Everyone talks about “Optimization”
Types of NC program optimization

- Avoid gouges automatically
- Improve trajectories
- Visualize
- Process analysis
- Feed rates
NC program optimization software

- Ability to automatically determine how much stock each cutter can machine without gouging the part
- Improve the trajectory of cutting motion by using continuous tangent motion rather than sharp, interrupted movements (VoluMILL)
- Visualize the machining process and imagine how to improve it
- Consider workpiece material & cutting tool properties, along with machine dynamics- to predict cutting forces caused by a given tool path, then analyze the results to identify opportunities to adjust portions of a toolpath, or select best machining strategies
Most NC optimization products change the toolpath trajectory

Increase machine tool utilization
A wide range of operations and strategies helps programmers create toolpath programs that reduce non-value-added motion. Optimized NC programs, and high-speed machining features reduce overall machining cycle time.

Mitigate risk to production
The realistic presentation of 3D enables programmers to create optimized NC programs in the manufacturing context including NC machine, cutter, tool assemblies, NC accessories and other elements. This provides a better understanding of the machining cell and helps to ensure that the toolpath and machining strategy take the tool’s physical environment into account. It reduces the risk of unexpected issues and production delays.

Accelerate NC programming
Users can quickly author and edit NC programs using powerful automated tools, capabilities and functions. Enterprise IP is capitalized and reused to make programming more efficient.
There are many strategy choices.
This session focuses specifically on feed rate optimization.

- No toolpath trajectories were harmed in the making of this presentation.
NC Program feed rate optimization has many benefits

- Reduces machining time
- Less tool wear
- Reduces machine tool wear
- Improves finish quality
- Consistent results
Optimization Benefits

- Decreased cutter wear by maintaining a constant chip load
Optimization of NC Program Feed Rates – Why?

- Reduces machining time
  - Increases productivity
  - Shortened lead times = faster time-to-market
- Prolongs cutting tool life, use more of the cutter
- Reduces machine tool and spindle wear
- Improves finish quality – material consistently removed via best methods
- Produces consistent results across machines, shifts, operators, and programmers (even if the “expert” isn’t around)
Using Optimization Software

- Slow the feed rate for hostile conditions
- Potentially employ greater axial depth
- Maintain aggressive feed rates for high speed “friendly” cuts

More efficient material removal
Fewer passes = less machining time
Fewer cycles = less wear on machine
What if you could experiment?

- Without risk of damage on your CNC machine
- Without any disruption in your production
- Without breaking cutters
- Without scrapping parts
Optimization of NC Program Feed Rates – How?

- Optimize by hand
- Use CAM software
- Adaptive controls
- VERICUT software
Optimization of NC Program Feed Rates – How?

- Optimize by hand
  - Very time-consuming & error-prone
  - Not all programmers have proper expertise
  - Difficult to visualize the cutting conditions for each cut
- Use CAM software
  - CAM software doesn’t know in-process material for each cut
  - What about Legacy NC programs?
- Adaptive controls
  - Must have for each NC machine
  - Reactive vs. pro-active
- VERICUT software
How Volume-based Optimization Works

… faster and better NC Programs!
Volume-based optimization

- Knowledge-based optimization
- Good when the user knows feeds/speeds, or VERICUT can “learn” from the NC program
- Many optimization strategies available
- Considers classic cutting conditions: Cutter shape, RPM, Chip thickness, contact area, vol removal rate

\[ \text{Width} \times \text{Depth} \times \text{Feed} = \text{Volume Removal Rate} \]

(Volume per minute)
Setup and experimentation (volume)

- Expertise vs. automatic configuration
- Learn ideal rates from an existing NC program
Interactive mode cont.

- Interactive panel displays cutting conditions
- Navigate the NC program evaluating cutting conditions & optimized feeds & speeds
- Adjust optimization settings as desired
- See immediate results
Cutting Condition Graphs
Cutting Condition Graphs
Cutting forces optimization

- Physics-based Optimization
- Considers cutter geometry and material properties
- Dyno tests to "characterize" cutting forces involved
- Excels when material is "trickier": strong/tough matls, trouble with small radial engagement, or breaking cutters
Force Optimization
Cutting Force Optimization

- Predict and visualize cutting forces
- Experiment with:
  - Cutting techniques
  - Cutter size/geometry/ number of flutes
- Determines the effect on your part and machine
DEMO:

- Air Cuts optimization
- Chip Thickness + Constant Volume Removal
- Force analysis & optimization
Goal of feed rate optimization:

Improve Quality
Make parts faster
Reduce operation cost

“A good hockey player plays where the puck is.
A great hockey player plays where the puck is going to be.”

— Wayne Gretzky
**Volume or Forces?**

<table>
<thead>
<tr>
<th>Volume</th>
<th>Cutting Forces</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Users with machining knowledge</td>
<td>✓ Dyno-tested machining characteristics</td>
</tr>
<tr>
<td>✓ Many optimization strategies</td>
<td>✓ Strong/tough materials</td>
</tr>
<tr>
<td>✓ User control over optimization settings</td>
<td>✓ Cuts with small radial engagement</td>
</tr>
<tr>
<td>✓ Ability to “Learn” from NC program</td>
<td>✓ Avoids breaking cutters from deflection/overload</td>
</tr>
<tr>
<td></td>
<td>✓ Maximum performance</td>
</tr>
</tbody>
</table>
Force or Volume?

Either way, your machining “reality” will never be the same.
Who is CGTech?

- Privately held and 100% self financed.
- Established in 1988
- World leader in NC verification
- Largest group of CNC machining experts in the world
- Headquartered in Southern California with offices in 11 countries

The power of CGTech expertise is available to your company.
Summary

- There is no longer any excuse not to optimize NC program feed rates.
- Many shops have told us they could no longer afford NOT to optimize.
- Optimization software is easier than ever to implement and use, and as a result, the shop will save money, machine parts more efficiently, improve part quality, make cutters last longer, and reduce machine wear.