Evolving Technology for LEAN, GREEN and BLUE Machining of Titanium

Lean and Green

Dr. Bert Erdel
Manufacturing Networks

Given the importance of part material, shape and size, there will have to be a shift from a system-centered view of manufacturing to a materials-centered view of manufacturing processes.

1. Manufacturing networks will follow the materials to be machined rather than the machine systems installed.

2. The attributes of Light-Small-Simple-Fast and Smart will continue to permeate all of manufacturing.

(Continued)
3. OEMs, Primes and their Upstream Supply Partners will have to be complete Process-oriented with the mandate of identical process pursuit from design-platforms to (sub-) assembly qualifications and everything in between.

4. The initiatives of LEAN, GREEN, BLUE will be at the center of all manufacturing activities.
Corporate Paradigms

- Lean, Green, Blue
- Innovation meeting Affordability
- Best Practice (Cost, Quality, Time)
- Value Chain Partnerships
- Speed-to-Market
- Product Life Cycle
- Global Competitiveness
“Lean” refers to: Reducing Waste

“Green” refers to: Cleaner Environment

“Blue” refers to: Lower Energy Usage
Manufacturing Paradigms

- Return on Investment
- Best Process
- Cost of Ownership
- Lean, Green, Blue
- Product Throughput
- Equipment Life Cycle
- Continuous Improvement
Machining Paradigms

- Process Cost
- First part-Good part-First Fit
- Product Cost
- Done in One
- Ease of Maintenance
- Productivity
- Application Agility
- Lean, Green, Blue
Technology Enablers

- Multitasking
- One-pass Machining
- Advanced Tooling
- Virtual Machining
- Modular Part Clamping
- Process Robustness
- Optimizing Parameters
- **Substituting Coolants, Dry, MVL**
Typical Machining Issues

- Machine Uptime
- Tool Life
- Process Reliability
- Produced Part Variation
- Difficult-To-Machine Material
- Temperature
- Chips
  - Coolant
Effective Initiatives

• Optimizing the use of Resources
• Reducing Variability
• Pursuing Standardization
• Specifying Advanced Technology
• Foregoing Errors

More precisely . . . .
• Process with best price/performance ratio
• Timely machine replacement
• Preventive maintenance
• Multitasking
• Advanced cutting tools
• Ergonomics, Safety, Health
• **Coolant substitution**
• Part handling
• Kaitzen

(Continued)
• Weighing alternative methods, e.g.:
  - hard turning vs. grinding
  - turn/mill vs. mill/turn
  - boring vs. reaming
  - high speed vs. high feed
  - multi spindle vs. single spindle
  - hydraulic vs. mechanical holder
  - carbide vs. diamond tool

• Optimizing energy consumption:

  Consider this . . . .
Increased Energy Consumption:

- High cutting forces
- Part material properties
- Machining parameters
- Aged machine
- Machine clean up
- Wet chips
- Continuous load on machine
- Worn tools
- Machine under constant full power
- In-process adjustments
- Tight blue print tolerances
- Part transportation

*Coolant*
Mercedes and Univ. Dortmund:

• Up to 15% of total Production Cost and
• Up to 60% of total Energy in machining

Directly related to traditional Coolant usage
The alternative

**Metalworking Crystals** (MWC)

*It’s new, innovative, robust, easy to apply . . . .*
Here is **how it works**: 

Recycled, gaseous CO2, liquefied in capillary tubes, turns into crystals at the cutting edge - cools and lubricates the process and evaporates.

*Clean, cost-effective, robust, easy-to-install process*
What are the **Benefits**?
Machining Total Cost - Monthly

Savings of 25%

- Crystal
- Emulsion
- MVL
- Dry

Legend:
- Energy
- Coolant
- Tools
- Labor
## Case Study

<table>
<thead>
<tr>
<th>Operation</th>
<th>Drilling</th>
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<tbody>
<tr>
<td>Dia</td>
<td>0.25”</td>
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<tr>
<td>rpm</td>
<td>700</td>
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<tr>
<td>ft/min</td>
<td>45</td>
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</tbody>
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| Tool       | Coated Carbide |

| Coolant    | Crystals vs. Emulsion |

<table>
<thead>
<tr>
<th>Result</th>
<th>Advantage Crystals</th>
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<tbody>
<tr>
<td></td>
<td>40% More Tool Life</td>
</tr>
<tr>
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<td>Dry Chips – Clean Part</td>
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<table>
<thead>
<tr>
<th>Savings</th>
<th>$85,000 Tooling per Machine /yr</th>
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<tbody>
<tr>
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<td>Recycling Chips</td>
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Vertical Milling Machine – Through Spindle
6Al-4V Titanium

<table>
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<tr>
<th>Surface Finish Results – 2X Improvement</th>
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<tbody>
<tr>
<td>Cutting Speed, SFM</td>
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<tr>
<td>Emulsion</td>
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<tr>
<td>CO2</td>
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</tbody>
</table>

Tool Life - 20% Improvement

Productivity - 30% Improvement w/ surface finish
• The attributes of the Lean, Green, Blue – initiatives have begun to permeate all industrial manufacture.

• Some measures are basic in nature-these are the easy ones to implement.

• Some are more complex-these are the more difficult ones to implement.

• Yet, other measures take guts, vision and determination to implement.

• Whatever the measures taken,

“One cannot solve today’s problems with yesterday’s solutions and expect to be competitive tomorrow”.
Thank you

Dr. Bert Erdel