

The North American Manufacturing Research Institution  
of the Society of Manufacturing Engineers Announces its ...

# TWENTY-FIRST NORTH AMERICAN MANUFACTURING RESEARCH CONFERENCE

## NAMRC XXI

May 26 - 28, 1993

and

*Symposium on U. S. Contributions to Machining  
and Grinding Research in the 20th Century*



Oklahoma State University  
Stillwater, Oklahoma, U. S. A.



**NAMRI** SME

Society of Manufacturing Engineers



Dear Colleague:

Welcome to NAMRC XXI.

This year, Oklahoma State University is pleased to host the North American Manufacturing Research Conference, an established international forum for technical presentations and discussion of basic and applied research results in material removal, material forming, machine tools, and manufacturing systems and controls.

There will be 61 papers presented representing 11 countries. All papers have been accepted by a peer review process conducted by the NAMRI/SME Scientific Committee. In addition, Jim Bryan, who has spent his distinguished career in precision engineering at Lawrence Livermore National Laboratory will speak to us in the keynote presentation on some implications of precision engineering on the future of manufacturing.

Immediately following the conclusion of NAMRC there will be a weekend symposium on "U. S. Contributions to Machining and Grinding Research in the 20th Century" honoring the pioneers and major contributors to the advancement of machining and grinding technology.

We hope that you will find NAMRC XXI and the historic weekend symposium a very productive and enjoyable experience.

Cordially,

*Don Lucca Ranga Komanduri*

Don Lucca and Ranga Komanduri  
Organizing Committee Co-Chairmen  
Oklahoma State University

Immediately following NAMRC XXI...

## **Symposium on U. S. Contributions to Machining and Grinding Research in the 20th Century**

Major contributions in advancing the science and technology of machining and grinding came about during this century starting with the pioneering work of F. W. Taylor, followed by that of O. W. Boston, H. Ernst, M. E. Martellotti, M. Kronenberg, M. E. Merchant, M. C. Shaw, B. T. Chao, K. Trigger, M. Field, A. O. Schmidt, W. W. Gilbert, F. Boulger, L. Colwell, C. Oxford, E. Thomsen, R. Hahn and their colleagues.

This two day symposium begins at 11:30 Friday, May 28 and concludes Sunday, 1:15 PM, May 30, 1993.

This historic Symposium will highlight the manufacturing research contributions (machining and grinding) predominantly by the U. S. researchers that enabled us to contribute towards the improvement of our standard of living. Some of the U. S. pioneers in manufacturing research will be in attendance to reflect on their work and record their experiences. It is planned to videotape the proceedings of the conference and provide the videotape highlights to the conference attendees. This event is planned to be interactive where the speakers, moderators, and audience are encouraged to participate in the deliberations of the Symposium.

See registration panel to register  
separately for this Symposium

## 1992-93 NAMRI/SME Board of Directors

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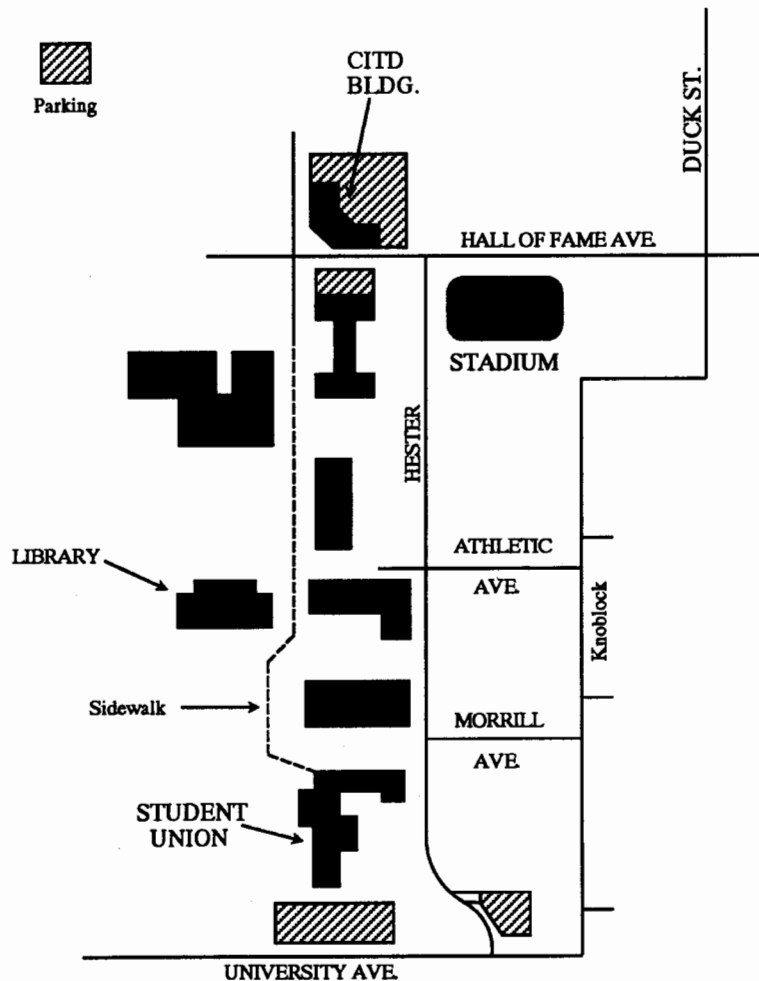
### NAMRC XXI Organizing Committee

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Y. Koren, University of Michigan  
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S. C-Y. Lu, University of Illinois at Urbana - Champaign  
A. T. Male, Concurrent Technologies Corporation  
S. Malkin, University of Massachusetts  
O. Masory, Florida Atlantic University  
S. I. Oh, Battelle Memorial Institute  
K. P. Rajurkar, University of Nebraska  
S. Ramalingam, University of Minnesota  
W. B. Rice, Queen's University  
G. Sathyanarayanan, Lehigh University  
C. H. Shen, General Motors Corporation  
R. Shivpuri, Ohio State University  
S. Smith, University of Florida  
K. Srinivasan, National Science Foundation  
J. M. Story, Aluminum Company of America  
J. W. Sutherland, Michigan Technological University  
J. Tlusty, University of Florida  
B. F. von Turkovich, University of Vermont  
K. J. Weinmann, Michigan Technological University  
W. R. D. Wilson, Northwestern University  
P. K. Wright, University of California - Berkeley

## Campus Map



## The Conference at a Glance

Campus building key: S.U. = Student Union  
CITD = Center for International Trade Development

Time	Event	Location
<b>Tuesday, May 25, 1993</b>		
5:00 - 7:30 PM	Evening Registration --	S. U. Sequoyah Room #280
6:00 - 7:30 PM	Reception --	S. U. Sequoyah Room #280
4:00 PM	NAMRI/SME Board of Directors Meeting -	S.U. Council Room #250
7:00 PM	NAMRI/SME Board of Directors Dinner -	S.U. Council Room #250
<b>Wednesday, May 26, 1993</b>		
8:00 AM	Registration --	CITD Foyer
	Continental Breakfast --	CITD Foyer
9:00 AM	Welcome & Keynote Presentation --	CITD Auditorium
10:30 AM	Concurrent Technical Paper Sessions	
12:00 - 1:30 PM	Lunch --	CITD Exhibit Hall
1:30 - 5:00 PM	Concurrent Technical Paper Sessions resume	
7:00 PM	Conference Banquet --	Best Western Hotel, 600 E. McElroy Ave.
<b>Thursday, May 27, 1993</b>		
8:00 AM	Registration --	CITD Foyer
	Continental Breakfast --	CITD Foyer
8:30 AM	Concurrent Technical Paper Sessions	
12:00 - 1:30 PM	NAMRI/SME Recognition Luncheon --	CITD Exhibit Hall
1:30 - 3:30 PM	Concurrent Technical Paper Sessions resume	
3:30 - 5:00 PM	Tour of Manufacturing Laboratories	
5:00 - 6:00 PM	Wine and Cheese Reception --	S. U. Sequoyah Room #280
6:00 PM	NAMRI/SME Membership Meeting --	S. U. Case Study #412
7:00 PM	ASME Production Engineering Div. Meeting --	S. U. Case Study #412
<b>Friday, May 28, 1993</b>		
8:00 AM	Symposium Registration -- Continental Breakfast --	CITD Foyer
8:30 AM	Concurrent Technical Paper Sessions	
10:00	Coffee Break and Adjourn	

## NAMRC XXI Technical Sessions and Program

Tuesday

### Tuesday, May 25

#### 5:00 PM - 7:30 PM - Registration

Student Union, Sequoyah Room #280 - 2nd Floor

#### 6:00 PM - 7:30 PM - Evening Reception

Student Union, Sequoyah Room #280 - 2nd Floor

#### 4:00 PM - NAMRI/SME Board of Directors Meeting

Student Union, Council Room #250 - 2nd Floor

#### 7:00 PM - 8:00 PM - NAMRI/SME Board of Directors Dinner

Student Union, Council Room #250 - 2nd Floor

### Wednesday, May 26

8:00 AM

#### Registration and Continental Breakfast

Center for International Trade Development, Foyer

9:00 AM

#### Opening Remarks

Center for International Trade Development, Auditorium

D. A. Lucca, Organizing Committee Co-Chairman

#### Welcoming Remarks

R. M. Bowen, Provost and Vice President for Academic Affairs

K. N. Reid, Dean of the College of Engineering, Architecture and Technology

#### Introductory Remarks

G. D. Lahoti, NAMRI/SME President, The Timken Co.

#### Keynote Presentation

"Lessons from the History of Precision Engineering and Their Role In the Future of Manufacturing", J. B. Bryan, Pleasanton, CA

#### About the Keynote Speaker

Jim Bryan has devoted his entire career to precision engineering. Making and measuring precision components and identifying the enemies of ideal performance continue to be his goal. An active member of B-89 since its 1963 founding, he was instrumental in three of its major standards. His key role in the development of precision diamond turning is world famous.

He has organized innumerable seminars, prepared dozens of papers, and served on the advisory panel of the Center for Manufacturing Technology of NBS. He has been honored many times, including medals from SME and SPIE. Jim is an active member of CIRP, ASME, and SME, and served on the Board of Directors of the American Society for Precision Engineering.

Since retiring from Lawrence Livermore National Laboratory, he has become a busy consultant when not sailing in the San Francisco Bay.

## NAMRC XXI Technical Sessions and Program

Wednesday continued

10:00 AM - 10:30 AM

#### Coffee Break

10:30 AM - 12:00 Noon

#### Session FM-1, Room #101 - 102

Co-Chairmen: A. T. Male, Concurrent Technologies Corp. and F. Micari, Università di Palermo

FM-1-1: "Analysis of Tooth Profile Accuracy in Precision Forged Spur Gears with Involute Teeth", M. H. Sadeghi and T. A. Dean, Tarbiat Modarres University, Iran

FM-1-2: "Determination of Heat Transfer Coefficients for Forgings Cooled in Different Media", R. Mehrotra, A. Vedhanayagam and R. Shivpuri, Ohio State University

FM-1-3: "Normalizing Heat Transfer versus Forced-Air Cooling of Hot-Forged 1117 Steels", K. Nyamekye, R. Kohser and M. Wicklund, University of Missouri-Rolla

10:30 AM - 12:00 Noon

#### Session MR-1, Room #104

Co-Chairmen: K. S. Taraman, Lawrence Technological University and S. Smith, University of Florida

MR-1-1: "Parametric Tool Path Planning Based on New Variable Step Strategy for Sculptured Surfaces", K. I. Kim and K. Kim, University of Illinois at Chicago

MR-1-2: "CAD Software for Helical Flute Grinding of Milling Cutters", B. Ekambaram and S. Malkin, University of Massachusetts

MR-1-3: "A Radial Depth-Based Tool Path Generation Method for Pocket-Machining", J. C. E. Ferreira and S. Hinduja, Catholic University of Rio De Janeiro, Brazil

10:30 AM - 12:00 Noon

#### Session MS-1, Room #105

Co-Chairmen: R. L. Rhorer, Los Alamos National Laboratory and A. C. Okafor, University of Missouri - Rolla

MS-1-1: "Optimal Selection of Manufacturing Tolerances for Serial Manipulators", O. Masory and A. Kumar, Florida Atlantic University

MS-1-2: "A Modeling System for Finite Element Analysis of Machine Products", T. Moriwaki, N. Sugimura and L. Wang, Kobe University, Japan

MS-1-3: "Analysis of Generating Motion for Five-Axis Machining Centers", S. Sakamoto and I. Inasaki, Keio University, Japan

**NAMRC XXI Technical Sessions and Program**  
Wednesday continued

12:00 Noon - 1:30 PM  
**Luncheon, CITD Exhibit Hall**

1:30 PM - 3:00 PM  
**Session FM-2, Room #101 - 102**

Co-Chairmen: R. N. Wright, Rensselaer Polytechnic Institute and S. C-Y. Tung, General Motors Research Laboratories

FM-2-1: "The Forming Characteristics of Mild Steel Coated with Aluminum by an Arc Coating Process", S. K. Kernosky and K. J. Weinmann, Michigan Technological University

FM-2-2: "Modelling the Joint of Tool-Work Interface Friction and Work Material Bulk Deformation in Metal Working Processes", X. Li, National University of Singapore, Singapore

FM-2-3: "New Concept for a Hydraulically Controlled Sheet Metal Strip Drawing Test Apparatus", J. R. Michler, V. D. Rao, A. R. Kashani, S. A. Majlessi and K. J. Weinmann, Michigan Technological University

1:30 PM - 3:00 PM  
**Session MR-2, Room #104**

Co-Chairmen: B. M. Kramer, National Science Foundation and J. S. VanKirk, Kennametal Inc.

MR-2-1: "Cutting Forces When Turning and Milling Cast Iron with Silicon Nitride Tools", D. A. Stephenson and J. W. Matthews, General Motors Research Laboratories

MR-2-2: "An Investigation of the Vibration of the Face Milling Process During High Speed Machining", R. Radulescu, S. G. Kapoor, W. J. Endres and R. E. DeVor, University of Illinois at Urbana-Champaign

MR-2-3: "A Model for the Stress Field Around the Shear Zone", D. Parthimos and K. F. Ehmann, Northwestern University

1:30 PM - 3:00 PM  
**Session MS-2, Room #105**

Co-Chairmen: W. C. Harsch, Eagle-Picher Research Laboratories and V. Raju, Rochester Institute of Technology

MS-2-1: "Development of a Robot System for Metal Molds Polishing (Application of Fuzzy Set Theory to Polishing Force Control)", T. Aoyama and I. Inasaki, Keio University, Japan

MS-2-2: "Experiments in High Speed Machining Using a Digital Feedforward Controller", E. D. Tung and M. Tomizuka, University of California, Berkeley

**NAMRC XXI Technical Sessions and Program**  
Wednesday continued

MS-2-3: "A Robust Control Scheme for Improved Machined Surface Texture", A. R. Kashani, J. W. Sutherland, J. R. Michler and K. S. Moon, Michigan Technological University

3:00 PM - 3:30 PM  
**Coffee Break**

3:30 PM - 5:00 PM  
**Session FM-3, Room # 101-102**

Co-Chairmen: K. J. Weinmann, Michigan Technological University and N. Saka, Massachusetts Institute of Technology

FM-3-1: "A Feature Based Approach for Simultaneous Engineering of Sheet Metal Components", M. Hoffmann, W. Greska and M. Geiger, University of Erlangen, Germany

FM-3-2: "Prediction of Sheet Metal Forming Limits and Quantitative Analysis of the Error", S. B. Padwal, R. C. Chaturvedi and A. S. Deshpande, Indian Institute of Technology, India

3:30 PM - 5:00 PM  
**Session MR-3, Room #104**

Co-Chairmen: J. E. Mayer, Texas A & M University and C-H Shen, General Motors Technical Center

MR-3-1: "Some Potentially Useful Parameters for Interactive Coated Abrasive Grinding", J. J. Gagliardi and R. J. Cosmano, 3M Company

MR-3-2: "Analysis of Wheel Waviness and Grain Wear in Grinding", H. K. Tonshoff, H. G. Wobker and F. Werner, University of Hannover, Germany

MR-3-3: "Camshaft Grinding Using Coated Abrasive Belts", J. M. Lee, C. H. Shen and E. Wasserbaech, General Motors Technical Center

3:30 PM - 5:00 PM  
**Session MS-3, Room #105**

Co-Chairmen: M. J. Sedlacek, Seagate Technology and D. C. Thompson, Lawrence Livermore National Lab.

MS-3-1: "Development of a Magnetostriction Based Cutting Tool Micropositioner", J. R. Michler, K. S. Moon, J. W. Sutherland and A. R. Kashani, Michigan Technological University

MS-3-2: "Information-Gain-Weighted Multiple Voting Scheme for Automated Fault Diagnosis of Manufacturing Processes", Y. Chen and D. Zhao, University of Michigan-Dearborn

## NAMRC XXI Technical Sessions and Program

Wednesday continued

MS-3-3: "Optimal Quality Image Acquisition", G. A. Joshi and S. M. Pandit, Michigan Technological University

7:00 PM - 9:00 PM

**Conference Banquet**, Best Western Hotel, 600 East McElroy Avenue

**Thursday, May 27**

8:00 AM

**Registration and Continental Breakfast**

Center for International Trade Development, Foyer

8:30 AM - 10:00 AM

**Session FM-4**, Room #101 - 102

Co-Chairmen: N. Alberti, Universita di Palermo and H. Malkani, Alcoa Technical Center

FM-4-1: "Polymer Blow Molding Process Design", J. C. Gerdeen, University of Colorado at Denver

FM-4-2: "FEM Simulator with Mesh Generator for Shape Rolling", K. Mori and K. Osakada, Osaka University, Japan

FM-4-3: "Die Shape Optimal Design in Extrusion of Elliptical and Rectangular Cross Sections from Round Bars by the Finite Element Method", M. S. Joun and S. M. Hwang, POSTECH, Korea

8:30 AM - 10:00 AM

**Session MR-4**, Room #104

Co-Chairmen: M. H. Attia, Ontario Hydro Research Division and D. A. Blaser, General Motors Research Laboratories

MR-4-1: "Influence of Toolholder Interfaces on Tooling Performance", E. I. Rivin, Wayne State University

MR-4-2: "Comparative Analysis of Planar and Helical Micro-Drill Points", S. K. Kang, C. Lin and K. F. Ehmann, Northwestern University

MR-4-3: "Experimental Study on Fixturing Stiffness of T-Slot Based Modular Fixtures", Y. Zhu, S. Zhang and Y. Rong, Southern Illinois University at Carbondale

8:30 AM - 10:00 AM

**Session MS-4**, Room #105

Co-Chairmen: A. Bagchi, Clemson University and J. B. Arnold, Martin Marietta Energy Systems, Inc.

## NAMRC XXI Technical Sessions and Program

Thursday continued

MS-4-1: "A DFM Framework for Integrating ARC Welding Parameters into Design", O. K. Eyada, J. P. Christein and K. K. Krishnan, Virginia Polytechnic Institute

MS-4-2: "Autonomous Turning Operation Planning with Predicting Tool Wear and Surface Roughness", T. Matsumura, T. Obikawa, T. Shirakashi and E. Usui, Tokyo Denki University, Japan

MS-4-3: "Improving the Pre-Planning Stage of CAPP through Case-Based Reasoning", M. Radtke, C. Schultz and G. Warnecke, University of Kaiserslautern, Germany

10:00 AM - 10:30 AM

**Coffee Break**

10:30 AM - 12:00 Noon

**Session MR-5**, Room #104

Co-Chairmen: K. C. Srinivasan, National Science Foundation and E. Kannatey-Asibu, Jr., The University of Michigan

MR-5-1: "A Comprehensive Evaluation of Tool Inserts for Chip Control Using Fuzzy Modeling of Machinability Parameters", I. S. Jawahir and J. Fei, University of Kentucky

MR-5-2: "Acoustic Emission Studies While Machining with Coated Tools", S. Somasundaram and S. Raman, University of Oklahoma

MR-5-3: "A New Process for Internal Finishing of Non-Ferromagnetic Tubing Using Rotating Magnetic Field", T. Shinmura, T. Iizuka and Y. Shinbo, Utsunomiya University, Japan

10:30 AM - 12:00 Noon

**Session MS-5**, Room #105

Co-Chairmen: J. J. Beaman, University of Texas and J. Lee, National Science Foundation

MS-5-1: "Research Issues in Demanufacturing", W. W. Olson and J. W. Sutherland, Michigan Technological University

MS-5-2: "Implementation and Evaluation of a Systems for Interactive Parametric Design", S. Yerramareddy and S. C-Y. Lu, University of Illinois

MS-5-3: "Automated Analysis of 3D Polyhedral Assemblies", P. K. Venuvinod, City Polytechnic of Hong Kong, Hong Kong

10:30 AM - 12:00 Noon

**Session MS-6**, Room #101 - 102

Co-Chairmen: J. Raja, The University of North Carolina at Charlotte and A. R. Klas, Seagate Technology

**NAMRC XXI Technical Sessions and Program**  
Thursday continued

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MS-6-1: "Characterization of Critical Force Levels for a Mobile Robot's Base Stability", C. F. Lin and G. J. Wiens, The University of Michigan

MS-6-2: "Robot Arm Control Using Recurrent Neural Network to Identify Robot's Inverse Dynamics", L. Yan and C. James Li, Columbia University

MS-6-3: "Metrological Methods of Assessment of Industrial and Metrological Robots", L. Nawara, Technical University of Cracow, Poland

12:00 Noon - 1:30 PM

NAMRI/SME Recognition Luncheon, CITD Exhibit Hall

1:30 PM - 3:00 PM

**Session MR-6**, Room #104

Co-Chairmen: M. Hashish, Quest Integrated, Inc. and V. C. Venkatesh, Tennessee Technological University

MR-6-1: "Study of Wire Electrical Discharge Machining of Polycrystalline Diamond", W. Z. Shuang, J. Kozak and K. P. Rajurkar, University of Nebraska-Lincoln

MR-6-2: "A Theoretical Model for Predicting Material Removal Rates in Rotary Ultrasonic Machining of Ceramics", D. Prabhakar, Z. J. Pei and P. M. Ferreira, University of Illinois at Urbana-Champaign

MR-6-3: "On-Line Identification of Spark Distribution Length in WEDM", W. M. Wang and K. P. Rajurkar, University of Nebraska-Lincoln

1:30 PM - 3:00 PM

**Session MS-7**, Room #105

Co-Chairmen: R. B. Jerard, University of New Hampshire and Y. Chen, University of Michigan - Dearborn

MS-7-1: "Guidance of an Infinitely Flexible Manipulator Using Splines Under Tension", P. J. Choi and J. A. Rice, University of Illinois at Chicago

MS-7-2: "Development of the Real Time CAM System Based on Parallel Processing and the Inverse Offset Method", H. Suzuki, H. Koresawa and M. Sakamoto, Kyushu Institute of Technology, Japan

MS-7-3: "Automated Optical Mensuration Using a Vertically Aligned Video Camera", C. C. Wang and S. J. Deutsch, Northeastern University

1:30 PM - 3:00 PM

**Session MS-8**, Room #101 - 102

Co-Chairmen: P. Farrington, University of Alabama-Huntsville and H. J. Stevens, Coming Inc.

**NAMRC XXI Technical Sessions and Program**  
Thursday continued

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MS-8-1: "Preliminary Experimentation and Modeling of Workpiece Displacement During Machining", M. J. Hockenberger and E. C. DeMeter, Pennsylvania State University

MS-8-2: "Development of a Flexible Telephone Jack Mother Board Assembly System", J. I. Ker, F. F. Chen and A. Shukla, Louisiana Tech University

MS-8-3: "Optimal Fixture Design for Deformable Sheet Metal Workpieces", M. R. Rearick, S. J. Hu and S. M. Wu, University of Michigan

3:00 PM - 3:30 PM

**Coffee Break**

3:30 PM - 5:00 PM

**Tour of Manufacturing Laboratories**

The Oklahoma Center for Integrated Design and Manufacturing at OSU conducts research activities which span many departments and three universities (Oklahoma State University, University of Oklahoma, and the University of Tulsa). Facilities on the OSU campus support research in areas which include ultra-precision machining, gentle grinding and polishing of advanced ceramics, low pressure CVD diamond synthesis, magnetic field assisted polishing and in situ machining. In addition, research in computer-aided design and manufacturing, web handling, intelligent systems, computer integrated manufacturing, simulation, and robotics is conducted. A tour of the research facilities which support the above activities at OSU will be given. Transportation to the Mechanical and Aerospace Engineering Research Laboratory will be provided.

5:00 - 6:00 PM

**Wine and Cheese Reception**, Student Union Sequoyah Room #280

Sponsored by the College of Engineering, Architecture and Technology

K. N. Reid, Dean

6:00 PM

**NAMRI/SME Membership Meeting**, Student Union Case Study #412

7:00 PM

**ASME Production Engineering Division Meeting**, Student Union Case Study #412

**Friday, May 28**

8:00 AM

**Registration and Continental Breakfast**

Center for International Trade Development, Foyer



# NAMRC XXI Technical Sessions and Program

Friday continued

8:30 AM - 10:00 AM

## Session FM-5, Room #101 - 102

Co-Chairmen: J. Ivaska, Tower Oil & Technology Co. and R. Shivpuri, The Ohio State University

FM-5-1: "Economical Manufacturing of Gearwheels by Near Net Shape Forging", E. Doege, J. Thalemann, F. Weber and C. Westerkamp, Institute for Metal Forming, Germany

FM-5-2: "Compatibility Between Tool Materials and Aluminum Sheet Metal Forming", K. Dohda and S. Kasiwaya, Gifu University, Japan and Y. Tsuchiya and T. Arai, Toyota, Japan

8:30 AM - 10:00 AM

## Session MR-7, Room #104

Co-Chairmen: F. F. Ling, The University of Texas and R. P. Lindsay, Norton Company

MR-7-1: "Chip Size Fineness Produced in Cutting Si<sub>3</sub>N<sub>4</sub>-BN Composite Ceramics", S. Enomoto and K. T. Yap, Nanyang Technological University, Singapore

MR-7-2: "Surface Finish Enhancement in Milling via Inverse Runout Trajectory Following of Workpiece", S. Y. Liang, J. J. Wang and P. A. Herman, Georgia Institute of Technology

MR-7-3: "Geometrical Quality of Drilled Graphite/Epoxy Composite Holes", C. W. Wern, K. Colligan and M. Ramulu, University of Washington

8:30 AM - 10:00 AM

## Session MS-9, Room #105

Co-Chairmen: K. Subramanian, Norton Company and G. P. Mulholland, New Mexico State University

MS-9-1: "A Simulation Approach to the Modification of an Assembly Line: A Case Study", F. Chan and A. Smith, University of South Australia, Australia

MS-9-2: "Effects of Tool Loading and Replenishing Practice on Design and Operation of Flexible Machining Center", F. F. Chen, J. Ker and D. Xu, The University of Southwestern Louisiana

MS-9-3: "Minimum Roughing Feed Rate for Double-Pass Turning Operation to be Economical Under Finish Feed Constraint", R. V. Narang and G. W. Fischer, Indiana-Purdue University

10:00 AM - 11:00 AM

Coffee Break and Adjourn

## General Conference Information

**Conference Registration:** Registration fees for NAMRC XXI are \$290.00 (U. S. funds) for advance registration and \$315.00 for registration received after May 17, 1993. This fee, payable to "OSU Engineering Extension", includes admission to all sessions, a bound copy of the 1993 Transactions, breakfasts, luncheons, breaks, two receptions and a conference banquet. There are no one-day registration fees or reduced fees for authors or session chairs.

Students and retirees will be admitted to the conference for \$95.00. This fee includes all the breakfasts, luncheons, breaks, two receptions and a conference banquet, but does not include the Transactions.

Extra tickets to conference meals may be purchased in advance or at the conference, at least one day prior to the meal. Please indicate requests for additional meal tickets on the registration form.

**Refund Policy:** Cancellations received by the Engineering Extension office before 5:00 PM CST, May 19, 1993, will receive a full refund. If notification is received by 5:00 PM CST, May 25, 1993, a \$50.00 cancellation fee is charged. The full fee is charged for no cancellation and no attendance.

**To Register:** See the form on the last page to assist in covering all conference details related to your registration.

**Accompanying Person Program:** Join faculty spouses and guests Wednesday for a casual tour of local points of interest and unique shops in downtown Stillwater, including a herb farm (weather permitting), and visits to an antique mall and local craft shops. Round out the tour with a visit to Stillwater's Eskimo Joe's Clothes. You will be back in time for the evening Conference Banquet. Thursday, be part of the trip to Tulsa to visit the world-class Gilcrease Art Museum, featuring the largest collection of Remington and Russell western paintings and sculptures under one roof. The Tulsa outing will continue in the afternoon with optional stops at various points of interests. The \$50.00 registration fee includes all transportation and fees. Meals are not included.

**Conference Entertainment:** Guy Logsdan, an entertainer recognized throughout the southwest, is known for his music, songs, poems, humor and stories about early western cowboy culture and Indian lore. Plan on participating in the conference banquet and enjoying this acclaimed down-home artist's entertainment.

**Parking:** Parking on campus is restricted by permit only. Designated parking for the NAMRC Conference is available only in the indicated areas shown on the map in this brochure.

No

## Travel Considerations

**Hotel Lodging:** A block of rooms have been reserved at the OSU Student Union Hotel, Holiday Inn, and Best Western Hotel, at a special room rate of \$40/night; cut off date for holding the rooms is May 11. For reservations, contact the Student Union Hotel, Oklahoma State University, Stillwater, OK 74078-0532, Phone (405) 744-6835, or FAX (405) 744-7652.

**Residence Hall Housing:** Contact Campus Housing Services, phone (405) 744-6956 directly for room reservations and additional information. \$20/single room, \$15/shared room; includes linens - cash payment required upon arrival.

**Conference Location:** NAMRC XXI will be held at Oklahoma State University, Stillwater, Oklahoma, centrally located in the United States. Stillwater is accessible via major interstate highways and major airlines which service Oklahoma City and Tulsa, approximately 70 miles away. It takes roughly 90 minutes by rental car. A "conference at a glance page & map" in this brochure will guide you to event locations - all paper session events will be held in the newly constructed Center for International Trade Development.

**Travel Arrangements:** International Tours of Stillwater will be pleased to assist you in obtaining the lowest possible airfare. Ask for Debbi Holesko at 1 (800) 678-2255.

**Transportation Assistance To and From the Conference:** Oklahoma State University will provide van transportation to and from the conference BETWEEN THE OKLAHOMA CITY AIRPORT AND STILLWATER ONLY. YOU MUST BE PRE-REGISTERED for the NAMRC Conference or Symposium TO RESERVE A SEAT ON A VAN. To be assured of being provided the most timely van transportation service, please reserve a seat by May 20, 1993, and provide approximate date/time of airport arrival and planned departure from Stillwater on the registration form.

The cost of van transportation is \$45 per person round trip. Plan for 1 3/4 hour van traveling time between the campus and airport.

**Planned Van Schedule:** Currently planned departure schedule from Oklahoma City Airport - you must reserve a seat:

May 25, 1993: 11:00 AM, 4:00 PM, 9:00 PM  
May 26, 1993: 11:00 AM, 4:00 PM  
May 27, 1993: 11:00 AM, 4:00 PM  
May 28, 1993: 11:00 AM, 4:00 PM

Currently planned departure schedule from OSU Student Union Hotel - you must reserve a seat:

May 26, 1993: 8:00 AM, 1:00 PM  
May 27, 1993: 8:00 AM, 1:00 PM  
May 28, 1993: 8:00 AM, 11:30 PM  
May 30, 1993: 1:30 PM

Any alterations to the planned van departure times from the proposed schedule will be faxed to those registered for van transportation.

Registration Form  
**NAMRC XXI**  
May 26 - 28, 1993



**Three ways to register:** mail or fax registration form to OSU Engineering Extension, 512 EN, Stillwater, OK 74078, USA; or Phone (405) 744-5714 or FAX (405) 744-5033

Dr. Mr. Ms. First Name \_\_\_\_\_ Last Name \_\_\_\_\_

Dr. Mr. Ms. First Name \_\_\_\_\_ Last Name \_\_\_\_\_

Organization \_\_\_\_\_

Address Line (1) \_\_\_\_\_

Address Line (2) \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_ Country \_\_\_\_\_

Phone (\_\_\_\_) \_\_\_\_\_ FAX (\_\_\_\_) \_\_\_\_\_

( ) Vegetarian Meals Requested

**"NAMRC XXI" May 26 - 28, 1993**

- \_\_\_ \$290.00 for registration postmarked, faxed or phoned on or before May 17, 1993
- \_\_\_ \$315.00 for registration postmarked, faxed or phoned after May 17, 1993
- \_\_\_ \$95.00 Students and Retirees (includes luncheons and banquet, does not include transactions)
- \_\_\_ Guest lunch ticket for May 26, 1993 \$12.00
- \_\_\_ Guest banquet ticket for May 26, 1993 \$20.00
- \_\_\_ Guest lunch ticket for May 27, 1993 \$12.00
- \_\_\_ Guest name \_\_\_\_\_

- \_\_\_ I need round-trip van transportation to and from Stillwater and the Oklahoma City Will Rogers International Airport (a seat must be reserved) \$45.00 (fill in below)  
Date and time of airport arrival: May \_\_\_\_, 1993 at \_\_\_\_\_ AM PM  
Date and time of departure from Stillwater: May \_\_\_\_, 1993 at \_\_\_\_\_ AM PM
- \_\_\_ Accompanying person program \$50.00  
Accompanying person name \_\_\_\_\_

**"Symposium on U. S. Contributions to Machining and Grinding Research In the 20th Century" May 28 - 30, 1993**

- \_\_\_ \$250.00 Fee
- \_\_\_ \$95.00 Student Fee

**TOTAL PAYMENT (U. S. Dollars)**

Make check payable to "OSU Engineering Extension"

- \_\_\_ Check enclosed \_\_\_\_\_ Will pay at conference
- \_\_\_ P. O. enclosed \_\_\_\_\_ Bill
- \_\_\_ Charge to Mastercard or Visa # \_\_\_\_\_ Exp. Date \_\_\_\_\_