Difficult to Machine Materials

National Technical Conference
Indianapolis
What is Machinability?

• “the ability of the material to travel through the shop, starting as bars, ending as parts, with the least amount of aggravation and trouble to the machine operator.”

• Anything that prevents a shop from achieving its production plan is “Difficult to Machine”

• I have a production bias.
Machinability is...
What is Difficult to Machine?

- Anything that interferes with the planned journey from bars to parts in our shop.
- Anything that increases costs
- Anything that increases time to produce
- Anything that reduces up time
- Anything that prevents us from holding tolerances geometry or finish
Obstacles to Production

• Chips nesting and balling,
• Frequent tool wear / destruction/ replacement
• Inability to maintain consistent size
• Inability to maintain consistent surface finish
• Inability to be rolled or cold worked
Terminology

- Difficult isn’t “hard”
- Tool failure modes
- Downtime- expected vs unexpected
- Low productivity may be expected
- May be a “bad estimating problem” not a “difficult machining problem”
Difficult to Machine Materials

- **Red Metals**- Type III long chip coppers and brasses such as such as
  - C10100 / C10200 Oxygen free Coppers
  - C61000 / C61300 /
  - C74500 Nickel silver

- **Plain Carbon and alloy steels**
  - 10XX 40XX 41XX others- machining and finish
  - 12XX- unable to thread roll/ cold work

- **Stainless Steels**
Difficult to Machine Materials

• Stainless Steels
  – Austenitics – (hardness not a guide for speed)
  – Martensitics
  – Precipitation hardening grades

• High Temp Alloys

• Nickel base alloys
  – Inconels and Monels

• Iron and Cobalt base alloys
  – A286
3 Primary Problem Classes

- Ductility
- Workhardening
- Heat and Abrasion
Solving for Ductility

• Chips difficult to break
• Long and stringy
• Interrupted cuts
• Saws
• Chip control
• Additional cold work possible?
• Tooling modifications- angles/ clearances/ coatings /
• Fluids?
Solving for Workhardening

<table>
<thead>
<tr>
<th>Material</th>
<th>HP/cubic inch removed/minute</th>
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<tbody>
<tr>
<td>Alloy steel</td>
<td>0.7</td>
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<tr>
<td>Austenitic Stainless</td>
<td>0.8</td>
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<tr>
<td>Martensitic</td>
<td>0.85</td>
</tr>
<tr>
<td>Precipitation hardening</td>
<td>1.1</td>
</tr>
<tr>
<td>Nickel base</td>
<td>1.2</td>
</tr>
<tr>
<td>Iron Cobalt</td>
<td>1.3</td>
</tr>
</tbody>
</table>
Workhardening (cont’d)

- Strategies to Avoid Cold Work
- Avoid tool dwell
- Tool radii
- Angles and clearances
- Sufficient depth of cut to get below surface work-hardened zone
- Rigid set-ups
Heat and Abrasion

- Operating parameters (Proper feed and speed to put heat in chip)
- Some materials are lousy conductors
- Coolant and coolant delivery
- Tool material
- Tool coating material
Now lets take some questions