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Getting Down

Plunge milling removes metal fast.

Plunge milling is one of the most effective methods there is for removing metal. Also referred to as "milling in the Z-axis," it is far more efficient than conventional endmilling for hogging, slotting difficult-to-machine materials and applications with long overhangs.

In fact, plunge milling typically cuts the time needed to remove large volumes of material by half—or more.

Other advantages to milling in the Z-axis include:

- reduced part distortion;
- lower radial stress on the milling machine, meaning spindles with worn bearings can be used to plunge-mill without degrading part quality;
- long reach, which is useful for milling deep pockets or surface cutting; and
- ability to slot high-temperature alloys, such as Inconel.

Plunge milling is good for jobs such as roughing cavities in molds and dies. It also is recommended for aerospace applications.

One specialized application is plunging turbine blades on a 3- or 4-axis machine. This job normally requires dedicated equipment. The blade is machined by milling down the part from tip to root; very complex geometries can be generated by simple X-Y translation during the plunge.

Plunging In

When plunge milling, overlapping cuts are made with the milling cutter's face. Plunge cuts up to 10" deep are possible without chatter or distortion. The cutter motion can be down or up into the workpiece, although down-cutting is more common.

It is possible, for some applications, to apply a button cutter, facemill or other cutter that is normally used for slotting, contouring, ramping or pocket milling.

Cutters specifically for plunging are available for roughing and semifinishing. These tools can cut into a pocket or along the edge of a workpiece, and they can even machine complex geometries, including undercuts. To ensure a constant cutting temperature, all shank-type tools have through-coolant capability.

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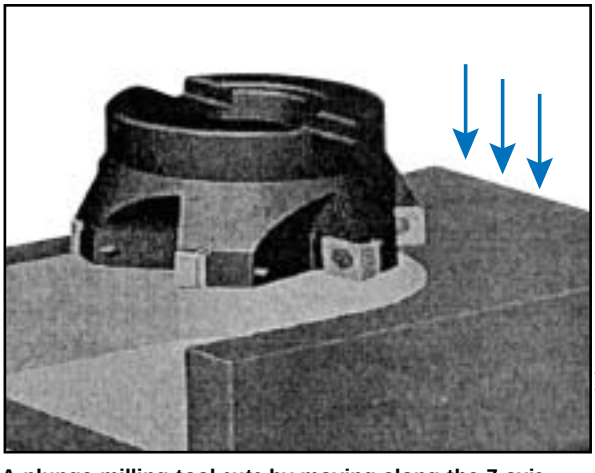
Plunge-milling tool bodies and inserts are designed so they are presented



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A plunge-milling tool cuts by moving along the Z-axis.

to the workpiece at the optimal angle. Typically, cutters have 87° or 90° cutting-edge angles. Feed rates range from 0.003 to 0.010 ipt.

The number of inserts per cutter depends on the tool diameter. A ¾"-dia. tool would have two inserts, for example, while a 5"-dia. cutter could have as many as eight.

When to Plunge

How do you decide if plunge milling is appropriate for a certain application? You can arrive at the answer by one of two directions: By considering the job or the machine that will perform it.

When considering suitability from the job perspective, look for applications that require high metal-removal rates. Plunge milling will dramatically reduce cycle times.

Other examples are jobs in which there are long axial engagements, such as the milling of large pockets and deep slots. Plunging tends to be more stable than side milling in these applications, due to the reduction in radial cutting forces.

Additionally, consider applications in which the cut must be made in an area of the workpiece that is inaccessible by conventional methods. Remember that a plunge-cutting tool can remove metal on the upstroke, allowing it to create complex geometries.

When gauging suitability from the machine standpoint, consider plunge milling if the equipment to be used has limited horsepower. Less power is required to plunge-mill than helical-mill, making it possible to gain more productivity from older or under-specified equipment.

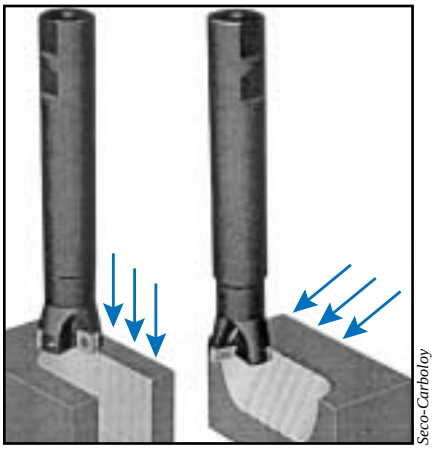
For example, plunging deep slots can be achieved on a 40-taper machine that cannot accommodate long-edge helical mills because of the high radial forces generated. These forces lead to chatter in a helical mill.

The relatively low radial forces that develop when plunge milling makes it ideal for older machines with worn spindle bearings. Since plunge milling is a roughing to semifinishing process, minor axial deflection, as the result of worn bearings, is less of an issue.

What's more of an issue is software. As simple as plunge milling sounds, it really challenges CNC software.

Software suppliers agree that more work needs to be done in this area. They are beginning to adapt or rewrite software that can handle the multitude of Z-axis lines of code. The software must be flexible so changes can be made to suit different applications.

Whether removing large amounts of metal—as is often the case with molds and dies—or machining complex aerospace-part geometries, plunge milling should be high on the list of techniques considered. It is much faster than conventional methods and can be utilized in almost any environment, from batch production of one-off prototypes to mass production.



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The cutter at left is making a straight vertical plunge. The other tool is moving in both the Z-axis and X-axis to cut a bevel.

About the Author

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