New Directions in Production and Inspection

by

Thomas R. Kurfess, Ph.D., P.E.
Professor

The George W. Woodruff School of Mechanical Engineering
and the
Manufacturing Research Center
Georgia Institute of Technology
Atlanta, GA  30332-0405
An Old Sensor a New Use

- Insertion Sleeve
- Measurement Head
- Work Piece
- Grinding Spindle
- Grinding Wheel
- Probe
Real-Time Measurement

Probe 1

500 nm/div

10 UPR High-Pass Filter

Probe 2

500 nm/div

10 UPR High-Pass Filter
Real-Time Frequency Analysis

- 31 UPR Indicating High Frequency Chatter.
Part – Turbine Nozzle Segment
Fadal VMC15 Machining Center

Machine Table  Fixture  Spindle  Fadal CNC Control
Machining
Inspection
Turbine Nozzle - Results
Controlling a Different Parameter - Subsurface Damage (Ti-Al γ)
**Subsurface Damage**

- Polished as-cast
- Damage depth
- Ground surface
- Polished as-cast surfaces
- Polished

**Images:**
- As-cast
- Damaged
- Polished

**Equation:**

\[ V_s = 30 \text{ m/s}, \ V_w = 0.5 \text{ m/min}, \ a = 25 \mu m \]
Deviations from Target and Analytics
Micro-Metrology - A Penny
Micro-Gear Analysis – Thinking Small

- Microtoming
- Tomography
Approach: Micro-Fabricated Position Sensing Grating Interferometer

- Based on intensity measurement of the diffraction pattern created by a grating and microlens
- Better resolution at focus
- Compact design.
Dynamic Measurement.

- MEMS Microphone
  - 160 \( \mu m \) diameter
  - Electrostatic actuated at 726 kHz by 100V(DC)\( \pm \)16V(AC)
  - 5, 10, 15 burst

- Detector signal
  - 720kHz\( \approx \)10cycles/1.39x10\(-5\) sec
  - Shows ringing.
Imaging at Focal Plane ($z=0$)
Optoelectronics Integration

- Flexible grating fingers
- Integration of electronics

- Fabrication of detector array
  - 1 mm pitch
  - 300 µm x 300 µm and
  - 100 µm x 100 µm.