. The only way to change the above is if you have a detailed blueprint with measurements for each. Unfortunately, many end users wouldn't know how or what dimensions to change to improve performance.

As an end user, you're left sifting through the various brands trying to find the end mill with the right combination of raw material, geometry, and coating that will work best for your exact setup. Your machining center capability, the holders you use, the coolant, and your speeds and feeds effect that end mill's performance.

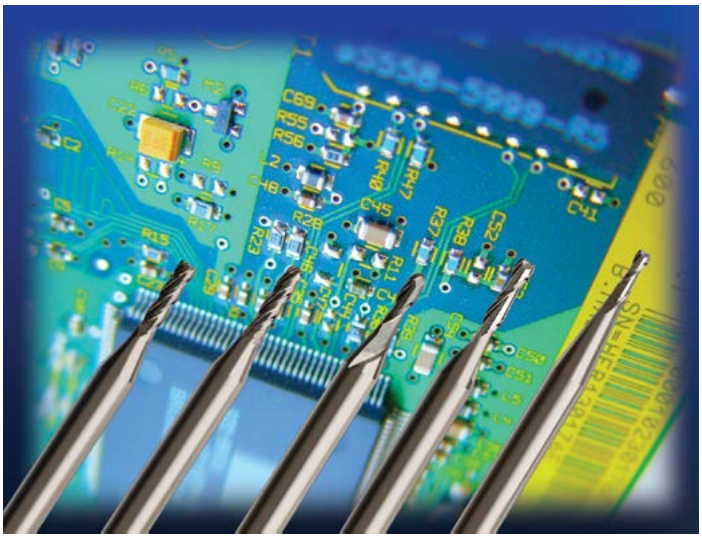
Testing different brands can be hit or miss. Brand A will knock it out of the park in one application but fall flat in another. This makes end mill testing frustrating. It doesn't matter how "high performance" an end mill is if it has the wrong geometry for your setup. Catalog end mills are built to work in as many different scenarios as possible, making them a general-purpose product.



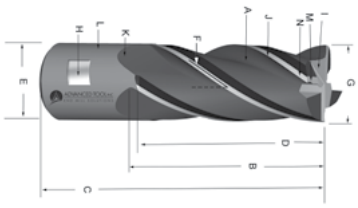
End Mill Geometry

A Better Way

Ask for Wear Analysis™ and a custom solution. Skip all the failed testing and wasted time. Wear Analysis™ looks at how the current end mill is wearing and tells the manufacturer exactly what's working and what's not. With this method, it's so easy to put a better performing end mill in your spindle. For high volume-milling, there is no greater cost savings.



MANUFACTURING THE PERFECT END MILL



Cemented Carbide (raw material)	End Mill Geometry	Tool Coating
Hardness vs Toughness Tungsten carbide (WC) grain size + cobalt (Co) % = Wear Resistance vs Fracture Resistance Grain size: • Nano (<0.2) • Ultrafine (.02-.05) • Submicron (.05-.08) Cobalt Percentage Range: typical 6% -12% Smaller grain size / lower cobalt = wear resistant Larger grain size / higher cobalt = tougher (breakage)	• Helix angle • Varied angles & indexing • Rake angle • Dish angle • Clearance angle (end & OD) • Land widths (end & OD) • Gash • Core diameter • Edge hone • Length of cut **always use the shortest possible to avoid deflection, chatter, poor cut, poor tool life • Radius / chamfer size ** largest possible	Different Recipes and Different Technology AlCIN, TiAlN, AlTiN, TiCN, Tib2, ZrN, Al203, etc • Physical Vapor Deposition (PVD): • High-power impulse magnetron sputtering (HiPIMS) • Arc Evaporation (ARC) • Sputtering • Thickness, Pre & Post Treatments, Edge honing

About Advanced Tool Inc.

Advanced Tool Inc. is a cutting tool manufacturer that specializes in end mill geometry.

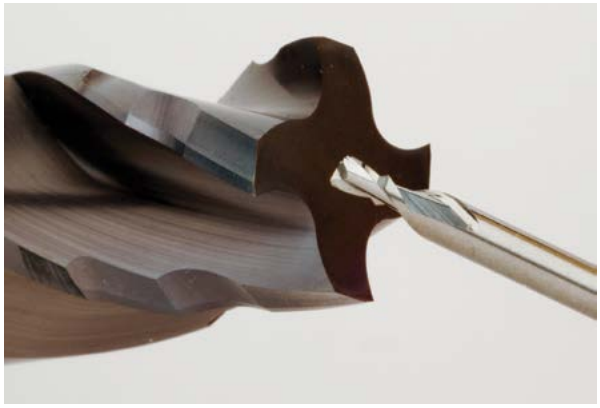
For years, we focused on catalog end mill sales (just like every other manufacturer). However, once we started dealing with high-volume milling customers, we knew we could do better. What we had on our shelf was great, but with a constant need to achieve perfection at the spindle, there was always something we could change that might work even better for that exact situation.

Here's the kicker: at higher volumes, no carrying cost, and eliminating unnecessary geometry, custom end mills often turned out to be cheaper than standards, and our customers gain even greater cost savings. It was a win-win.

How We Became Geometry Experts: In 1975, Advanced Tool started as a regrind house. Our claim to fame was when we began adjusting the regrind geometry based on wear patterns. Customers started getting more tool life out of our reground tool than they did when the tool was brand new. This is when Wear Analysis™ was born.

Our passion has always been to continuously improve end mill performance. By looking at wear patterns for over 40 years, we've refined our process and know exactly how to improve geometry. On top of that, we add better substrates and coatings. This allows our customers to test up to four combinations engineered to their exact needs. With this model, it's pretty easy to beat whatever is currently in the spindle. We have a 92% win rate against any major competitor.

Our only goal: save you money. This is how we keep your business.



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