

Research & Technology

6 of the BEST: Small Companies that are Changing the Industry

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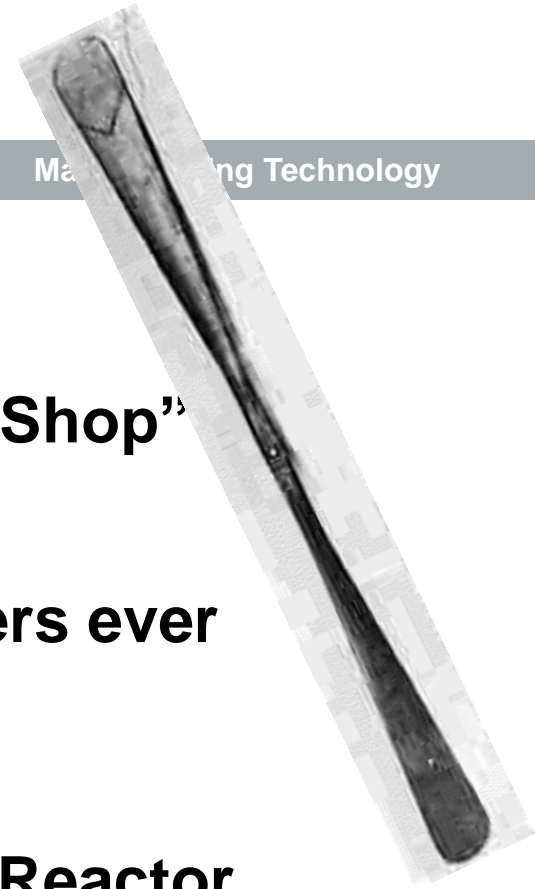
6 of the BEST – The Game Changers

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Manufacturing Technology

Innovation comes in all sizes

- Orville & Wilber were “2 Guys from a Bike Shop”
 - Neither completed High School
 - Made one of the most efficient propellers ever
 - 80% efficiency, vs. 88% for A-400M
- 14 year old Taylor Wilson makes a Fusion Reactor
 - Created fusion isotope generator for use in hospitals
 - Also working on methods to process fissile waste



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Manufacturing Technology

Finding the “Future”

- Open Eyes and Open Mind
 - Continual search & exploration
 - Technology Scouts
 - Read, Rummage and Research
 - Edison vs. Tesla
- Build Bridges, not Barriers
 - Squelch “Not Invented Here Syndrome”
- Partners perform better than “vendors”
- Coalition – Capacity, Capability & Commitment



Advanced Manufacturing Research Centre

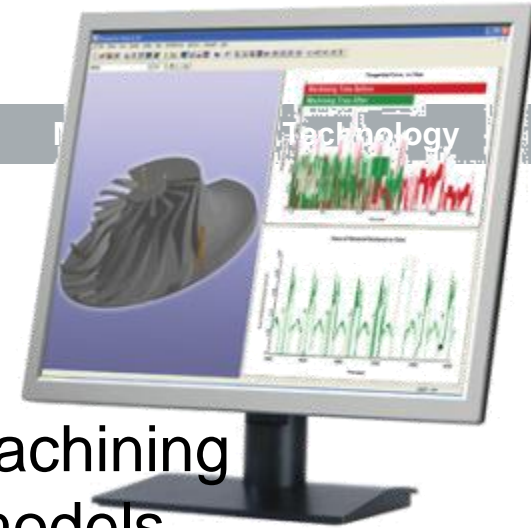


Third Wave Systems

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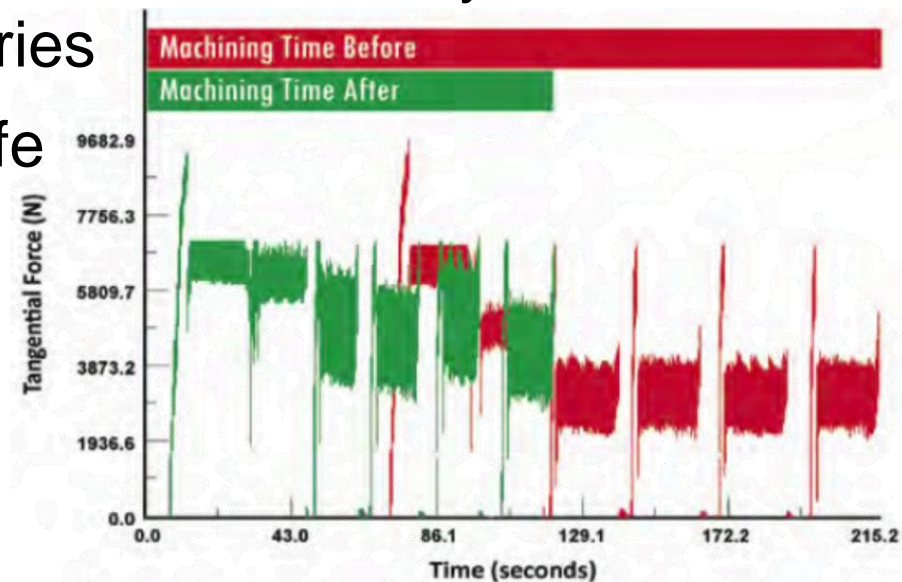
Founded in 1995 by Marusich Brothers

- “Success requires constant innovation”
- First commercially-available FEA-based machining simulation software with custom material models.



“Production Module” (2003) lets users

- Analyze and optimize NC programs, machine dynamics, tooling and work-piece geometries
- Shorter run times, longer tool life
- Lower residual stress = Longer Part life



Third Wave Systems

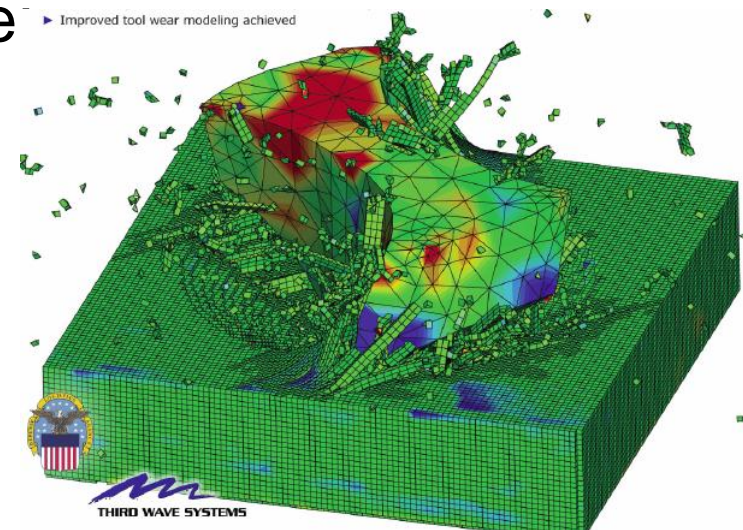
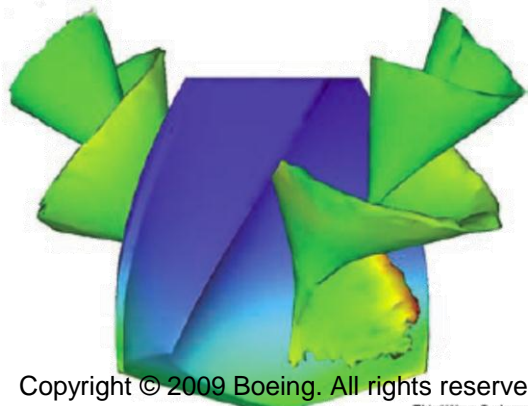
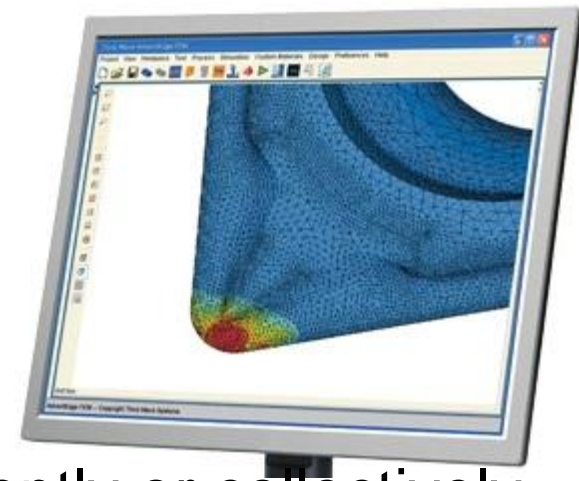
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AdvantEdge FEM –

- 140 physics-based material models
- View chip, tool, workpiece, cutter independently or collectively
- Faster mesh generation, selective refinement
- Supports multi-core processing

Third Wave the Gold Standard, used worldwide

- 100 academic institutions worldwide
- 50+ conducting research



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Technicut Cutting Tools

- Founding member & Tier 1 Partner @ AMRC-Sheffield
- “commitment to long-term business partnerships”
 - “Made In Sheffield”



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Technicut Cutting Tools

- Continual innovation through application of science

- Mega-Flute®



- Raptor - Mill®



- Dream Cutter®



- HSS Shell Mill



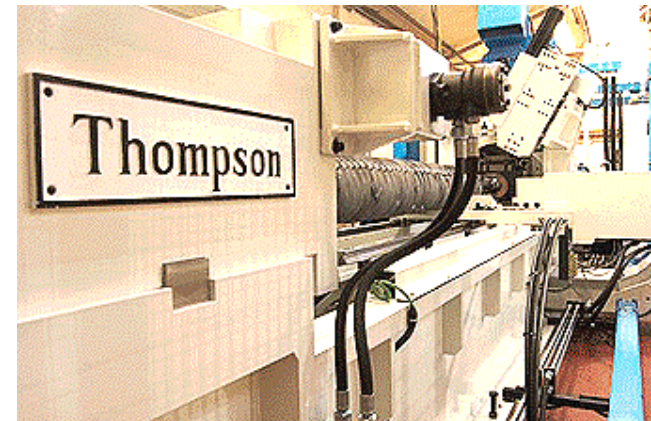
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Thompson Friction Welding

- **Founded in 1834; became Thompson in 1936**
- **Makers of Friction Welding Machines & Service Provider**
 - **Customers: Ford, Dana, Sandvik, Caterpillar, CASE, John Deere, Atlas, New Holland, Komatsu**
- **Rotary Friction for axles, pistons, oil & gas drills**
 - **Direct drive enables precise angular location**
 - **Robust, defect free process**
 - **Grain refinement, improved strength**

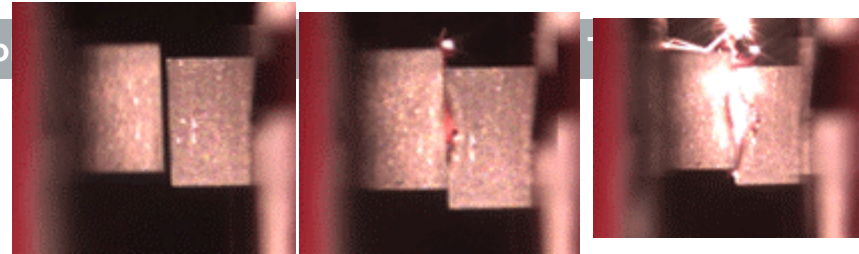


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Linear Friction Welding

- Joins rectangular blocks with reciprocating motion
- Robust, defect free process
- Grain refinement, improved strength



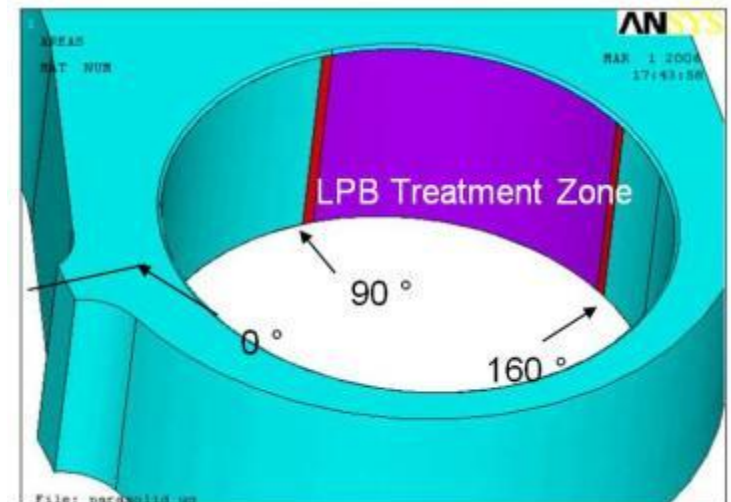
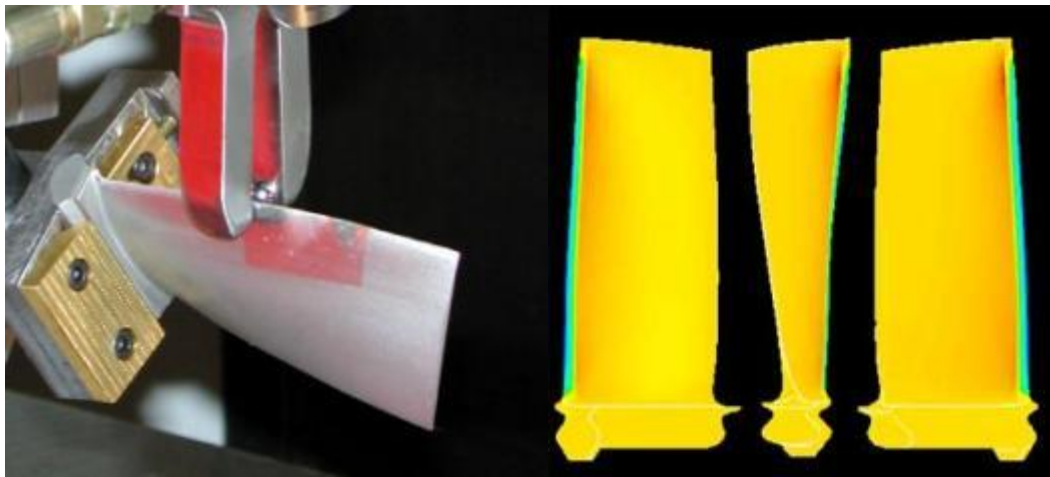
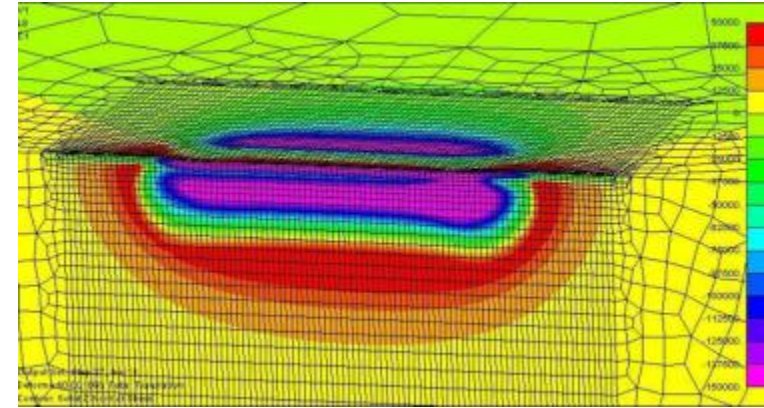
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Lambda Technologies - Cincinnati

- 1977: x-ray diffraction & materials testing
- 2000: Developed Low Plasticity Burnishing
- 2007: Turbine blades, propellers, landing gear
- **Low Plasticity Burnishing**
- High-hardness ball under pressure rolled over surface
- Single pass provides deep compression
- Low cold work provides stable compression



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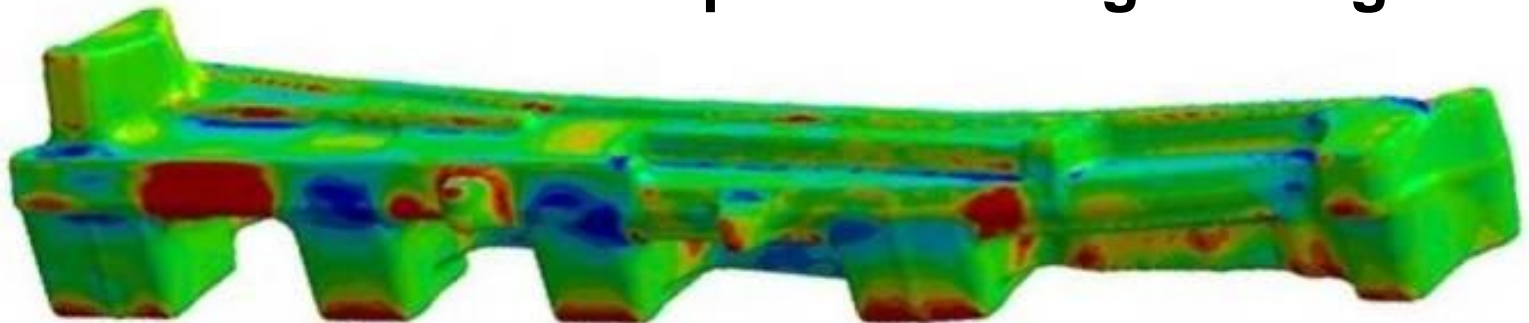
Lambda Technologies

- **Compressive stress prevents fatigue, damage growth & corrosion**
- **Provides method to correct undesirable residual stress**
 - Reduce distortion with Engineered CNC operation
 - **PREVENT** distortion with pro-active engineering



LPB Processing of a P110 coupling

LPB ELIMINATES SSC IN STEEL COUPLINGS

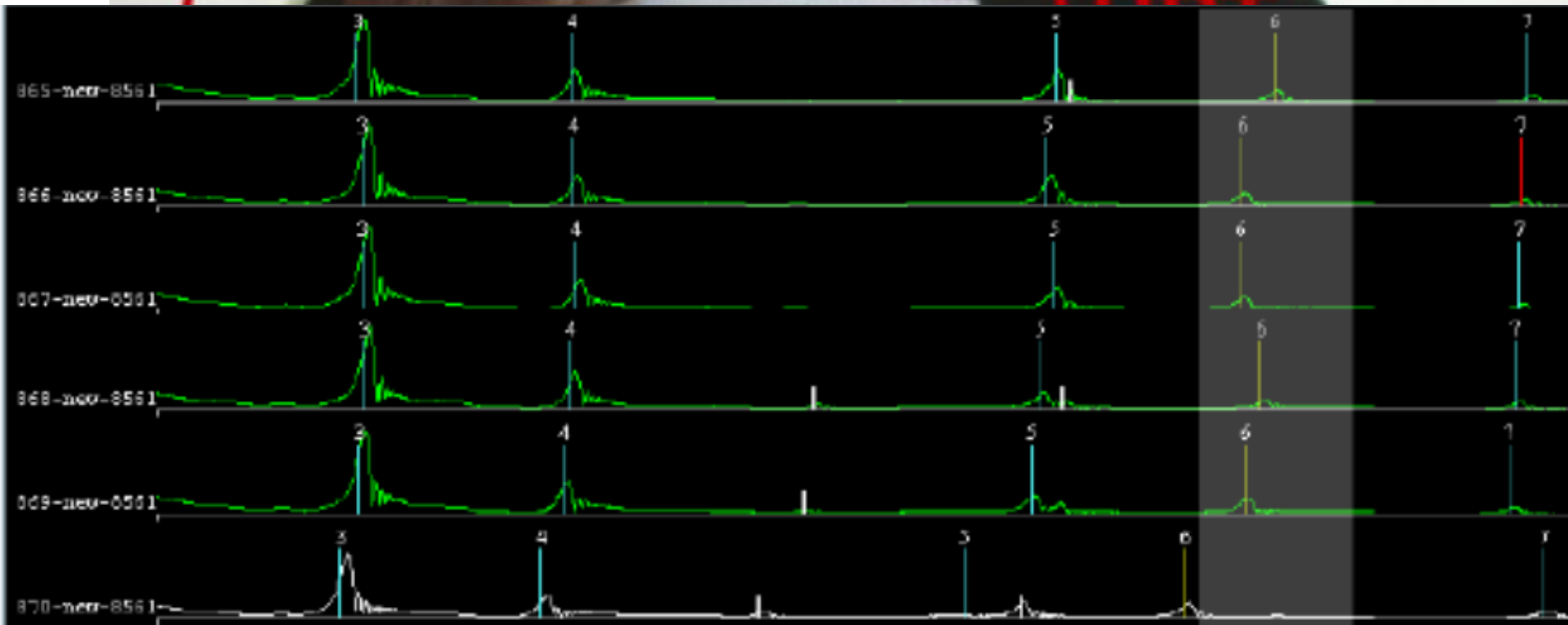


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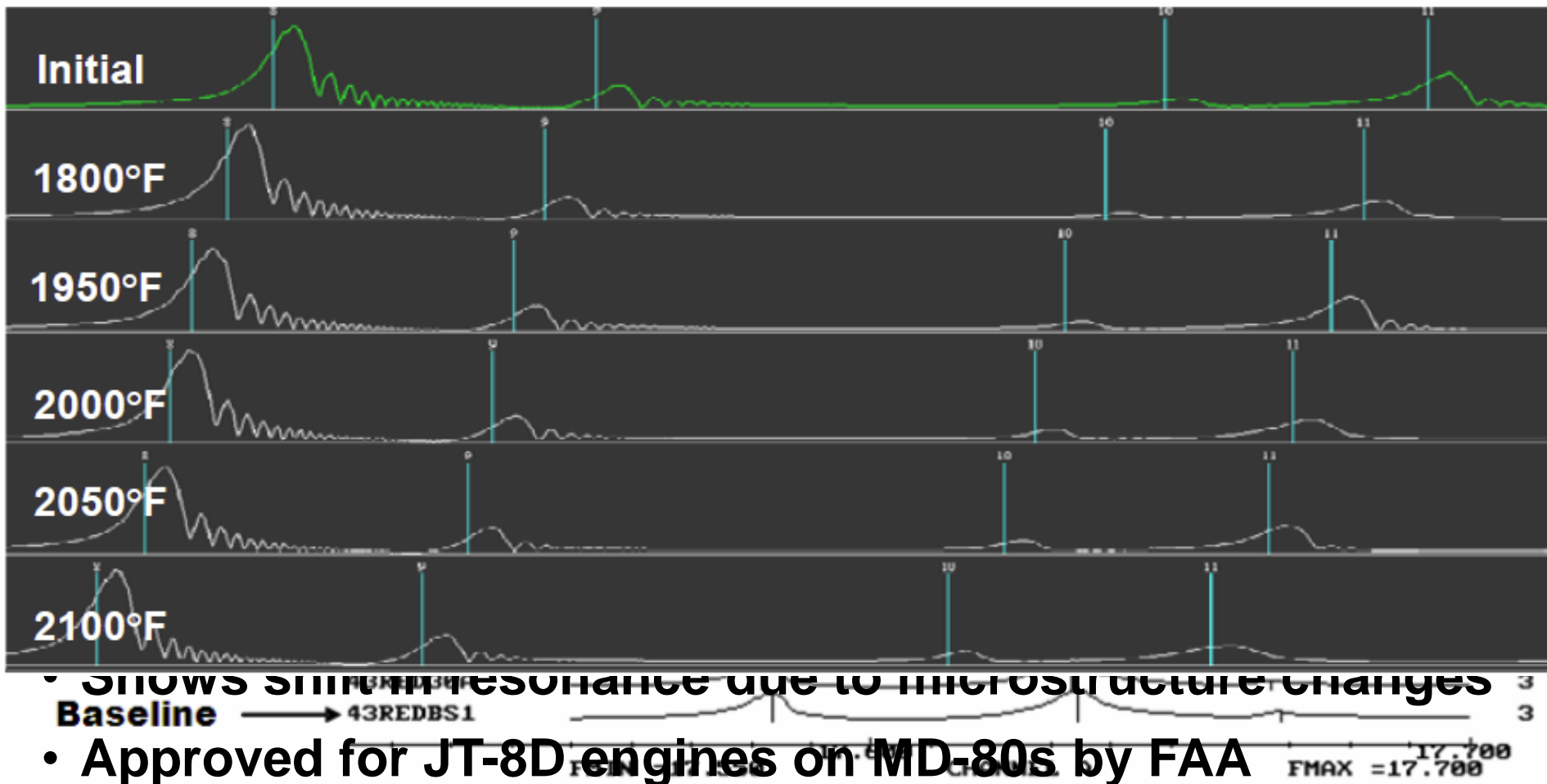


- Detects cracks, porosity, inclusions, Micro-Structure, oxide layers, over-torque, over temp, braze defects

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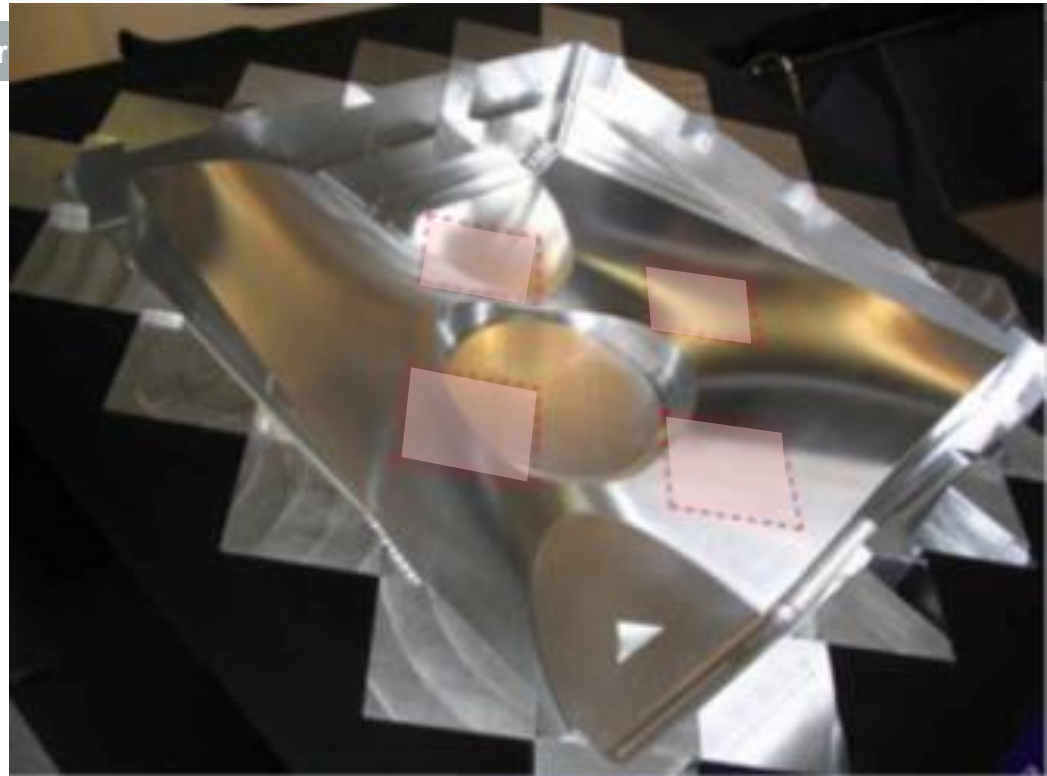


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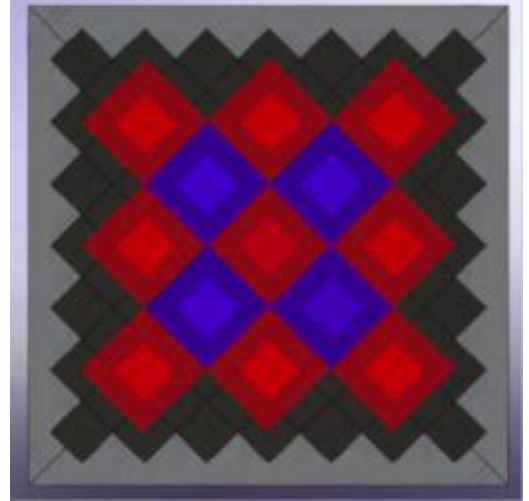
Surface Generation

- Founded in 2002 -



Multi-zone 'real-time' thermal control

- Closed loop control
- Control the whole process
- Production to a specification



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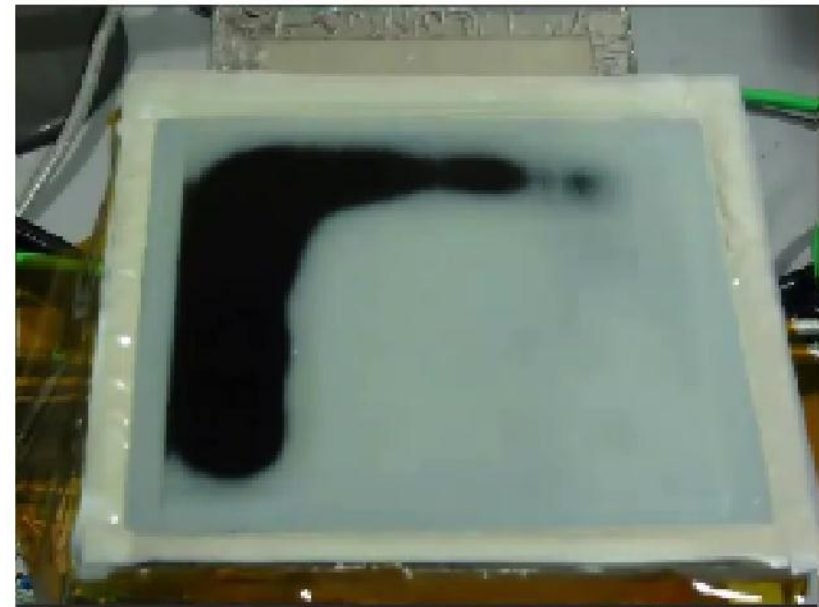
REAL Self-Heated Tools

- 90% energy goes to metal CAN
- Monitored with thermocouples
- Slow heat to avoid ooze & Exotherm = lost throughput



SELF HEATING TOOLS with TOTAL PROCESS CONTROL

- Up 200°C per minute; +/- 0.5°C , down 400°C per minute
- Completely closed loop
- Turn regions on & off as desired
- Riding the Exotherm !



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The Game Changers

- Third Wave Simulation Software
- Technicut Cutting Tools
- Thomson Welding
- Lambda Technologies
- Vibrant NDT
- Surface Generation
- Open Eyes and Open Mind
- Build Bridges, not Barriers
- Partners perform better than “vendors”
- Coalition – Capacity, Capability & Commitment