THIRD WAVE AdvantEdge™
TECHNOLOGY FOR MACHINING SOLUTIONS

Case Study #20
High Speed Machining
Increasing Material Removal Rate

Problem:

A 25% or more increase in the material removal rate of a rough milling operation in AL6061-T6 is desired. The upper limit and margin of operation are unknown, as are any possible detrimental effects on other quality measures.

Why is Third Wave *AdvantEdge*™ needed?

To determine the highest practical cutting speed without interruption of production and degradation of any other quality measures.

Objectives:

Determine the highest cutting speed that will:

1. Maintain the tool temperature within 50°C of the original conditions, so that the tool life is not significantly affected.
2. Minimize part distortion by limiting the cutting forces to an increase of 30 lbs or less.
3. Not require any change in tool design, feed, and depth of cut from the original setup.

Project Setup:

Model the cutting process with the following three cutting speeds and original parameters:

1. Cutting Speeds:
   - 3000 sfm (the original cutting speed)
   - 3750 sfm (a 25% increase in MRR)
   - 4500 sfm (a 50% increase in MRR)
2. Feed: 0.010 in/rev
3. Depth of Cut: 0.250 inches
4. Rake Angle: 20°
5. Clearance Angle: 8°
6. Cutting Edge Radius: 0.001 inches
7. Tool Insert Material: Tungsten carbide
8. Workpiece Material: AL6061-T6

Results Analysis:

1. **Temperature**:
   Increasing the cutting speed from 3000 sfm to 4500 sfm only increases the maximum tool temperature from 580°C to 600°C (Fig. 1,2,3). On the tool, the region where temperature exceeds 500°C is along the rake face starting at the tool tip with a length approximately equal to the feed.

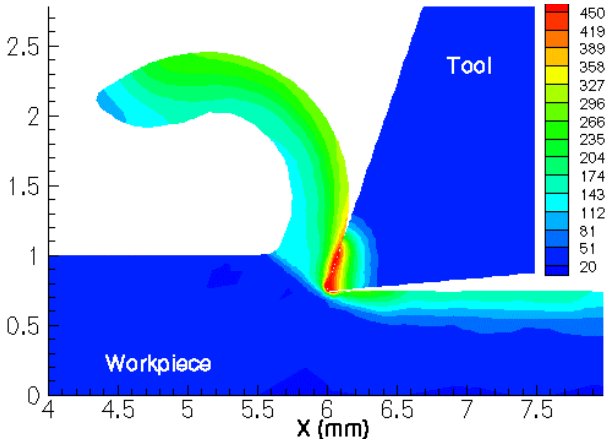

Figure 1: AL6061 at cutting speed = 3000 sfm

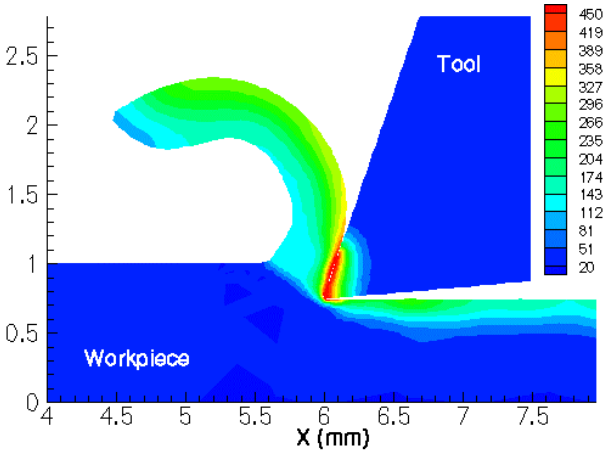

Figure 2: AL6061 at cutting speed = 3750 sfm

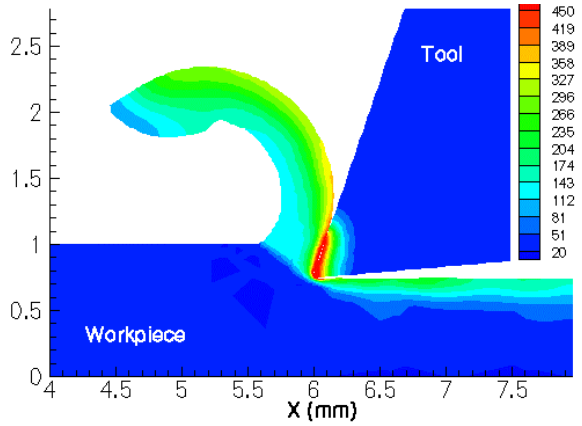

Figure 3: AL6061 at cutting speed = 4500 sfm

2. Cutting Forces:

Increasing the cutting speed from 3000 sfm to 4500 sfm did not result in a significant increase in cutting forces (Figure 4).

Cutting speed (sfm):	3000	3750	4500
Cutting force (lb):	210	210	215
Feed force (lb):	30	35	40

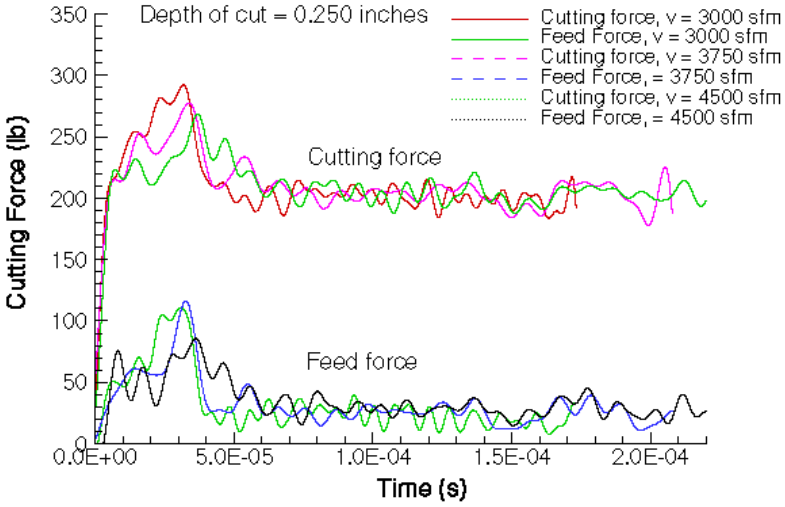

Figure 4: Cutting and feed forces at three different cutting speeds.

Conclusions:

The material removal rate for the AL6061-T6 rough milling operation can be increased by 50% by increasing the cutting speed from 3000 sfm to 4500 sfm. Third Wave *AdvantEdge* has shown that this increase is achievable because:

- It will not cause tool overheating (the temperature rise is less than 30°C).
- It will not cause increased part distortion (cutting forces increase less than 15 lb).

Therefore, no upgrade of the original tool or change of other cutting parameters is necessary.

Recommendation:

By using Third Wave *AdvantEdge* you can determine cutting forces and temperatures to investigate the feasibility of using higher cutting speeds to increase material removal rate. Third Wave *AdvantEdge* can also be used to optimize other cutting parameters (feed, tool geometry, tool material, etc.) to explore the possibilities for even greater material removal rate.

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