Evolving GREEN and LEAN Technologies for High Productivity

Lean and Green

Morris Group, Inc.
Dr. Bert Erdel
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.

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

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

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
- Continuous load on machine
- Wet chips
- Worn tools
- Machine under constant full power
- In-process adjustments
- Tight blue print tolerances
- Part transportation
- Coolant

The game changer . . . .
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 with Ice-Crystals**
- Process Optimization
- Increased Tool Life
- Faster Throughput
- Production Increase
- Dry Chips
- Better Finishes

- Lower Costs
- Eliminating Coolant Issues
- Less Energy Usage
- Less Waste
- Clean Parts
- Cost Effectiveness

*“Every new Technology is first seen as magical”*

Arthur C. Clarke
1961
How does MWC fare against “the others”?

The most pronounced advantages vis-à-vis:

“Emulsion” - cost, environment, tool life, productivity

“Oil” - cost, environment

“Dry” - cost, tool life, limited applications

“Nitrogen” - cost, limited applications, no retrofits

“MQL” - no cooling, environment, limited usage

Advantage “Crystals”
Machining Total Cost - Monthly

Savings of 25%
## Case Studies

<table>
<thead>
<tr>
<th></th>
<th>Composite CFRP</th>
<th>Titanium Ti6A-4V</th>
<th>High Temp Alloy X22 Cr Mo V 121</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operation</strong></td>
<td>Drilling</td>
<td>Drilling</td>
<td>Milling</td>
</tr>
<tr>
<td></td>
<td>Dia 0.25 in.</td>
<td>dia. 0.25 in.</td>
<td>dia 40 mm</td>
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<tr>
<td></td>
<td>6,000 rpm</td>
<td>700 rpm</td>
<td>2400 rpm</td>
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<tr>
<td></td>
<td>400 ft/min.</td>
<td>45 ft/min.</td>
<td>4 m/min.</td>
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<tr>
<td><strong>Machine</strong></td>
<td>CNC-vertical</td>
<td>CNC vertical</td>
<td>5-axes</td>
</tr>
<tr>
<td><strong>Tool</strong></td>
<td>PDC-drill</td>
<td>coated carbide</td>
<td>4 inserts carbide</td>
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<tr>
<td><strong>Coolant</strong></td>
<td>ICE vs dry</td>
<td>ICE vs emulsion</td>
<td>ICE vs MVL</td>
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<tr>
<td><strong>Customer</strong></td>
<td>Aerospace</td>
<td>Defense</td>
<td>Machine builder</td>
</tr>
<tr>
<td><strong>Result</strong></td>
<td>Advantage ICE</td>
<td>Advantage ICE</td>
<td>Advantage ICE</td>
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<tr>
<td></td>
<td>15% more tool life</td>
<td>3x tool life</td>
<td>55% increase feed</td>
</tr>
<tr>
<td></td>
<td>55% less part temp</td>
<td>Chips dry</td>
<td>same rpm, same wear</td>
</tr>
<tr>
<td></td>
<td>Clean part</td>
<td>Clean part</td>
<td></td>
</tr>
<tr>
<td><strong>Savings</strong></td>
<td>$100,000 pa tools</td>
<td>$100,000 pa tools</td>
<td>double part output</td>
</tr>
<tr>
<td></td>
<td>Labor to qualify part</td>
<td>labor to qualify part</td>
<td>energy savings 1kW</td>
</tr>
<tr>
<td></td>
<td>Recycling chips</td>
<td>Recycling chips</td>
<td>per part run</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>dry chips</td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td>Turning ops yield</td>
<td>Similar results</td>
<td>Clean parts</td>
</tr>
</tbody>
</table>
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”.

On the year of its 70th Anniversary, for The Robert E. Morris Company, the Future has already begun . . . .