WAVEFORM

A Primer for Setting Proper Feeds and Speeds

The new Waveform cycle is superior to the traditional Roughing cycle where machinable geometry features are offset (inward or outward) by the % Stepover. Traditional toolpaths have to run slower feeds and speeds due to the variable width of cut conditions encountered in corners. Tool load spikes as chip thickness increases in areas where the tool finds more material than it did while cutting in a straight line.

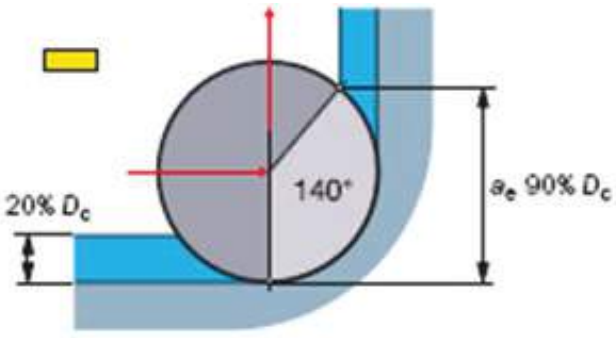
Waveform toolpath has been developed to remove tool load spikes and maintain consistent chip load. Traditional roughing toolpath results in inconsistent tool load and erratic machine motion. Waveform's algorithm calculates toolpath based off the actual width of cut, generating a fluid toolpath throughout the machinable elements using a smooth flowing motion - without the need to program feeds and speeds for heavy tool load conditions.

Consistent tool loads generated from the Waveform toolpath offers users the opportunity to completely rethink speeds, feeds and depth of cut. Continuing to use your standard speeds and feeds will work, but are likely to be very conservative. Traditional toolpath speeds and feeds were assigned with consideration of extreme cutting conditions. Consistent tool loads allow much higher feeds, speeds, and allow full depth of cut permitting material removal at the tool manufacturer's recommendations.

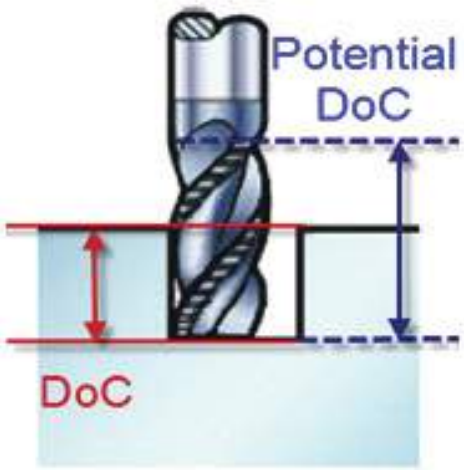
Cutting Data Calculations

Straight line test cuts will help maximize your cutting potential. Straight line test cutting mimics Waveform toolpath. Calculating the correct speeds and feeds takes minimal testing to generate. The information below will help set up your own straight line tests and expose your optimised roughing potential.

Cutters are given specific flute lengths that can be maximized to create even tool wear throughout the length of the tool. Spindle speeds and feeds are optimised using basic testing that can vary depending on work holding, tooling, fixturing, machine and material. Speeds and feeds are typically quite faster than traditional toolpath, while the depth of cut typically starts at 1 to 1.5 times the diameter of the cutter.



Traditional - Toolpath Overloading in a Corner



EDGECAM BY HEXAGON

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Waveform machining is standard with Edgecam, no additional purchase necessary.

Traditional Toolpath

Starting with tooling, using an odd number of flutes helps with rigidity. Recommendations are to use 5 to 7 flute cutters on Steel and 3 to 5 flute cutters on Aluminium. Using hydraulic, shrink fit or collet chucks are highly recommended. Weldon chucks are not recommended because they don't encompass the full diameter of the cutter, throwing
the cutter out of balance.

Place the designated material in your machine's fixture leaving a machinable amount of stock above the work fixture. Assigning the work offset at the lower right corner will simplify the NC code. Looking into the machine, we will test cut the front of the stock from right to left creating a straight line climb cut. A large lead-in will
ensure machine acceleration to proper feed rate before entering the cut. Starting with a depth of cut (DoC) of 1 to 1.5 X diameter, calculate speeds and feeds based on suppliers recommendations.

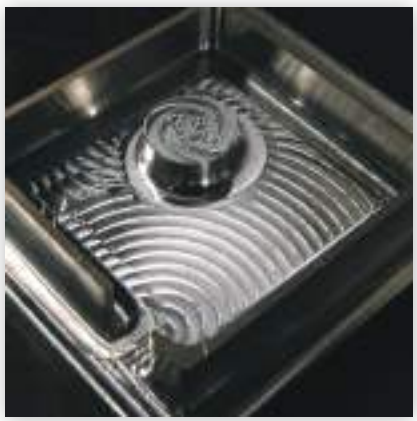
Waveform Toolpath

Proper chips should have a smooth edge from start to end (see photos). In Steel, heat from machining will be removed with the chips, leaving them a bluish brown colour.

Based on your tool type and material, adjusting one parameter at a time, depth of cut or width of cut, will optimise feeds and speeds.

Desirable Result

Undesirable Result



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Sample Straight Line Test Code

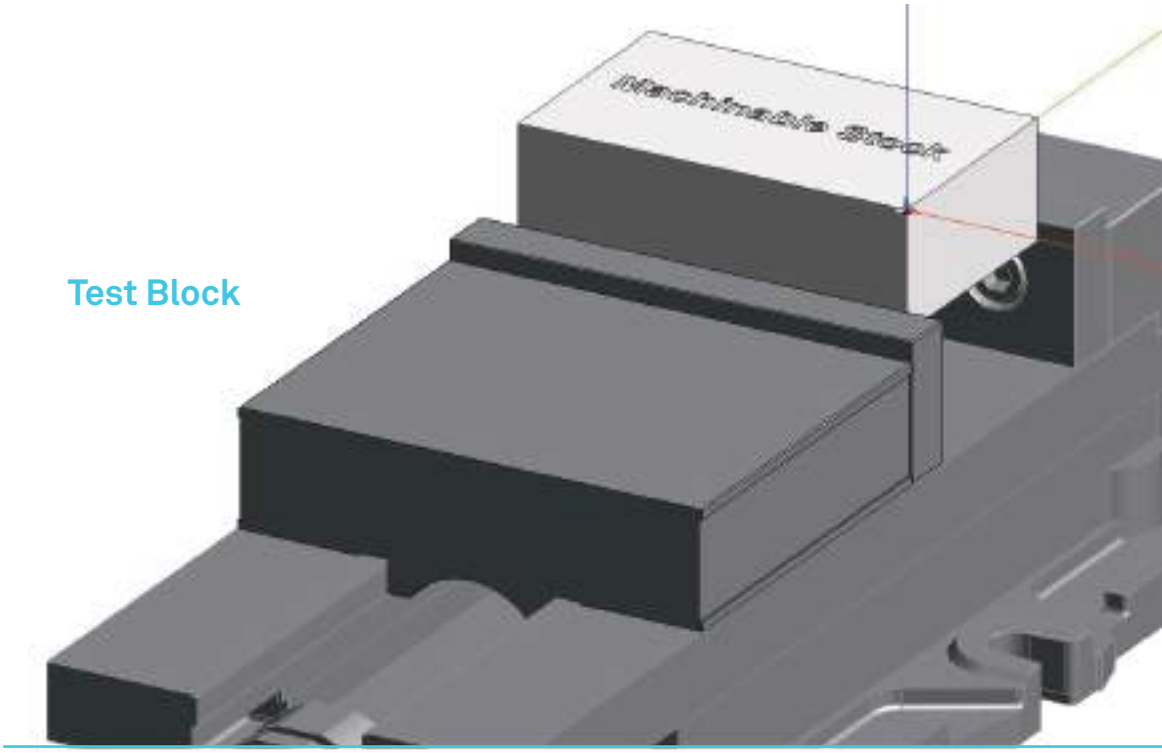
```
%O1000
N1 G90 G20 G00 G40
N2 T1 M6
N3 S[RPM] M3
N4 M8
N5 X3. Y[%Stepover X Tool Dia]
N6 G43 Z0.25 H01
N7 Z[Depth of Cut]
N8 G1 X-10 F[Feedrate]
N9 G0 Z0.25
N10 G28 Z0
N11 G28 X0
N12 M30
```

Key factors to consider for straightline test cuts are chip colour, chip edges, load meter, and sound.

Features include:

- Reduces cycle time.
- Improves tool life.
- Lengthens machine maintenance cycles.
- Keeps constant chip load.
- Cuts deeper and faster.

Test Block



Fixturing and Starting Location