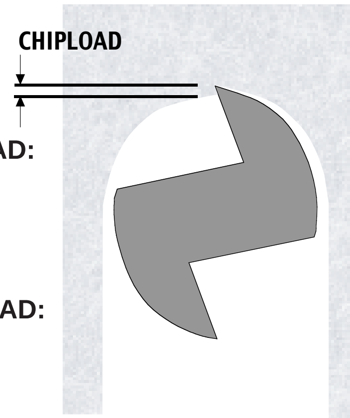
FEEDS & SPEEDS

To understand the concept of speeds and feeds, it is necessary to visualize what occurs at the cutting edge of the tool. A chip or thickness of material is being removed from the base part. The size and thickness of the chip is controlled by the rotation speed of the spindle and the forward movement of the tool into the material. In a single flute tool, the chip load is equal to the amount of material cut by one edge in one revolution of the spindle. The actual chipload remains the same with multi-flute tools but the chipload is spread over the number of flutes in the cut per revolution.

CHIPLOAD

CHIPLOAD = THICKNESS OF CHIP REMOVED

$$\text{CHIPLOAD} = \frac{\text{FEED RATE}}{\text{RPM} * \text{FLUTES}}$$



TO INCREASE CHIPLOAD:
- Increase FEED RATE
- Decrease RPM
- Use less FLUTES

TO DECREASE CHIPLOAD:
- Decrease FEED RATE
- Increase RPM
- Use more FLUTES

(i.e. two flutes provides two chips equal to one half the amount of travel in one revolution) Regardless, it is extremely important to produce chips of adequate thickness, not dust, fines, or slivers.

Most of the energy expended during these actions is released as heat. Heat is one of the major factors in tool wear. The most effective way to reduce the heat is to have it removed with the chip. This can be accomplished by cutting the correct size of chips which will both dissipate heat as well as yield a high quality part edge finish due to minimization of re-cut chips. This is only possible when a tool possesses the proper geometry allowing for optimization of both speed and finish characteristics. Onsrud Cutter provides a complete guide to tool selection in their catalog as well as the two websites (**www.onsrud.com** and **www.plasticrouting.com**). These sources also provide information on recommended feeds and speeds for a variety of materials.

Another indication of proper speed and feeds is the tool temperature. As a standard procedure, run a "Cool Tool Test" by running a nest of parts and checking the temperature of the tool after the spindles stop rotating. If a proper speed and feed is utilized, the tool should be at or near room temperature. Remember, **heat** is what breaks down the cutting edge of the tool.

When chipload is inadequate, the first change is to adjust the feed speed. This is the controlling factor in productivity. If the feed rate is maximized due to part configuration, hold down capabilities, software limits, or machine limitations, then the spindle speed should be lowered. This does two things; 1) it increases the chip thickness and 2) it lowers the number of times the cutting edge is presented to the material. The second factor can be a major factor in increased tool life. This could increase tool life by 15 to 20%. It also reduces the spindle bearing temperatures by reducing heat transmitted into the spindle.

In the final analysis, the entire process of maximizing feeds and speeds extends tool life and reduces part cost by significantly lowering cycle times.

FINDING THE RIGHT FEED AND SPEED

- START AT THE LOW END OF THE MANUFACTURER'S FEED AND SPEED RECOMMENDATIONS.
- USE THE FEED RATE OVERRIDE TO INCREASE THE FEED RATE UNTIL:
  - THE EDGE FINISH DETERIORATES BECAUSE OF TOOL CHATTER
  - THE MACHINE DEFAULTS TO A SLOWER SPEED DUE TO TIGHT RADII.
  - THE PART IS PUSHED OFF THE VACUUM.
- ONCE THE MAX FEED RATE IS DISCOVERED, RUN 90% OF THE MAX FEED RATE AND REDUCE THE SPINDLE RPM UNTIL THE EDGE FINISH ONCE AGAIN DETERIORATES.
- THIS IS THE POINT OF MAXIMUM PRODUCTIVITY AND BEST TOOL LIFE

REDUCING TOOL WEAR

- PICK THE RIGHT TOOL FOR THE JOB!
- INCREASE CHIPLOAD
  - INCREASE FEED RATES
  - DECREASE SPINDLE
  - DECREASE FLUTES
- WHY DOES INCREASED CHIP SIZE IMPROVE TOOL WEAR?
  - MORE WORK PER REVOLUTION
  - LESS HEAT

ACHIEVING MAXIMUM FEED RATES

- **MATERIAL CONSISTENCY**
  - Are materials multi-sourced or from a single vendor?
  - Do the wood laminates vary?
  - Different colors of the same plastic can machine very differently?
  - Is the aluminum or plastic sheet stock flat or warped?
  - Are plastic thermoformed parts of a consistent temperature?
- **OPERATOR SKILLS AND ABILITY**
  - Willingness to change methods of procedure, programming, fixturing.
  - Accountability to adequately measure tool life and edge finish.
  - If the tool life increase by 25% or the edge finish improves by 15 pinches, do they know it? More importantly, do you know it?
  - Willingness and/or incentive to feed more parts across the machine to gain throughout.
- **CONDITION OF THE MACHINE**
  - Minimal Spindle Runout (Do you ever check this?)
  - Clean collets, collet nuts, tool holders, spindle taper.
  - Good dust collection. Can you clear gummy chips?
  - Servos and controller. Can the machine maintain high feed rates in a tight radius?.
- **FIXTURING**
  - Must have the ability to hold prots ROCK SOLID
  - Properly made spoilboards that allow consistent part holding raised spoilboards that allow non-stop multi-pass machining.
  - Minimize unsupported edges during 5-axis machining.