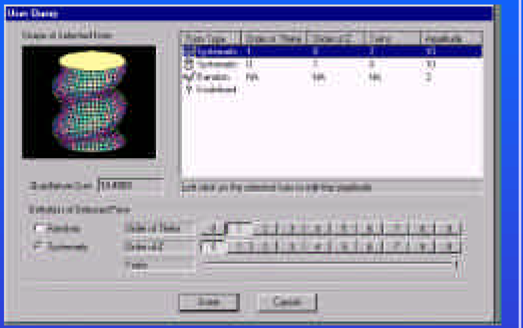
Shop Floor as a National Measurement Institute

Goal

- To provide technical methodologies, tools, education, and standards to allow US manufacturing firms to meet the global market requirement for “new traceability” by making measurements on the shop floor

Deliverables

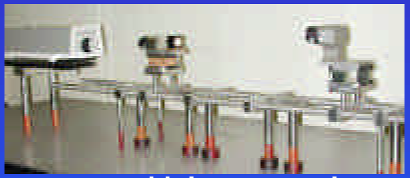
- Shop floor laser based ball bar calibration instrument
- Web based metrology tutorials
- Dilatometer for coefficient of thermal expansion measurements
- Methods to rapidly calculate the shop floor measurement uncertainty from thermal distortion of workpieces
- Long beam path index of refraction corrections for shop floor measurements



Customers and Collaborators

- Boeing Corporation
- Caterpillar Corporation
- MetroSage LLC
- University of Florida
- Air Force CCG Program

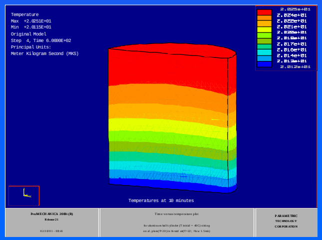
Dilatometer for CTE Measurements

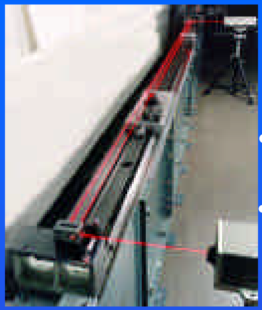


Invar instrument with laser metrology system, environmental enclosure not shown

Thermal Distortion of Workpiece Measurements

FEA analysis provides guidance for more approximate but rapid calculation methods

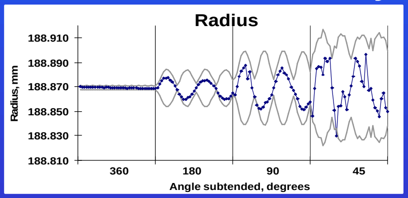




Long Beam Path Interferometry

- Web based index of refraction calculations
- Multi-wavelength determination of effective index

Measurement Uncertainty



Measurement uncertainty based on novel simulation by constraint method

Shop Floor as a National Measurement Institute

Steven D. Phillips, Program Manager (FY-2001)

Program Goal:

To increase the number of shop floor dimensional measurements satisfying the "new traceability" requirements

"New Traceability"
The property of a result of a measurement such that it is related through an unbroken chain of comparisons, each with stated GUM*-based uncertainty, to an international or national standard

* *Guide to Expression of Uncertainty in Measurement*, ISO, 1993

Shop Floor as a National Measurement Institute

Program Objectives (revised in FY 2001)

(1) closer connection to the international standard of length by reducing the dependence upon calibrations made by NIST or any other National Measurement Institute (NMI) and corresponding improvement in measurement accuracy;

(2) measurement uncertainty statements to describe the expected variability in the measurement result;

(3) education of industrial public on measurement uncertainty and traceability

Coefficient of Thermal Expansion Project
Project Leader: Ted Doiron

Dilatometer for measuring CTEs is 80% Complete

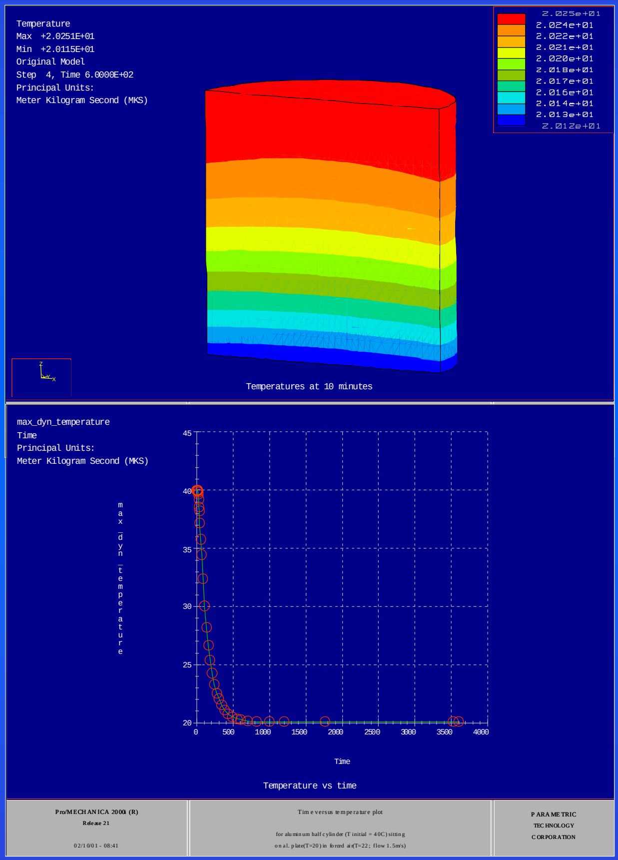
Web site searchable database of CTEs is under development

Web site of on CTE tutorial and thermal uncertainty under development

Thermal Distortion of Workpieces Project

Project Leader: Al Wavering

Developing rapid methods to estimate the measurement uncertainty due to thermal distortion & Evaluate shop floor environments



Separation of general problem into simpler classes

- Bulk metallic workpieces subject to moderate air convection are isothermal: T(x,y,z,t) ® T(t)
- Simple conduction problems are modeled by linear temperature gradients T(x,y,z,t) ® T(t) + ∇T(t)
- Complex problems are attached by a thermal power series: $\left\{(T-20), \frac{\partial T}{\partial t}, \frac{\partial^2 T}{\partial t^2}, \nabla T, \nabla^2 T, \frac{\partial^2 T}{\partial t \partial x} \ldots\right\}$

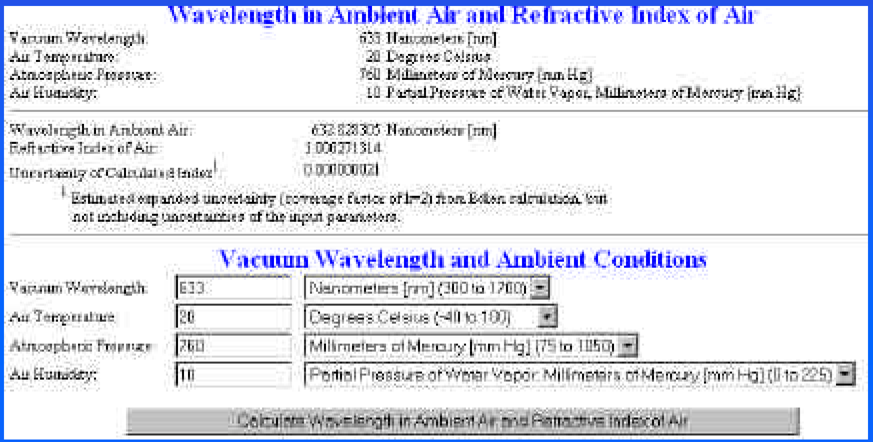
  and Nearest Neighbor Perturbation $\sum_{j}^{N} G_{ij}$

Shop floor thermal conditions are being measured and human interface queries developed to extract information from industrial personal.

Long Beam Path Interferometry Project

Project Leader: Jack Stone

- Errors in Edlen equation that limit its accuracy under shop floor conditions have been identified



- Web page created that does Edlen and Ciddor calculations of index
- Web-based tutorial on index of refraction completed
- Optical multi-wavelength interferometry to determine effective index of refraction over long beam paths determined to be uneconomical but supplemented with acoustic frequencies under investigation
- B89.1.18 standard on interferometer testing addressing traceability and discuss uncertainty budgets in final draft form

Measurement Uncertainty Project
Project Leader: Steve Phillips

- Laser interferometer based ball bar length measuring instrument 70% complete (UF collaboration)

- Coordinate transformation test software complete

- Web pages on introduction to measurement uncertainty for industry 75% complete

- B89.7.3 Standard on Application of Uncertainty (decision rules & uncertainty integrity) in final draft form