Center for Machine Tool Systems Research (CMTSR)

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Machining Software to Improve Part Quality and Production

Computer software to simulate machining and machine tool systems developed by the center has yielded improvements to parts' quality and production. The Center members that have been using the suite of machining simulation software developed by UIUC Professors Richard DeVor and Shiv Kapoor in engineering design, manufacturing, and diagnostic activities within their corporations include General Motors, Ford Motor Company, Caterpillar Inc., Kennametal, Inc. and Delphi Automotive. Specifically, the process simulation work has helped companies to develop reconfigurable fixtures for rapidly changing part designs and fault diagnosis work in machining processes that employ a control cycle and exercise control over product, processes, and resources. A joint venture that happened because of center I/UCRC research work on process simulation is a new company called "Pre-con." For more information, contact Ed De Chazal, 313-821-5897; e-mail: edechazal@webcradle.net.

Constant Velocity Joint Wear Measurement and Analysis

Professor Mike Philpott at the University of Illinois, Urbana-Champaign, working with Center member Rockford Acromatic, Rockford, Ill. on the Constant Velocity Joint Wear measurement and analysis research received two U.S. patents. The research addressed the problem facing the Constant Veloity (CV) rebuilder of evaluating the specific component, or components, in the driveline needing to be replaced or refurbished. The economics of CV joint rebuilding is dependent on the rebuilder's ability to accurately evaluate component degradation and serviceability. The primary invention relates to the mathematical models of measuring and quantifying wear in the complex profiles of CV joints, without prior knowledge of the nominal or designed geometry. The instrument provides a direct quantitative method of CV joint track wear. The second patent deals with the development of a handheld device for measuring certain important parameters of splines. The patents were U.S. Patent No. 128,992 on "Method and Means for Measuring Wear in Constant Velocity Joints" Oct 15, 1996; and U. S. Patent No. 315071 on "Spline Counting Mechanism" Nov. 21, 1995.

Feature-Based Costing Software

A company named FBC Systems was created based on feature-based costing technology work funded by Center for Machine Tool Systems Research. The company has developed the first feature-based costing software that allows engineers to determine the cost during the early conceptual design stage of product development. The focus of this research has been on developing cost models based on key cost drivers in the designers' knowledge domain. The software is designed to help engineers make choices that minimize the cost of parts before one gets further into the product development cycle. For more information, on FBC Systems, contact Dr. Mike Philpott at mphilpot@fbcost.com or Eric Hiller at ehiller@fbcost.com, web site: FBCost.com.

Ceramics Machining Technology

Technology for machining ceramic materials has led to joint patents between the University of Illinois (Professor P. M. Ferreira and his students) and the Nashua Company. A hybrid process that combines conventional grinding with ultrasonic grinding was developed for machining ceramic materials. An experimental test rig, consisting of a modified milling machine fitted with an ultrasonic spindle and a constant pressure feed worktable, was developed to demonstrate the feasibility of the new technology. The research has been shown to improve the productivity of machining ceramic components, including machining of ceramic disks used by computer industry, and possible suppression of tool glazing to make the process more widely acceptable ("Rotary Ultrasonic Grinder," U. S. Patent Number 08,447,780, 1997).

Tetrahedral Tripod Type Machine Tool

A functional Tetrahedral Tripod Type machine tool, which is based on the use of hybrid serial-parallel schemes, has been designed, constructed, and delivered to Center member Caterpillar, Inc. for applications in ceramic machining. It has spatial positioning capability that positions the platform in space with no rotations. The design is modular, and possesses speed, accuracy, and high stiffness. It is reconfigurable so that it can be tailored to manufacturer needs, including 3-axis milling. It also addresses the complex issues of precisely controlling the machining process, the need for high machine stiffness in grinding of structural ceramics, and issues involving precise tool-workpiece engagement by employing a hybrid position/force controller.

Micromechanical Test Apparatus

Prof. Sottos at the University of Illinois Urbana-Champaign (UIUC) and Dr. Andrew Skipor at Motorola Labs, Motorola Advanced Technology Center (MATC), have established a successful record of research and tech-transfer. Their first Motorola sponsored project (1994-1999) investigated bending reliability and dimensional stability of plastic ball grid array (PBGA) packages. This research resulted in the development of a unique capability to test small-scale electronic components. A micromechanical test apparatus was designed specifically to investigate the response of area array electronic packaging to both thermal and flexural loading.

Self-Healing Polymers to Improve Microelectronic Components

The Machine Tool Systems Research Center's current Motorola sponsored project (2001-2004) seeks to improve the reliability of microelectronic components through the use of self-healing polymers. A comprehensive experimental program is in progress to assess the fatigue behavior of self-healing polymers for potential use in printed circuit board (PCB) laminates. Excellent progress has been made on characterizing the fatigue characteristics of self-healing epoxy. A self-healing PCB laminate test vehicle was designed and fabricated for on-site testing at Motorola by Dr. Andrew Skipor.