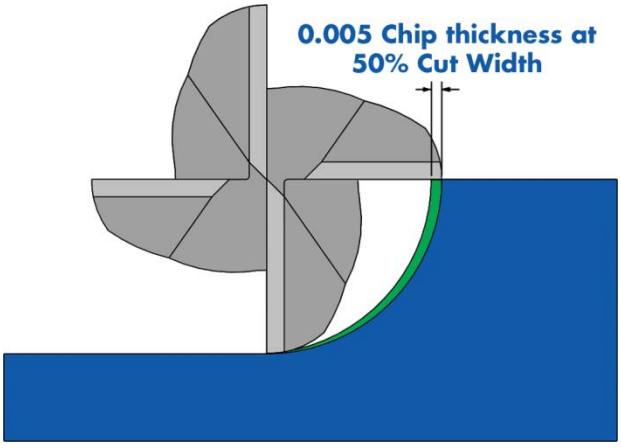
What is Active Chip Thickness Control™ (ACTC™) in VoluMill?

The Active Chip Thickness Control function in VoluMill is a calculator designed specifically to be used with VoluMill toolpaths. Since VoluMill toolpaths contain a far higher percentage of constant-width cuts than any other rough milling toolpath technologies, you can actively manipulate the maximum thickness of the chips to increase rough milling productivity even further. Cycle time reductions in the range of 35% beyond what you are currently achieving with VoluMill are now just a few clicks away. The following is an overview of this functionality, including examples and recommendations for its use.

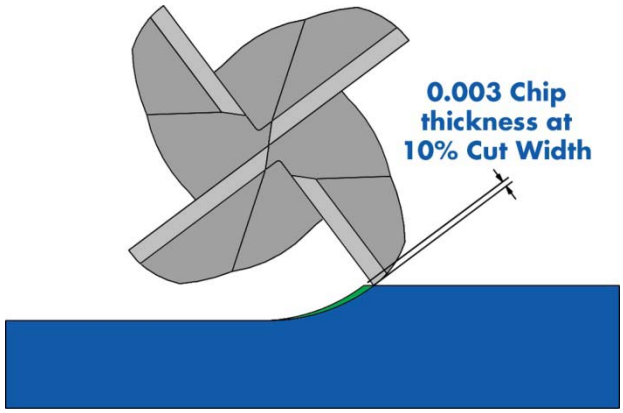
Your cutting tool manufacturer recommends a Feed per Tooth (IPT) value for a specific cutting tool in a specific material. Though this value is often called a "chip load" or "chip load per tooth," it really is not an indicator of the load on the tool.

When climb milling, a chip is thicker towards its beginning than at its end. It has a maximum thickness at a single point, and thins down from there. This maximum chip thickness is a much truer measure of the load on the tool than is the feed-per-tooth value. The thickness of a chip is a function of its length; the longer the chip, the thicker the chip. And the length of a chip is a function of the width of cut.

The Maximum Chip Thickness (MCT) is equal to the feed per tooth only if the cut width is greater than or equal to 50% of tool diameter:



If the cut width is less than 50% of tool diameter, the IPT is reduced. If the cut width is 10%, for example, the MCT is 60% of the feed per tooth:



Active Chip Thickness Control in VoluMill includes chip thickness in the parameter calculations. When the Active Chip Thickness Control dialog is displayed, the values for RPM, IPM, and Cut Width are inherited from the main VoluMill dialog, and values for SFM and IPT are shown as well. Note that the Chip Thickness is also displayed. This is the maximum thickness of the chips that will result, based on the current spindle speed, feed rate, and cut width, along with the tool diameter and number of flutes. This value is grayed out because Chip Thickness is the default option from the *Calculate the:* dropdown list at the top of the dialog.

From here any one of the parameters can be calculated based on changes to any of the other parameters. For example, a ½-inch diameter, 5-flute cutter, at 400 SFM (3,056 RPM), 100 IPM (.0065 IPT), at a 7% Cut Width (.035), yields a Chip Thickness of 0.0033. These are parameters commonly used to rough mill 6Al4V titanium with VoluMill. With a 1.000 axial depth of cut, these parameters produce a material removal rate of 3.5 cubic inches per minute while in the cut.

A good adjustment to make is to the Cut Width parameter. In this example, it is already known that the tool can clear the 0.0033 thick chip, so the following manipulation is available: with the Chip Thickness set to 0.0033, choose Feed from the *Calculate the:* dropdown list, and double the Cut Width value from .035 (7% of tool diameter) to .070 (14% of tool diameter). Pushing the *Calculate* button shows that the IPM must be reduced to 73.54 (0.0048 IPT) in order to maintain the chip thickness at 0.0033 with this larger cut width and longer chip. Yes, this is a feed rate reduction of 26.46%. But the doubling of the cut width effectively reduces the overall toolpath length by 50%, yielding a cycle time reduction of approximately 35%. Note that the calculated MRR increases to 5.15 cubic inches per minute. Pushing the Apply Parameters button will close the ACTC dialog and update the parameters on the VoluMill toolpath dialog.

Click this link to view a video demonstration of the ACTC function in action.

The method described above is the recommended use of the ACTC function. If you choose to use it for other purposes, please remember that some laws of physics will always remain in effect. For example, you may choose to find out what happens to the Chip Thickness if you modify the spindle speed. From the initial parameters of 3,056 RPM, 100 IPM and resulting Chip Thickness of 0.0033,

choosing Chip Thickness from the *Calculate the:* dropdown and increasing the RPM value to 4,000 updates the Chip Thickness to 0.0026. Also note, however, that the IPT value also updates, to 0.005. This is required due to the change in spindle speed. There are no new mathematics involved in the ACTC function, but you now have direct control of the actual thickness of the chips that your rough milling toolpaths will produce. The near constant, and always bounded, width of cut that VoluMill produces makes this possible.

As always, use your own machining experiences and knowledge of your machining environment as a guide. It may be tempting, for instance, to increase the Cut Width even more to further reduce cycle times, and this very well may be possible. But always remember that there will be physical limits to what your machining hardware can handle.