THE MATERIALS JOINING EXPERTS

Recent Developments in

Ultrasonic Machining

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Ultrasonics Engineering, EWI

Outline

- Range of US machining
- Prior work: ‘60s and ’70s
- Current work
- Recent developments at EWI
- Future work to be done
- Summary
- Questions

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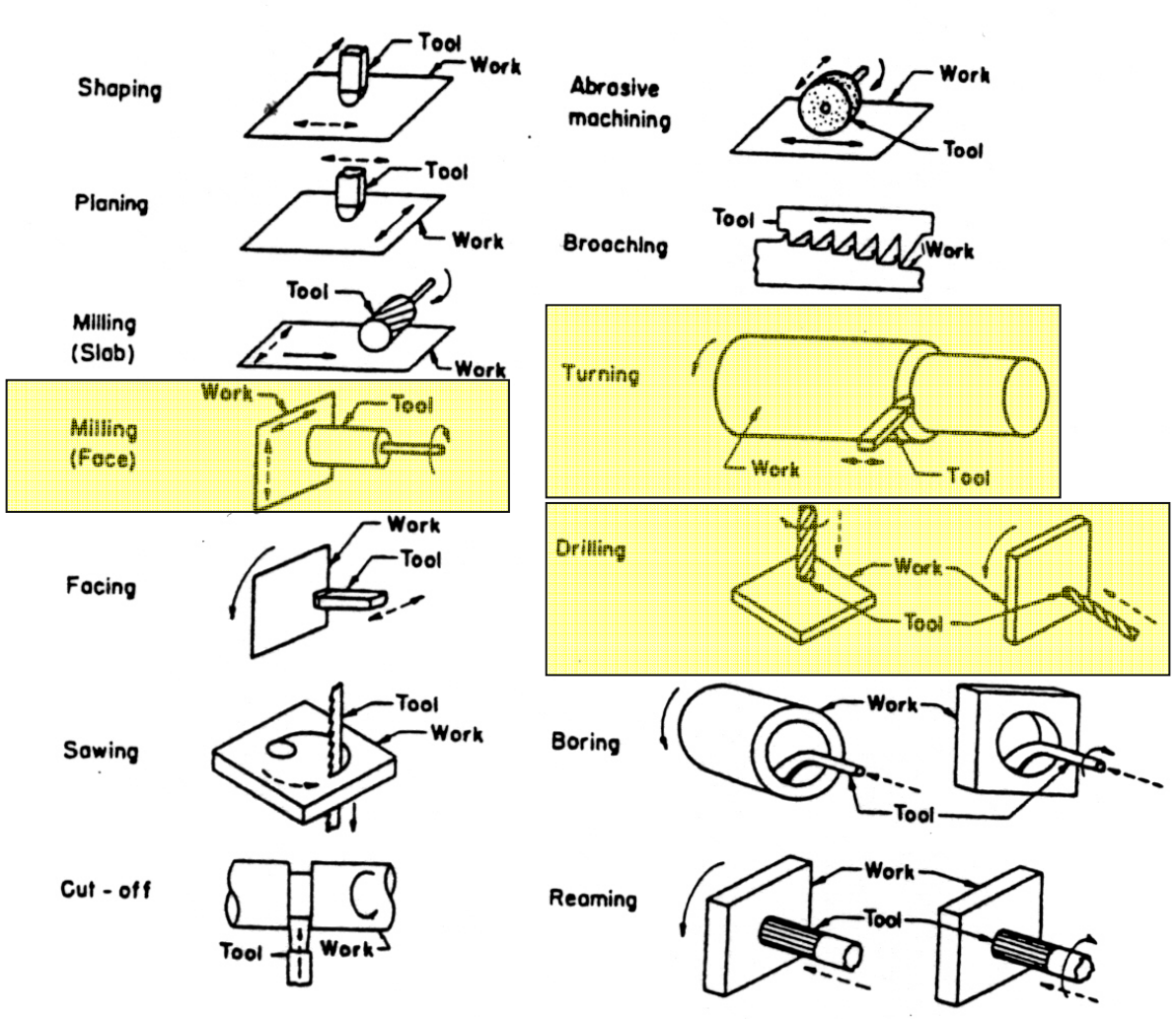
Machining Processes



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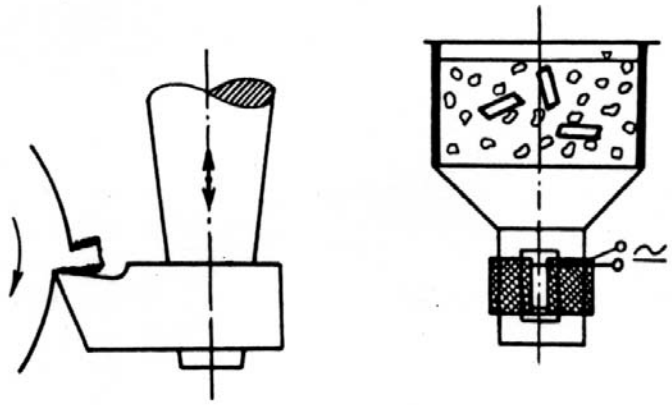
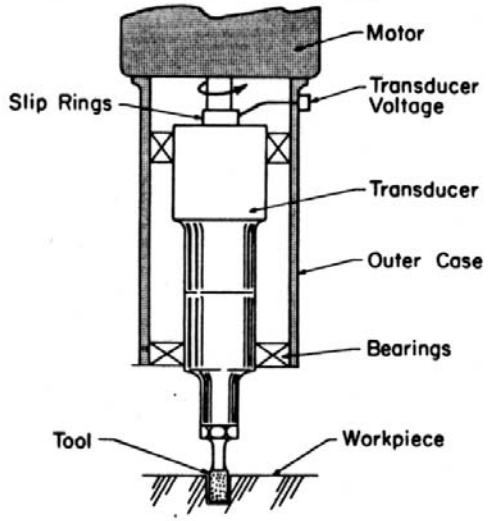
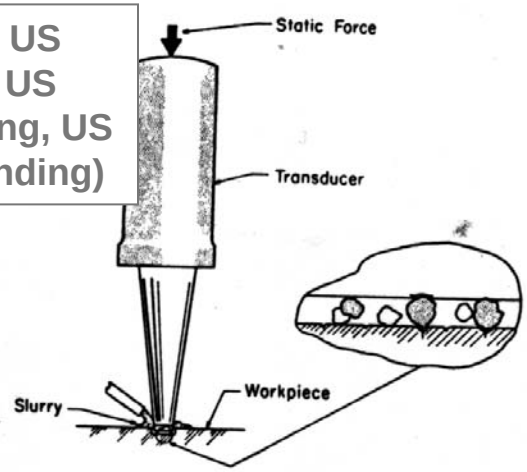
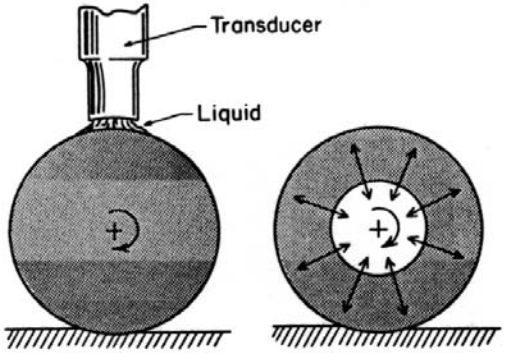
Range of US Machining Processes





"Conventional" US Machining (aka US Impact Machining, US Drilling, US Grinding)





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Prior Work on US Machining

- Work at Aeroprojects on US twist drilling and US turning – 1970s
- Machine tools (drill press, lathe, mill) fitted with ultrasonic transducers
- Benefits noted: lower forces, faster feeds, longer burrs, less chatter, deeper drill depths, better tool life, less lubricant

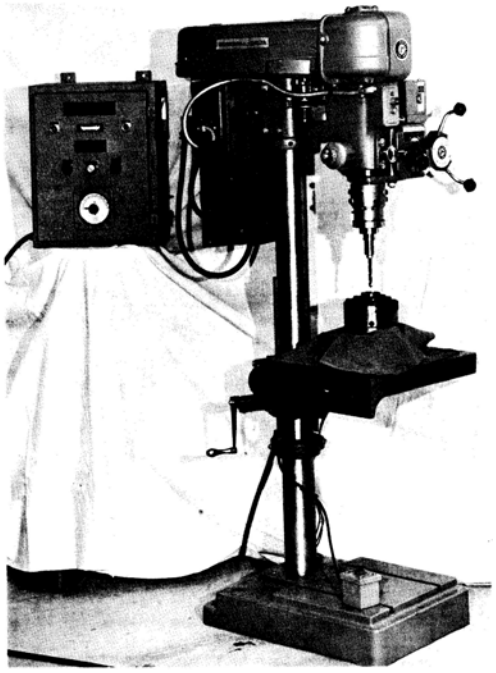

Figure 1

EXPERIMENTAL ULTRASONIC SYSTEM
INSTALLED ON STANDARD DRILL PRESS

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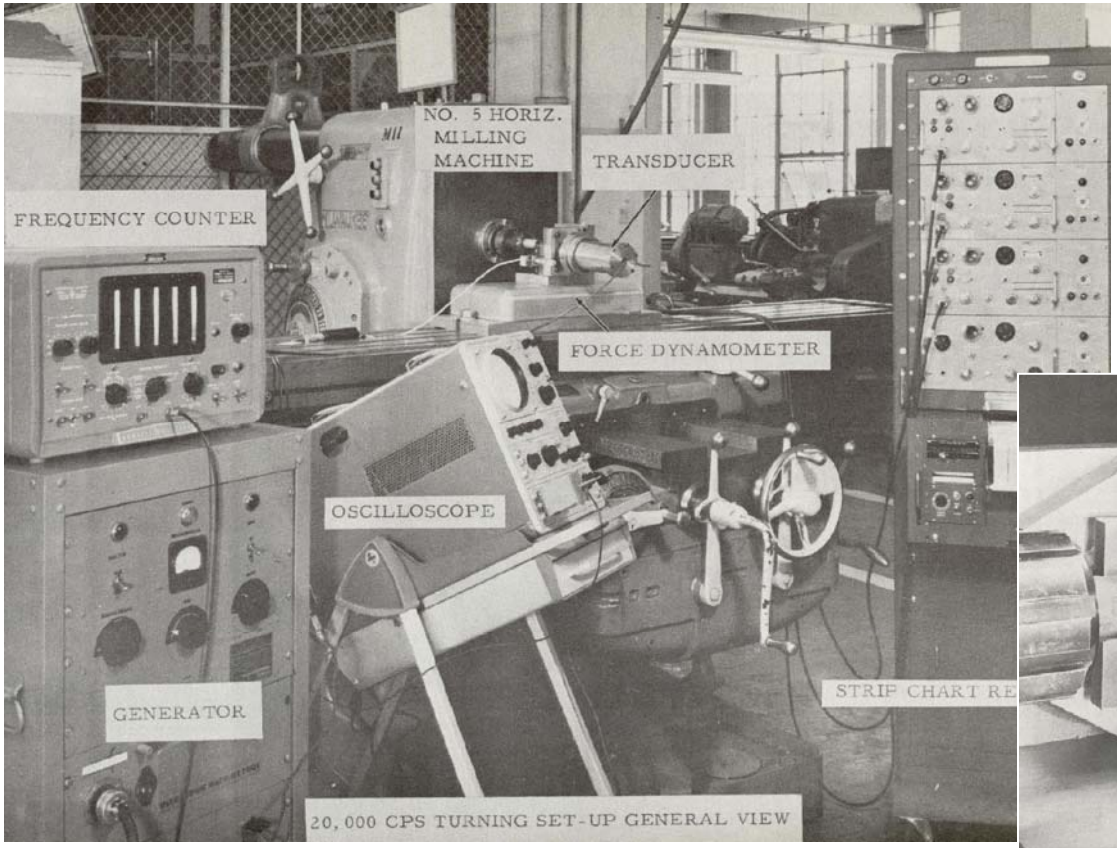
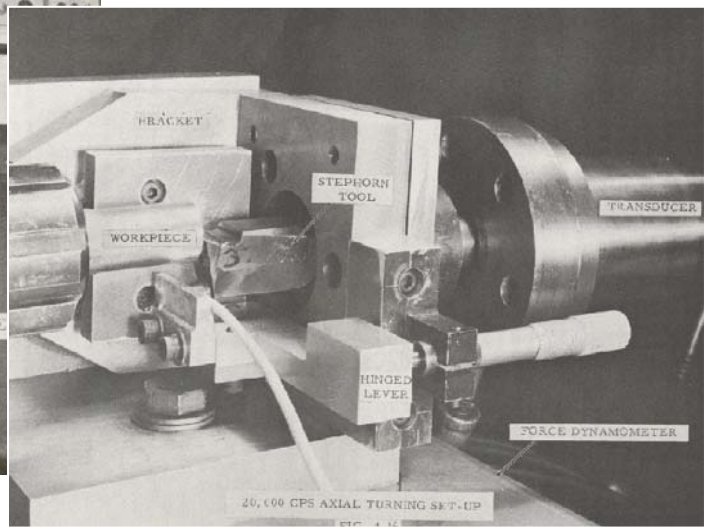
Work at Cincinnati Milacron – 1960s





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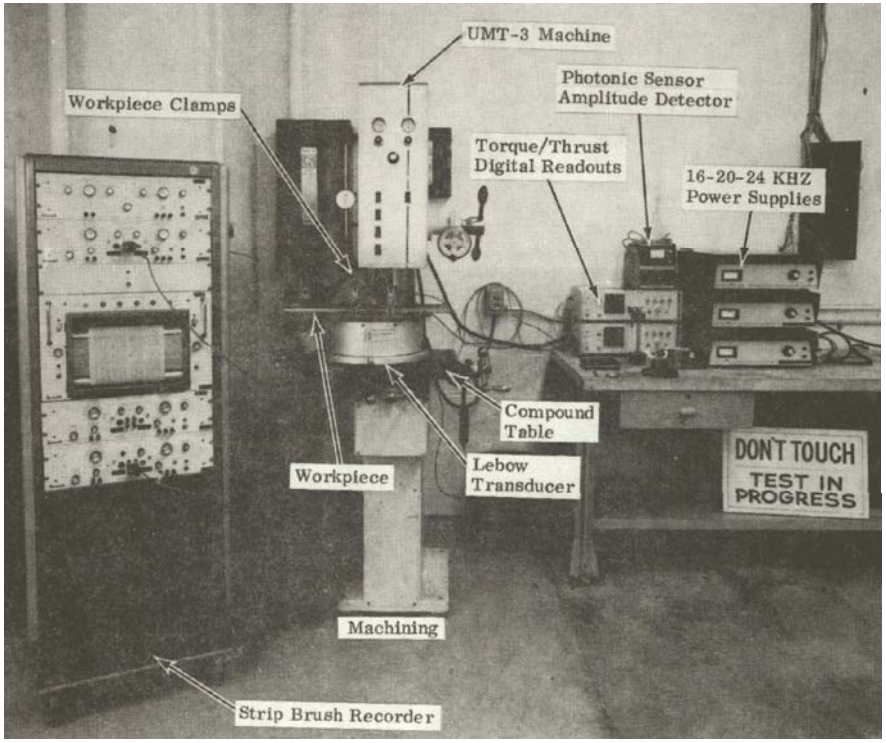
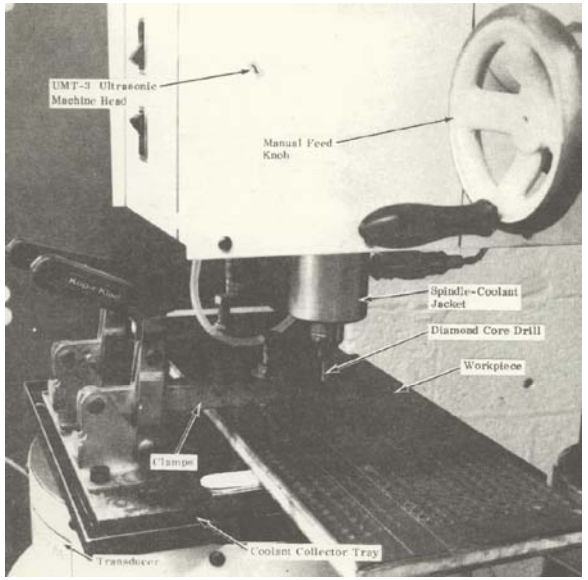
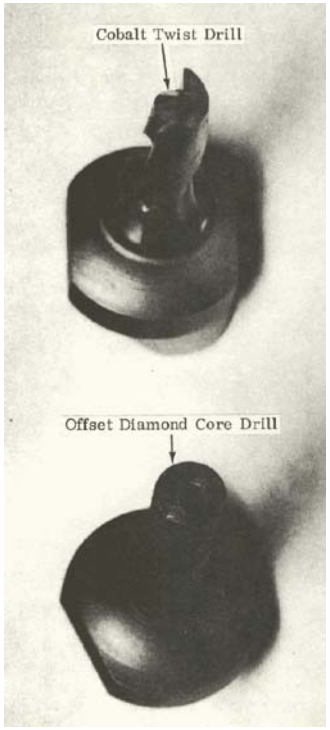
Work at Grumman – 1970s







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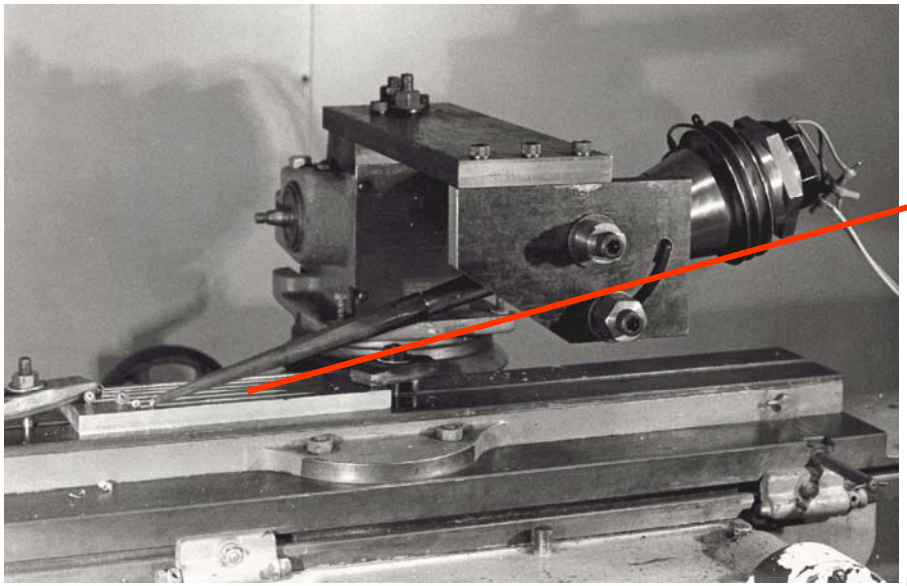
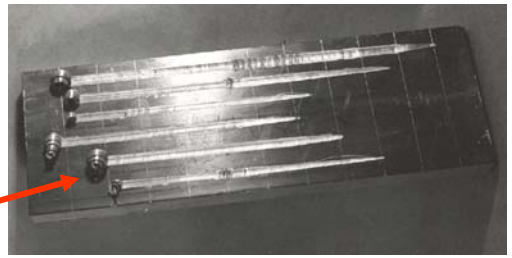
Ohio State – 1970s



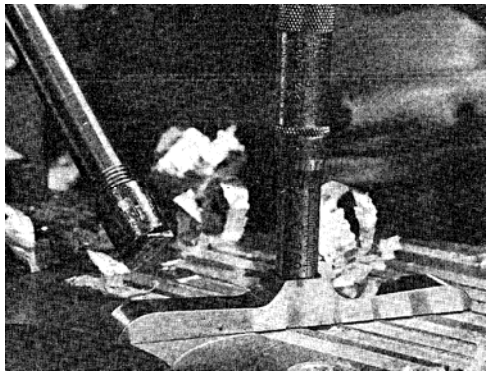


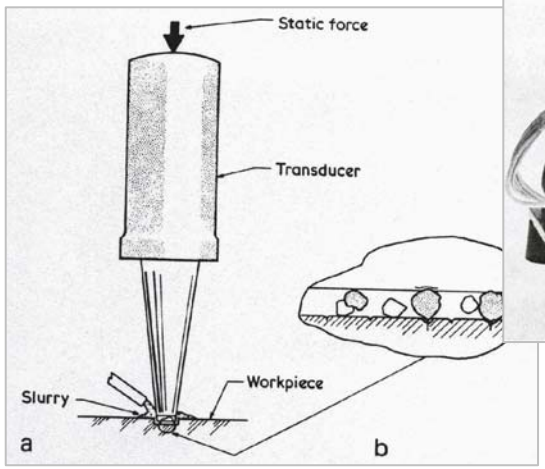
Macrosonics in industry

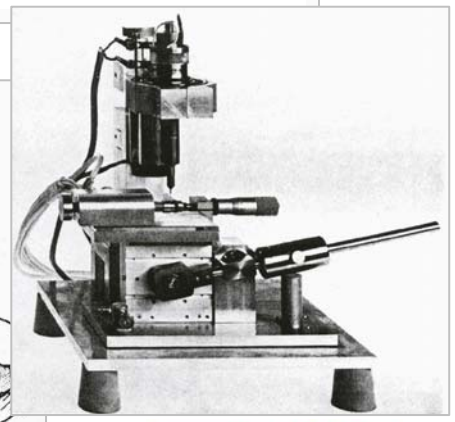
5. Ultrasonic machining

K. F. GRAFF

Ultrasonics, May 1975







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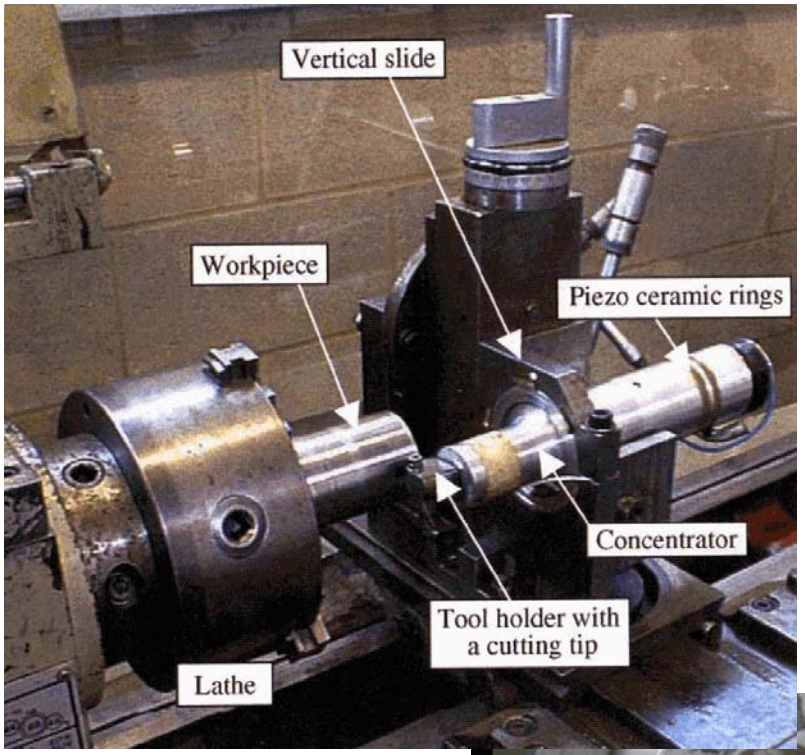
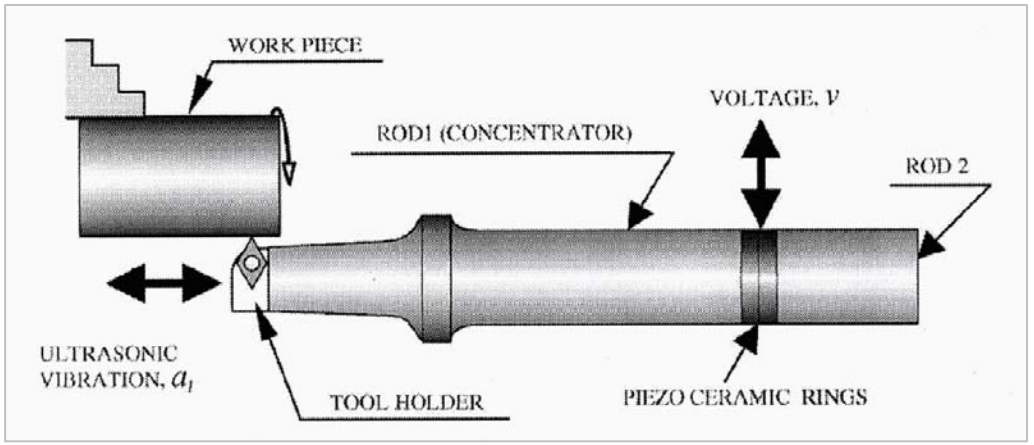
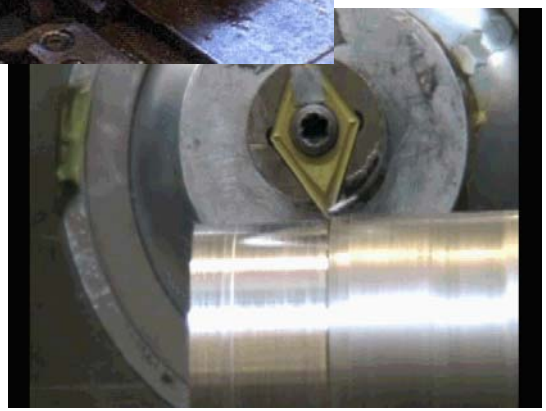
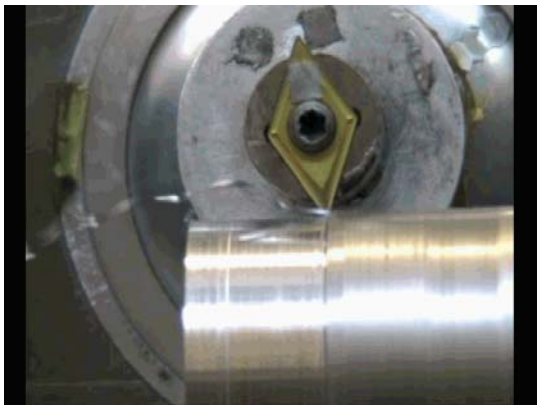
Work at Loughborough ~ 2006









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…Work on Twist Drilling

ELSEVIER

Ultrasonics

Ultrasonics 36 (1998) 89–96

Ultrasonic cutting as a nonlinear (vibro-impact) process

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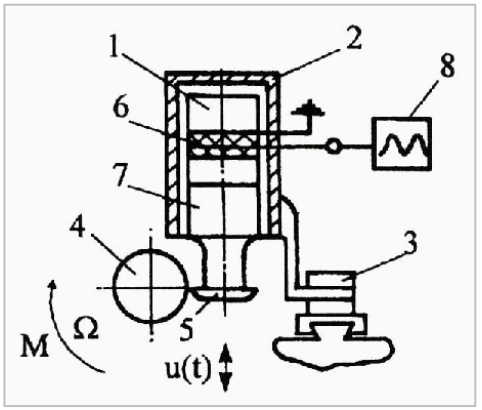
[b] Department of Mechanical Engineering, Loughborough University, Loughborough, Leicestershire LE11 3TU, UK



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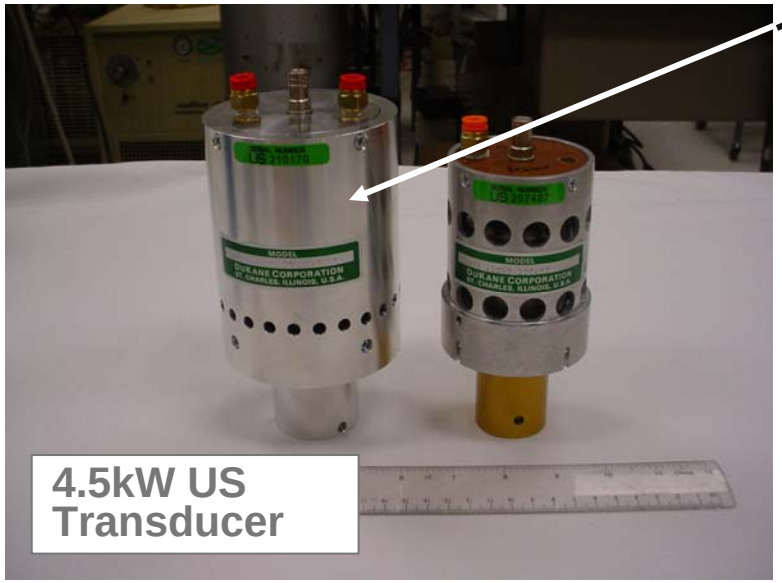
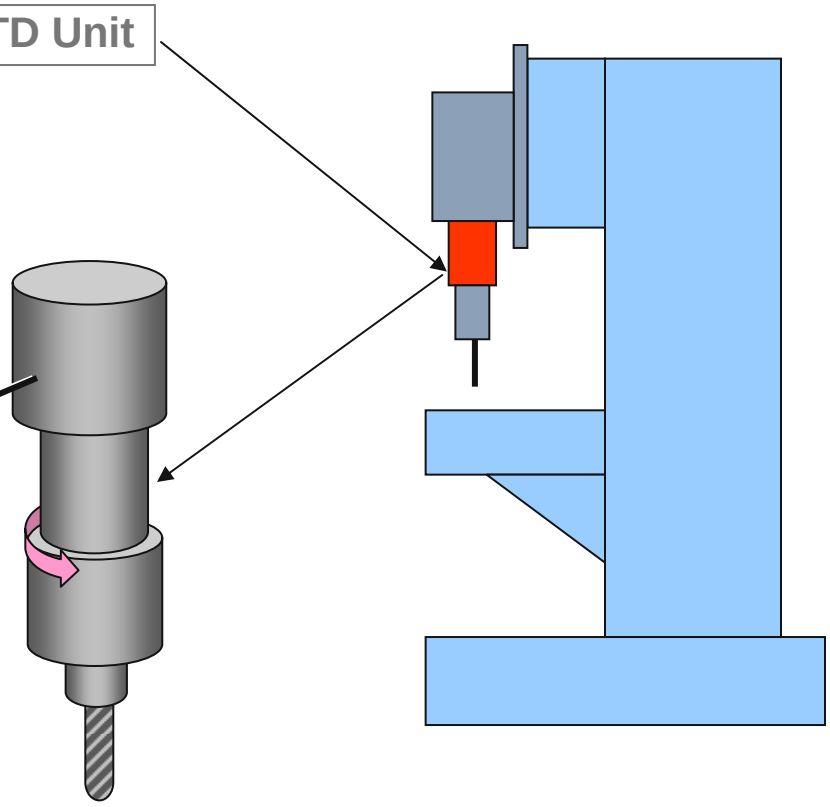
EWI concept for US TD System

- Basic concept …
- US unit …





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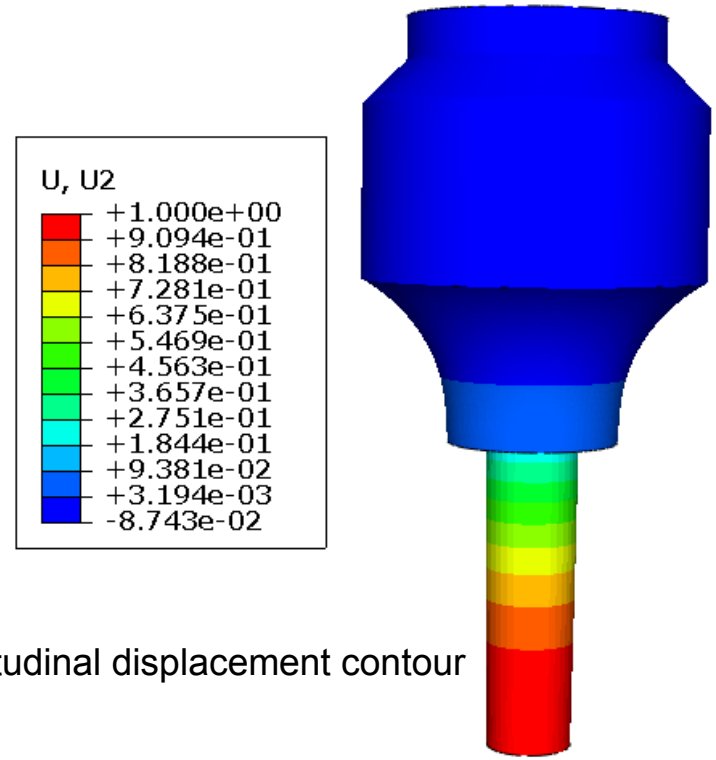
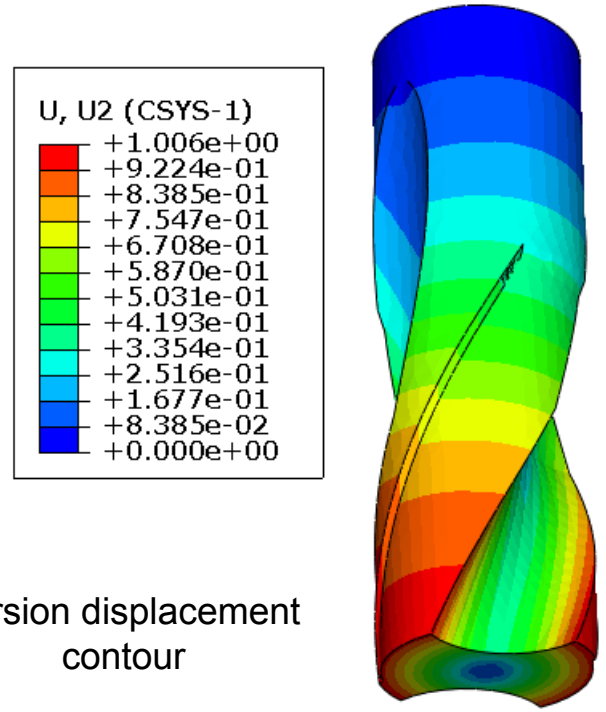
Vibration analysis of drill concepts



Longitudinal displacement contour



Torsion displacement contour

Investigation of individual vibration modes

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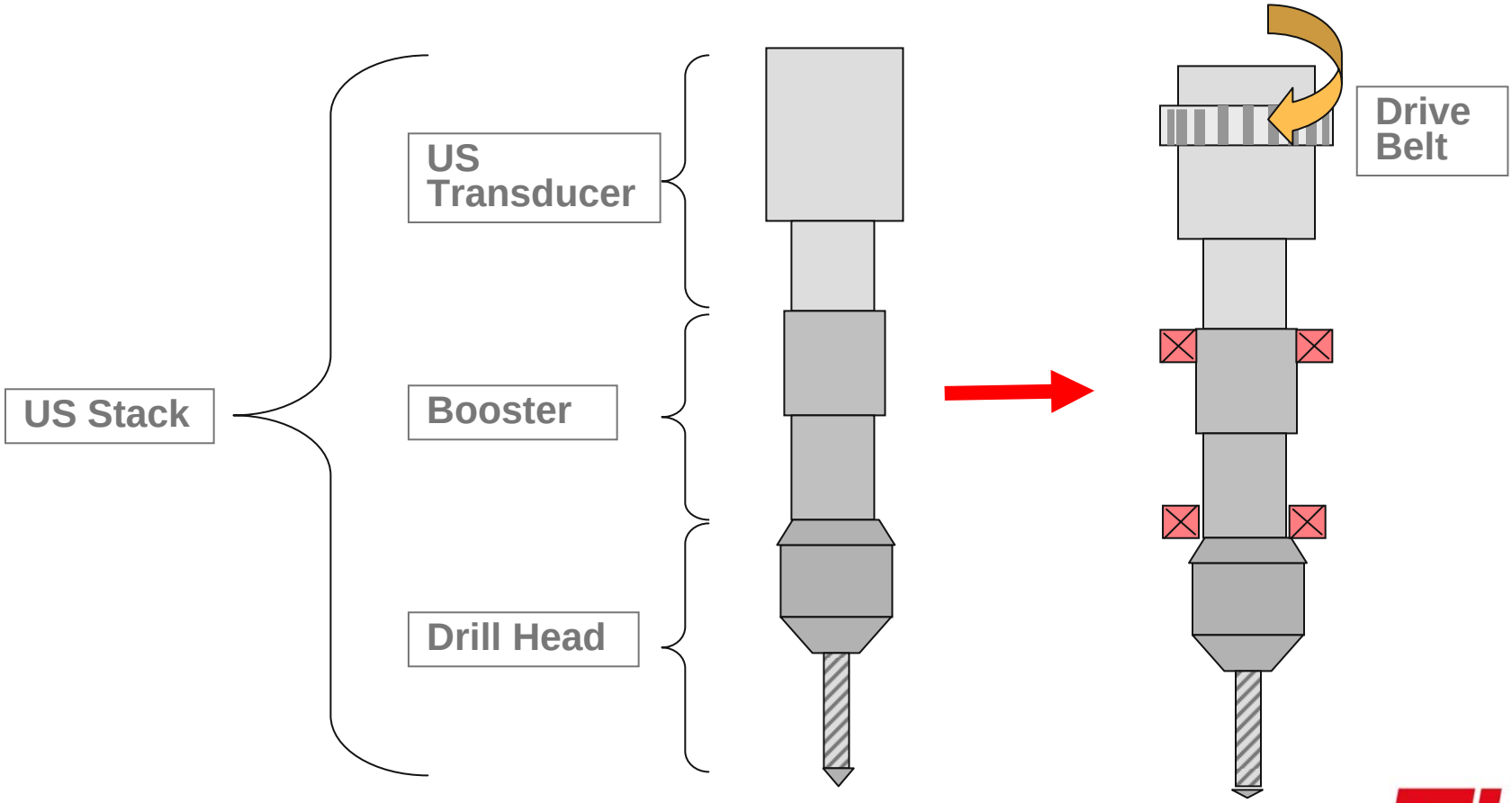
US Drilling – Allowing for Support, Rotation, Force, and Electrical Connections



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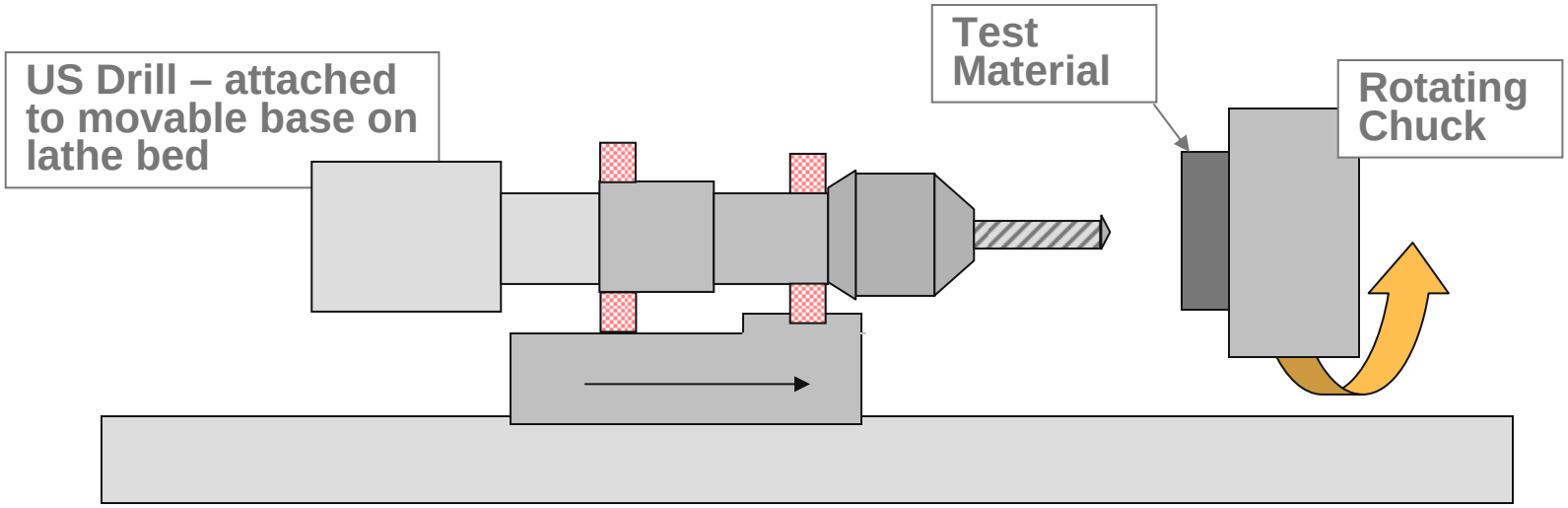
Stationary US Drilling Test Bed

- **Permits development of US components and tooling for drilling, milling, turning**



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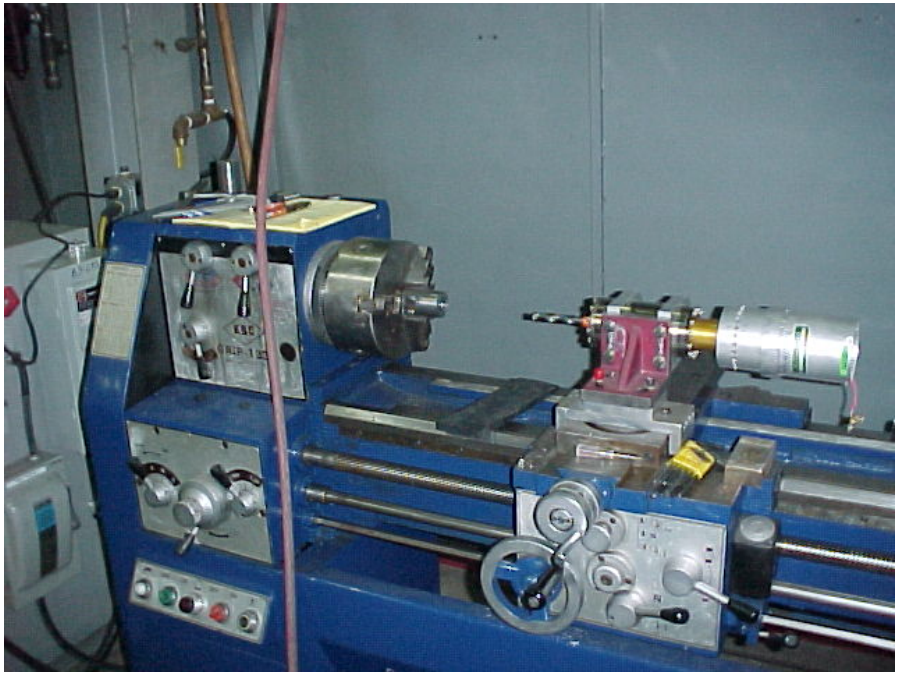
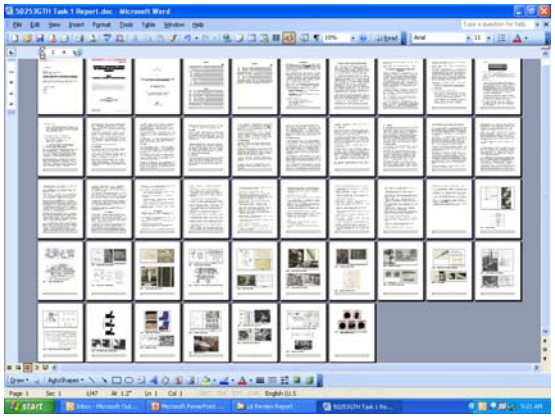
Current Work at EWI



Test bed (configured for drilling in this photo)



Comprehensive literature search

Drill designs

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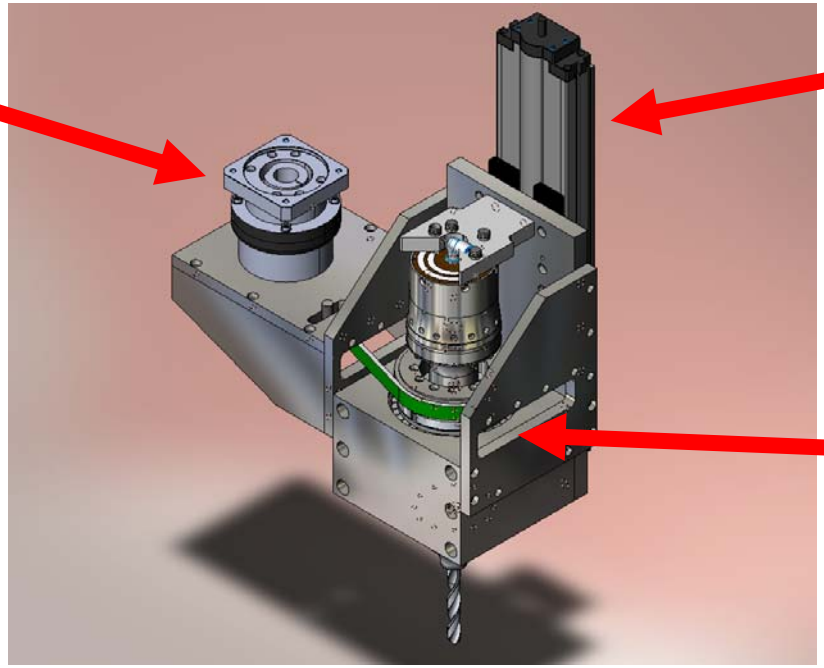
Current Status



Drill head design: Mounts on standard "knee" mill

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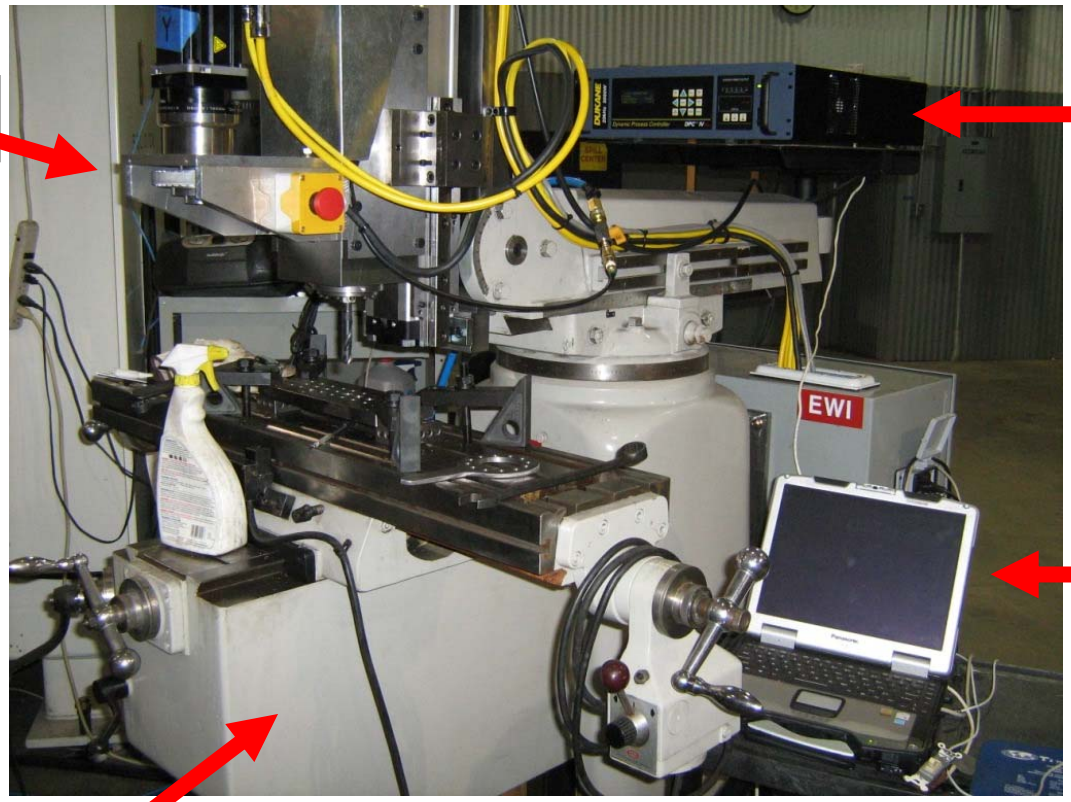
Current Status

Drill head



Dukane 20kHz, 5kW power supply

Laptop for control of drives, US, and data collection

Knee mill

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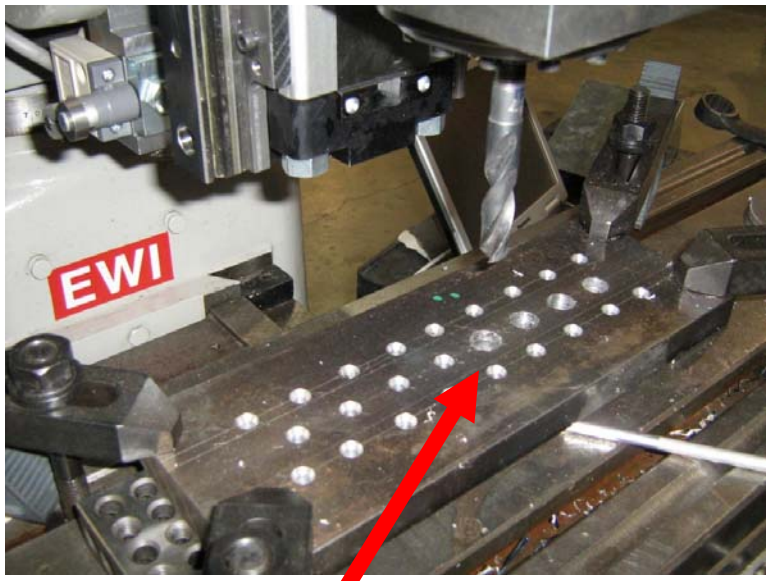
Drilling with Vertical Mill

- ½” drill bit into ¾” steel plate
  - without sonics: 45s
  - with sonics: 15s
  - Power draw up to 2kW
- 1/8” drill bit into ¼” steel plate
  - without sonics: 15s
  - with sonics: 1.2s
  - Power draw up to 600W
- ¾” drill in development
- Video to follow…



½” holes in steel plate

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Drilling with Vertical Mill

- Video of ultrasonic twist drilling with ½- and ⅛-in. bits

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Next Steps

- Investment of resources to evaluate and enhance the technology (process/product) originally developed by EWI
- Continuing applications development
  - With input from industry
- Considering future portable systems

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Questions

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