

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

# 20th NORTH AMERICAN MANUFACTURING RESEARCH CONFERENCE

**NAMRC XX**  
**MAY 20-22, 1992**



Washington State University  
Pullman, Washington USA

WSU Photographic Services

*Celebrating*  
1932 **60** 1992  
YEARS OF SERVICE  
TO MANUFACTURING



**NAMRI** SME

North American Manufacturing Research Institution  
of the Society of Manufacturing Engineers

**1991-92 NAMRI/SME  
BOARD OF DIRECTORS**



**PRESIDENT**

Ranga Komanduri  
Oklahoma State University

**PRESIDENT-ELECT**

Goverdhan D. Lahoti  
The Timken Company

**SECRETARY**

Soo-Ik Oh  
Battelle Columbus Laboratories

**PAST PRESIDENT**

David A. Dornfeld  
University of California

**DIRECTORS**

Paul H. Cohen  
The Pennsylvania State University

Delcie R. Durham  
University of Vermont

Ronald A. Kohser  
University of Missouri-Rolla

James M. Story  
Alcoa Tech Center A

William R.D. Wilson  
Northwestern University

**CHAIRMAN, SCIENTIFIC COMMITTEE**

Richard E. DeVor, University of Illinois at Urbana-Champaign

**NAMRC XX ORGANIZING COMMITTEE**

**Abdel Bayoumi, Co-Chair**

**David Hutton, Co-Chair**

Howard Hamilton

Nancy Mack

Hussein Zbib

**1992 SCIENTIFIC COMMITTEE OF NAMRI/SME**

**Scientific Committee Chairman: Richard E. DeVor**  
University of Illinois at Urbana-Champaign

A.E. Bayoumi, Washington State University

J.T. Black, Auburn University

G. Chryssolouris, Massachusetts Institute of Technology

P. Cohen, Pennsylvania State University

M.F. DeVries, University of Wisconsin-Madison

W.R. DeVries, Rensselaer Polytechnic University

D.A. Dornfeld, University of California-Berkeley

N.A. Duffie, University of Wisconsin-Madison

D.R. Durham, University of Vermont

K. Ehmann, Northwestern University

J.C. Gerdeen, University of Colorado-Denver

I. Ham, Pennsylvania State University

S. Kalpakjian, Illinois Institute of Technology

S.G. Kapoor, University of Illinois at Urbana-Champaign

L.A. Kendall, University of Minnesota-Duluth

B.E. Klamecki, University of Minnesota

W.A. Knight, University of Rhode Island

R.A. Kohser, University of Missouri-Rolla

R. Komanduri, Oklahoma State University

L. Kops, McGill University

Y. Koren, University of Michigan

G.D. Lahoti, Timkin Company

S.C-Y. Lu, University of Illinois at Urbana-Champaign

A.T. Male, Consultant

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

K. Srinivasan, Ohio State University

J. 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

S.M. Wu, University of Michigan

# 20th NORTH AMERICAN MANUFACTURING RESEARCH CONFERENCE—NAMRC XX

## ABOUT THE MEETING

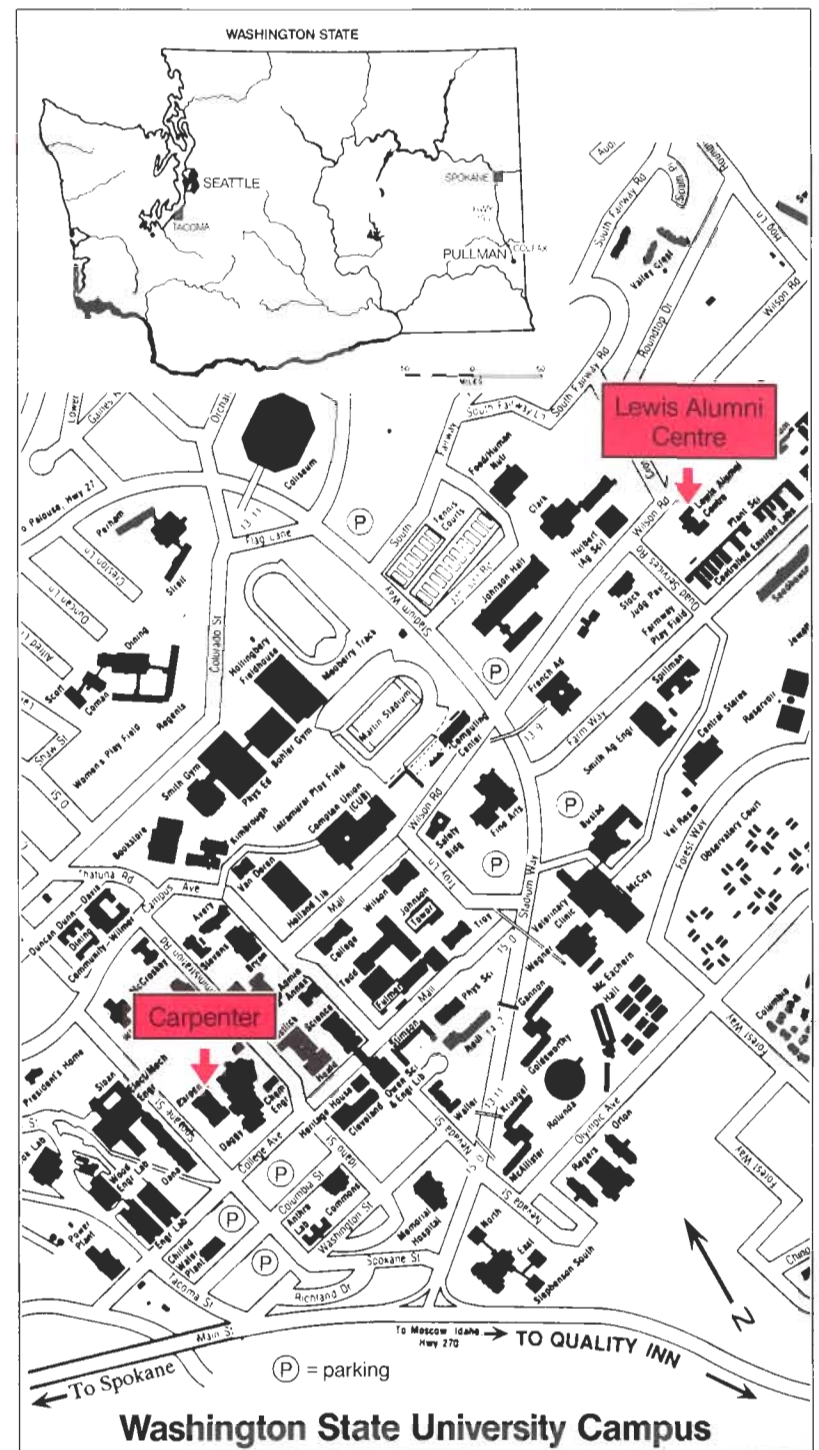
The 20th North American Manufacturing Research Conference (NAMRC XX), on May 20-22, 1992, in Pullman, Washington, is designed to provide a forum for the timely presentation and critical discussion of the results of basic and applied research in material forming, material removal, and manufacturing systems/automation. All papers presented at the conference are contained in the bound volume titled "Transactions of the 20th North American Manufacturing Research Institution of SME - 1992." These papers have been accepted based upon a review of full length submissions, and they highlight manufacturing research efforts from universities, centers, and companies around the world. Participants this year will also receive a special 20th Anniversary index of authors and paper titles with abstracts prepared by NAMRI/SME.

The conference will feature three parallel sessions in material forming, material removal, and manufacturing systems. All presentations will be in Carpenter Hall, the newly remodeled School of Architecture building, near the engineering complex. The sessions will include formal presentations of the papers and a discussion period following each presentation. The conference begins with a keynote address and features several panels during the three days. Many informal social events and tours are planned. Bring a spouse or guest to enjoy the planned activities!

## PULLMAN AND HOW TO GET THERE (See maps)

The conference will be held at Washington State University, in Pullman, Washington, which is located 80 miles south of Spokane and 300 miles east of Seattle. Nestled in the rolling wheatfields known as "the Palouse," Pullman is home to the second largest university in the state with a land-grant history surpassing 100 years. Eight miles to the east is Moscow, Idaho, home of the University of Idaho.

Getting to Pullman is easier than reaching many university towns. The Pullman/Moscow Airport is served by Horizon Airlines via connections with Spokane and Seattle, WA; Portland, OR; and Boise, ID. You may choose to fly into the Pullman/Moscow Airport, or arrive in Spokane and drive to Pullman: Take I-90 east and Highway 195 south through Colfax to Pullman. Rental cars are available from the major agencies at both airports. The Campus Link van service from Spokane to Pullman is available by calling (208) 882-1223. If you are taking the Boeing Tour in Auburn until 3:30 p.m. on Tuesday, May 19, there are flights from Seattle to Pullman departing at 6:20 p.m. and 8:35 p.m. If you arrive in Spokane, Campus Link departs to Pullman at 12:05 p.m., 5:40 p.m. and 9:05 p.m. Make reservations early



as Horizon Air and Campus Link have limited seating. For ground transportation from the Pullman Airport, contact the University Inn or the Quality Inn. Student drivers will assist with local transportation and will meet incoming Pullman flights on Tuesday, May 19. Phone during conference for emergencies, (509) 334-9964.

#### **AIRFARE DISCOUNTS**

WSU, on behalf of NAMRC XX has officially named FIRSTRAVEL (travel agency) to assist you with travel arrangements and provide discounts of 5% off excursion fares and 40% off coach fares on domestic flights by United Airlines. Discounts on rental cars are also offered by booking through FIRSTRAVEL. Valid travel dates for airfare discounts are May 17 through May 25, 1992. Please call 1-800-735-6363 as soon as possible for best seat and price availability. Inform FIRSTRAVEL's agent that you are participating in the NAMRC conference. Airline tickets will be sent by certified mail or, if necessary, by express service.

#### **MOTEL LODGING**

Please make your own motel reservation. The Quality Inn and the University Inn have rooms blocked for this event and can provide transportation to and from the Pullman airport if requested. The Quality Inn will provide transportation to and from Carpenter Hall for NAMRC attendees upon request.

Rates for 1 person: Prices do not include tax and are subject to change.

#### **Motels in Pullman, Washington**

Area Code (509)

American Travel Inn	334-3500	\$30.00
Cougar Land Motel	334-3535	\$33.00
Hilltop Motor Inn	334-2555	\$25.95
Manor Lodge Motel	334-2511	\$20.00
Quality Inn, Paradise Creek	332-0500	\$42.50

#### **Motels in Moscow, Idaho**

Area Code (208)

Motel "6"	882-5511	\$22.95
Super 8	883-3898	\$30.00
University Inn Motel	882-0550	\$49.50

#### **CAMPUS HOUSING**

Rooms in the WSU Stimson Residence Hall are also available. Within walking distance of the Compton Union Building, this nicely remodeled, older dormitory has shared suites and baths. Rates for a single are \$21.00 per night and \$15.00 per person for a double (includes linens, blanket and pillow). You may wish to bring hangers for the closet. **No smoking is allowed in any university or state building.**

#### **TRANSACTIONS AND ANNIVERSARY INDEX**

All registered NAMRC participants will receive one hardbound copy of the "Transactions of the North American Manufacturing Research Institution of SME - 1992" at the time of registration. Additional copies may be purchased at the registration desk or by contacting Conferences & Institutes, Proceedings Sales, 208 Van Doren Hall, Washington State University, Pullman, WA 99164-5222. The cost is \$65 plus shipping per copy. In honor of NAMRC's 20th year, a special anniversary Index of papers and authors will also be given to attendees.

#### **PARKING**

Parking on campus is by permit only. Permits will be mailed with your WSU registration confirmation, or pick one up at the first night reception. Parking will be allowed in lots posted as **Green, Yellow, Red, or Blue with a permit on your rearview mirror or dashboard.** Do not park in covered lots, at meters, fire or handicapped zones.

#### **TOUR OF BOEING FABRICATION FACILITY**

Before heading to Pullman for the conference, NAMRC attendees will be allowed to tour the Boeing Metal Fabrication Facility in Auburn, Washington, on **Tuesday, May 19, 1:30-3:30 p.m.** The Boeing address is 700 15th St. S.W. in Auburn, within 30 minutes from the Seattle-Tacoma Airport. If you drive, take I-5 south to Highway 18. Turn right onto West Valley Road South (Hwy. 181) and turn left onto 15th St. S.W. Meet at the front entrance. Group bus transportation to and from the Sea-Tac Airport is available at a cost of **\$12.00**, payable to Northwest Convention Services by **April 17, 1992** (use separate form provided). The bus will leave the Sea-Tac Airport baggage claim area at 12:45 p.m. and return to Sea-Tac by 4:30 p.m. Meet tour guide in red or blue blazer. Current scheduled Horizon flights to Pullman depart at 6:20 p.m. and 8:35 p.m. Enclose a stamped, self-addressed envelope if you would like a confirmation. Please arrive 15 minutes prior to departure. Refunds for cancellations will only be made if a written request is received at Convention Services Northwest by April 17 (\$5.00 handling fee), or if tour minimums are not met.

#### **SPOUSE/GUEST PROGRAM**

There are two parts to this program designed for visiting spouses, guests and others who are not attending the conference. On Wednesday, May 20, a trip to the Nez Perce National Historical Park is planned for 1:30 p.m. departure from Pullman's Quality Inn Motel. Cars or vans will take you on a magnificent 45 mile drive down the Lewiston grade, across the Clearwater River and on to the park where the Nez Perce Indian history is richly portrayed. Instead of returning to Pullman, the van will take you directly to the evening Bar-B-Q along the banks of the Snake River. Return with the others to Pullman around 9:00 p.m.

The second part of the program is a six-hour tour on Thursday, May 21, of the local area known as the Palouse. This tour through the rolling hills near Pullman will make your introduction to the area a memorable one. Leaving at 9:00 a.m., from the Quality Inn Motel, a local historian will explain the geological events that formed the unique, undulating landscape that figures prominently into the agricultural and timber industry of the Palouse. Stops include a pioneer village, Colfax (our county seat), the historic Perkins House for lunch, the Dry Pea and Lentil Commission and the Appaloosa Horse Club and Museum. Cost for the Palouse Tour is \$30, payable to Wheatland Travel by April 20th, address: S. 1650 Grand Ave, Pullman, WA 99163, phone (800) 336-2016, Suzanne Myklebust. Complete the separate form provided.



### HELL'S GATE PARK SALMON BARBECUE

Dress casually and relax after a busy day of meetings at the all-conference Salmon Barbecue on Wednesday, May 20. This event will be from 5:00 to 9:00 p.m. at the Hell's Gate State Park on the Snake River just south of Lewiston, Idaho. Bus transportation is included in the registration fee and will depart Pullman's Quality Inn Motel at 4:00 p.m. At the Park, enjoy refreshments and a fabulous salmon dinner under the picnic shelter of this spacious park on the quiet banks of the Snake River. At 7:00 p.m. there will be a special display of Nez Perce Indian Nation culture with descriptions, dancing and drumming performed by local drummers and dancers in full costume. You may even learn one of the Indians' dances! The Park closes at sunset. This barbecue is included in the registration fee. Extra Spouse/Guest tickets can be purchased. Use the WSU Registration form.

### BLOUNT, INC., MANUFACTURING TOUR

On Friday, May 22, following the NAMRC program and a sandwich lunch at the Quality Inn, there will be a post-conference tour of Blount, Inc., in Lewiston, Idaho. Blount is a small but modern manufacturing firm that is primarily a metal forming plant for cartridge brass. You may sign up for the tour on the WSU registration form and pay a \$10.00 additional fee for the round trip bus ride. This tour departs at 1:00 p.m. from the Quality Inn Motel and returns around 4:00 p.m.

### CONFERENCE REGISTRATION

Registration fees for NAMRC XX are \$275.00 (U.S. funds) for advance registration and \$300 for registration after May 11. This fee, payable to Washington State University, includes admission to all sessions, a bound copy of the 1992 Transactions of NAMRI/SME, the Special 20th Anniversary Index, refreshments, three luncheons, and the Salmon Barbecue. There are no one-day registration fees or reduced fees for authors or session chairs.

Students will be admitted to the conference for \$90.00. Retirees will be admitted for \$165.00. These fees include all the refreshment breaks, conference meals, but do not include the Transactions. Bound copies of the Transactions with a copy of the Index can be purchased at the registration desk for \$65, or contact Conferences & Institutes Proceedings Sales, Washington State University, 208 Van Doren Hall, Pullman, WA 99164-5222.

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.

### REFUNDS

The registration fee is refundable in full up to five working days before the conference. Cancellation within five days of the conference will be subject to a \$50 cancellation fee. No refunds once the conference begins.

### TO REGISTER

Complete the registration forms, include the proper fees, and send to the separate vendors as indicated. Checks, money orders, purchase order numbers or VISA/Mastercard are accepted for WSU payments. All other vendors accept checks only. There are three easy ways to register and pay for the conference and events handled by WSU:

1. Call by phone with PO# or bankcard, (509) 335-3530
2. FAX form and payment information to (509) 335-0945
3. Mail form and payment to: Conferences & Institutes, Washington State University, 208 Van Doren Hall, Pullman, WA 99164-5222

FOR OTHER EVENTS, FILL OUT THE FORM AND MAIL WITH YOUR CHECK TO THE APPROPRIATE ADDRESS.

For additional information about the program content, contact Dr. David Hutton, Conference Co-Chair, at (509) 335-7437. For registration, call Conferences & Institutes at (509) 335-3530. For specific questions about tours, events and lodging, call Nancy Mack or Lael Turnbow at C & I, (509) 335-3530.

### POST-CONFERENCE EVENTS

#### WHITE WATER RAFT TRIP

On Saturday, May 23, ride the rapids of the famous Salmon "River of No Return" in a sturdy rubber raft with certified outfitters and guides. Begin at 7:00 a.m. with a 2 1/2 hour van ride to Riggins, Idaho, where you will load onto rafts for a day of white water rafting through some of the Salmon River's most magnificent rapids. Enjoy a famous riverside deli-lunch. All equipment except wetsuits are provided. You can rent a wetsuit from WSU for \$3.00-8.00 + deposit.

The cost is **\$68.00** which includes, transportation, lunch and equipment. Make your raft trip payment to: **Salmon River Experience**, 812 Truman, Moscow, Idaho 83843 (208) 882-2385. Use the form provided. The trip will finish at 5:00 p.m. arriving back in Pullman by 8:00 p.m. There will be an opportunity to stop for snacks on the way home. Extremely unfavorable weather, water conditions or insufficient reservations can be cause for trip cancellation. Reservations must be made by **April 20, 1992**.

### **JET BOAT TRIP**

For sheer excitement, few experiences can match a jet boat ride through Hells Canyon, the deepest canyon in North America! On Saturday, May 23, if you aren't up to rafting, try a comfortable jet boat ride up the Snake River. Adventure, unequaled scenery, abundant wildlife, fascinating geologic formations and the intriguing flavor of the American West combine to provide a memorable trip. Departure time is 8:00 a.m. from Port of Wilma, in Lewiston, Idaho. Arrival time back at Lewiston is 5:00 p.m. You must provide your own transportation to and from Lewiston. Cost is **\$70** per person including lunch, payable by check to **Beamer's Landing**, P.O. Box 1223, Lewiston, ID 83501, by **May 15th**. Water conditions or insufficient reservations can be cause for trip cancellation. Use the special form in this brochure.

### **TRIP TO VICTORIA, BRITISH COLUMBIA, CANADA**

Take a 2-1/2 hour voyage aboard the Victoria Clipper jet catamaran on Sunday, May 24 departing at 7:30 a.m. from Seattle's Pier 69, Victoria Clipper terminal and returning at 8:45 p.m. in Seattle. Cruise the Pacific Northwest's scenic coastline, past the San Juan Islands and into one of the prettiest city harbors in the world. Spend the afternoon exploring Victoria, B.C.'s antique stores, Butchart Gardens, and the Empress Hotel (reservations required for high tea). Proof of citizenship (birth certificate, driver's license or voter registration) is required by Canadian Customs. Cost is **\$77 (U.S.)** per person. Make payment by check to **Convention Services Northwest**, by **April 17, 1992**, using the separate form enclosed. Please arrive 15 minutes prior to tour departure. Refunds for cancellations will only be made if written request is received at the Convention Services Northwest office by April 17, 1992, or tour minimums are not met. There is a \$5.00 handling fee for refunds. Address: Tower Building, Suite 1200, 1809 7th Ave, Seattle, WA 98101, phone (206) 292-9198, FAX (206) 292-0559, Kris Eastman. If you would like a confirmation, please enclose a self-addressed stamped envelope.





Society of  
Manufacturing Engineers

# WSU REGISTRATION FORM

**NAMRC XX**  
**May 20-22, 1992**  
**Pullman, Washington**

(e 1341)

Duplicate this form for additional persons.

*Please print or type:*

First \_\_\_\_\_ Middle Initial \_\_\_\_\_ Last \_\_\_\_\_

Company/Organization \_\_\_\_\_

Business Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_

Zip+4 \_\_\_\_\_ Country \_\_\_\_\_

Business Telephone: ( ) \_\_\_\_\_

Indicate Your Fees, payable to "Washington State University":

\_\_\_\_\_ Advance registration Fee, includes luncheons, salmon barbecue (transportation provided), Transactions and special Index, **\$275.00**

\_\_\_\_\_ Registration Fee postmarked after May 11, 1992, includes same as above, **\$300.00**

\_\_\_\_\_ Students, includes meals, no Transactions, **\$90.00**

\_\_\_\_\_ Retirees, includes meals, no Transactions, **\$165.00**

\_\_\_\_\_ Extra copy of Transactions, **\$65.00**

\_\_\_\_\_ Transportation to May 22 industry tour to Blount, Inc., **\$10.00**

\_\_\_\_\_ Wednesday, May 20 extra barbecue ticket with transportation, **\$20.00**

\_\_\_\_\_ Wednesday, May 20 extra lunch ticket, **\$11.00**

\_\_\_\_\_ Thursday, May 21 extra lunch ticket, **\$11.00**

\_\_\_\_\_ Friday, May 22 extra lunch ticket, **\$11.00**

\_\_\_\_\_ Spouse/Guest Transportation May 20 to Indian Park, **\$10.00**

Campus Housing Option in Stimson Residence Hall (see page 5 of this brochure)

Single room **\$21.00** per night x \_\_\_\_\_ nights. Dates: \_\_\_\_\_

Double room **\$15.00** per night x \_\_\_\_\_ nights. Dates: \_\_\_\_\_

**\$ \_\_\_\_\_ TOTAL PAYMENT in U.S. Funds**

Check enclosed payable to "Washington State University"

Purchase Order - number \_\_\_\_\_

Charge my:  VISA  Mastercard

Card Number \_\_\_\_\_ Expiration Date \_\_\_\_\_

This confirms a telephone registration.

**THREE EASY WAYS TO REGISTER WITH WSU:**

1. Call by phone with PO# or bankcard, (509) 335-3530

2. FAX form and payment information to (509) 335-0945

3. Mail form and payment to: Conferences & Institutes, Washington State University, 208 Van Doren Hall, Pullman, WA 99164-5222

NAMRC XX Group Event Sponsored by SME and hosted by Washington State University



**TRANSPORTATION TO BOEING TOUR, MAY 19  
VICTORIA, B.C. BOAT TRIP, MAY 24**

Send check payable to **April 17th** payable to **NW Convention Services, Tower Building, Suite 1200, 1809 7th Ave., Seattle, WA 98101.**  
FAX 206/292-0559.

- Yes, sign me up for transportation from Sea-Tac Airport to the Boeing Facility Tour, Auburn, WA, on May 19. Cost: \$12.00
- Yes, sign me up for the May 24 day trip to Victoria, B.C. Cost: \$77.00

NAME \_\_\_\_\_  
ADDRESS \_\_\_\_\_  
CITY \_\_\_\_\_ STATE \_\_\_\_\_ ZIP \_\_\_\_\_  
PHONE \_\_\_\_\_

NAMRC XX Group Event Sponsored by SME and hosted by Washington State University



**JET BOAT DAY TRIP ON THE SNAKE RIVER, MAY 23**

Send check payable to **Beamer's Landing, P.O. Box 1223, Lewiston, ID 83501.** Phone: (208) 743-4800. Fees must be received by **May 15th.**

- Yes, sign me up for the Jet Boat Trip, and lunch. Cost: \$70.00

Note: You must provide your own transportation to Lewiston's Port of Wilma departure point.

NAME \_\_\_\_\_  
ADDRESS \_\_\_\_\_  
CITY \_\_\_\_\_ STATE \_\_\_\_\_ ZIP \_\_\_\_\_  
PHONE \_\_\_\_\_

NAMRC XX Group Event Sponsored by SME and hosted by Washington State University



**WHITE WATER RAFT TRIP, MAY 23,  
ON THE SALMON RIVER**

Send check payable to: **Salmon River Experience, 812 Truman, Moscow, ID 83843.** Phone (208) 882-2385. Fees must be received by **April 20th.**

- Yes, sign me up for the White Water Raft Trip, including lunch and roundtrip transportation to Riggins, ID, from Pullman, WA. Cost: \$68.00

Note: Wet suits available for \$3-8 rent plus deposit at WSU, pay when you arrive.

NAME \_\_\_\_\_  
ADDRESS \_\_\_\_\_  
CITY \_\_\_\_\_ STATE \_\_\_\_\_ ZIP \_\_\_\_\_  
PHONE \_\_\_\_\_

NAMRC XX Group Event Sponsored by SME and hosted by Washington State University



**SPOUSE/GUEST PROGRAM, MAY 21**

Send check by **April 20th** payable to **Wheatland Travel, S. 1650 Grand Ave, Pullman, WA 99163,** phone (800) 336-2016, Suzanne Myklebust.

- Spouse/Guest Tour on May 21: a six-hour tour of the Palouse with lunch, \$30.00

Name of spouse or guest:

NAME \_\_\_\_\_  
ADDRESS \_\_\_\_\_  
CITY \_\_\_\_\_ STATE \_\_\_\_\_ ZIP \_\_\_\_\_  
PHONE \_\_\_\_\_



# **NAMRC XX**

## **Technical Program and Sessions**

---

### **TUESDAY, MAY 19**

---

6:00 - 9:00 pm

**REGISTRATION AND RECEPTION** Lewis Alumni Centre

7:00 pm

**NAMRI/SME BOARD OF DIRECTORS DINNER** Quality Inn, Pullman

8:00 pm

**NAMRI/SME BOARD OF DIRECTORS MEETING** Quality Inn, Pullman

---

### **WEDNESDAY, MAY 20**

---

7:30 - 9:00 am

**REGISTRATION** Carpenter Hall Lobby

8:30 - 9:00 am

**OPENING SESSION** Carpenter Hall, Room 102

#### **OPENING REMARKS**

A.E. Bayoumi and D.V. Hutton, Co-Chairmen, NAMRC XX Organizing Committee

#### **WELCOMING REMARKS**

Samuel H. Smith, President, Washington State University  
Reid C. Miller, Dean of Engineering and Architecture, Washington State University

#### **INTRODUCTORY REMARKS**

Ranga Komanduri, NAMRI/SME President, Oklahoma State University

9:00 - 10:00 am

#### **KEYNOTE PRESENTATION**

"Evolution and Revolution in Engineering"  
A.D. "Bert" Welliver, Senior Vice President, Engineering and Technology,  
The Boeing Company, Seattle, Washington

10:00 -10:30 am

#### **BREAK**

10:30 am - 12:00 noon

#### **SESSION 1**

**SESSION F-1** Carpenter Hall, Room 101

Co-Chairmen: G.S. Gunasekara, The Ohio State University  
G. D.Lahoti, The Timken Company

**F-1-1:** "Characterization of Wire and Bar Rolling by Three Dimensional Rigid-Plastic Finite Element Method," J. Yanagimoto and M. Kiuchi, University of Tokyo

**F-1-2:** "A Multipoint Temperature Sensor for Metal Rolling," S. Zou and J. Jeswiet, Queen's University

**F-1-3:** "Spread in Hot Rolling: An Experimental/Theoretical Evaluation," T.L. Zacharoff, Worcester Polytechnic Institute; M.L. Devenpeck and K.F. Kennedy, Alcoa Technical Center

**SESSION M-1** Carpenter Hall, Room 102

Co-Chairmen: S.G. Kapoor, University of Illinois at Urbana-Champaign  
D. Lucca, Oklahoma State University

**M-1-1:** "Precision Platen Grinding of Cast Iron - Belt Wear, Surface Roughness and Grinding Forces," G. Spur and K. Becker, Technical University Berlin

**M-1-2:** "Roundness Generation During Centerless Grinding," K. Kim, C.N. Chu and M.M. Barash, Purdue University

**M-1-3:** "Metal Removal Distribution and Flow Characteristics in Abrasive Flow Machining," R.E. Williams, K.P. Rajurkar and J. Kozak, University of Nebraska - Lincoln

**SESSION S-1** Carpenter Hall, Room 212

Co-Chairmen: G. Chyrssolouris, Massachusetts Institute of Technology  
M. Salvo, Boeing Commercial Airplane Group

**S-1-1:** "Automated Inspection Using Machine Vision: Data Dependent Systems Approach," S.M. Pandit and G.A. Joshi, Michigan Technological University

**S-1-2:** "Controlling Weld Penetration in GTAW Using Vision Sensing and Adaptive Control Technique," R. Kovacevic, University of Kentucky; Y. Zhang, L. Wu and D. Chen, Harbin Institute of Technology

**S-1-3:** "Verification of the Vision Camera's Extrinsic Alignment for Automated Visual Inspection," C.-C. Wang, Northern Illinois University

**12:00 noon - 1:30 pm**

**LUNCHEON** Compton Union Building, Cascade Room

**1:30 - 3:00 pm**

**SESSION 2**

**SESSION F-2** Carpenter Hall, Room 101

Panel Discussion: "Challenges and Progress in Superplastic Forming"  
Chairman: C.H. Hamilton, Washington State University

**SESSION M-2** Carpenter Hall, Room 102

Co-Chairmen: R. Komanduri, Oklahoma State University  
W.R. DeVries, Rensselaer Polytechnic Institute

**M-2-1:** "Automated Monitoring of Microdrilling Operations," I.N. Tansel and O. Rodriguez, Florida International University

**M-2-2:** "Monitoring of Micromachining Process Using Acoustic Emission," J.J. Liu and D.A. Dornfeld, University of California at Berkeley

**M-2-3:** "Investigation of Acoustic Emission Sensing for Laser Drilling," G. Chyrssolouris, P. Sheng and N. Anastasia, Massachusetts Institute of Technology

**SESSION S-2** Carpenter Hall, Room 212

Co-Chairmen: S.M. Pandit, Michigan Technological University  
J.L. Garbini, University of Washington

**S-2-1:** "Computer Integrated Design for Manufacturability (DFM) through a Heterarchical CIM System Structure," M.L. Philpott, R.P. Nita and H. Noderer University of Illinois at Urbana-Champaign

**S-2-2:** "ASPAT - A Prototype System for Automatic Tolerancing," S. Raman and M.H. Lokhandwala, University of Oklahoma

**S-2-3:** "Representation, Acquisition and Manipulation of Probabilistic Attribute Values to Support Engineering Decision Making," S.A. Schwarz and S. C-Y. Lu, University of Illinois at Urbana-Champaign

**5:00 - 9:00 pm**

**SALMON BARBECUE** Hell's Gate State Park, Lewiston, Idaho

---

## THURSDAY, MAY 21

---

**8:30 - 10:00 am**

**SESSION 3**

**SESSION F-3** Carpenter Hall, Room 101

Co-Chairmen: R.A. Kohser, University of Missouri - Rolla  
K. Kees, Blount Incorporated

**F-3-1:** "On Flow Localization of Stretch-Forming Sheet Metal," R. Joshi, A.E. Bayoumi and H. Zbib, Washington State University

**F-3-2:** "Evaluation of the Parameters which Govern Local Necking in 3003-0 Al Sheet," A. Zayed and H. Conrad, North Carolina State University

**F-3-3:** "The Development of Apparatus Used to Measure Shear and Normal Forces for Sheet Material Forming Friction Measurement," M. Li and B.E. Klamecki, University of Minnesota; K.J. Weinmann, Michigan Technological University

**SESSION M-3** Carpenter Hall, Room 102

Co-Chairmen: J.W. Sutherland, Michigan Technological University  
I.S. Jawahir, University of Kentucky

**M-3-1:** "Effect of Thermal Load on Wire Rupture in WEDM," W.M. Wang, K.P. Rajurkar and S. Boyina, University of Nebraska - Lincoln

**M-3-2:** "Laser Contouring of Space Shuttle Tiles," P.J. Bishop, A. Minardi, M. He and B. Shelton, University of Central Florida

**M-3-3:** "An Experimental Investigation of Material Removal Rates in Rotary Ultrasonic Machining," D. Prabhakar and P.M. Ferreira, University of Illinois at Urbana-Champaign; M. Haselkorn, Caterpillar, Inc.

**SESSION S-3** Carpenter Hall, Room 212

Panel Discussion: "Quality Issues in Manufacturing"  
Chairman: L.A. Kendall, University of Minnesota - Duluth

**10:00-10:30 am**

**BREAK**

**10:30 am - 12 noon**

**SESSION 4**



**SESSION F-4** Carpenter Hall, Room 101

Co-Chairmen: K. Stelson, University of Minnesota  
K.J. Weinmann, Michigan Technological University

**F-4-1:** "Effect of Optimal Streamlined Extrusion Die on Process and Product," M.S. Joun and S.M. Hwang, Pohang Institute of Science and Technology

**F-4-2:** "Roll Design System for ERW Tubes and Pipes," A. Tani and M. Kiuchi, University of Tokyo

**SESSION M-4** Carpenter Hall, Room 102

Co-Chairmen: David Hutton, Washington State University  
A. Thangaraj, Michigan Technological University

**M-4-1:** "Assessing Final Plastic Deformation in the Chip Formation Zone Based on Frictionless Compression Test Data,"  
W. Grzesik, Opole Technical University; J. Litwin, CEGEP de Saint-Laurent

**M-4-2:** "Tool Wear Modeling by Abductive Network Using Cutter Force Measurements," O. Masory, Florida Atlantic University

**M-4-3:** "A Cutting Force Model for Face Milling with a Step Cutter," F. Gu, S.G. Kapoor and R.E. DeVor, University of Illinois at Urbana-Champaign; P. Bandyopadhyay, General Motors Research Laboratories

**SESSION S-4** Carpenter Hall, Room 212

Co-Chairmen: A. Lehtihet, Pennsylvania State University  
S. Smith, University of Florida

**S-4-1:** "Robot MIG Weld Seam Tracking by Dip-Resistance Monitoring," M.L. Philpott, University of Illinois at Urbana-Champaign

**S-4-2:** "Identification of Root Causes of Variation in Automobile Body Assembly," S.J. Hu and S.M. Wu, University of Michigan at Ann Arbor

**S-4-3:** "Fundamentals for the Automatic Assembly of Dimensionally Instable Components, Especially O-Rings and Sealing Elements, Parts A & B," T. Jauch, G. Wack and G. Warnecke, University of Kaiserslautern

12:00 noon - 1:30 pm

**NAMRI/SME LUNCHEON** Compton Union Building, Cascade Room

1:30 - 3:00 pm

**SESSION 5**

**SESSION F-5** Carpenter Hall, Room 101

Co-Chairmen: D.R. Durham, University of Vermont  
M. Ramulu, University of Washington

**F-5-1:** "Stamping Process Model for Real-Time Control," S.A. Majlessi, A.R. Kashani and K.J. Weinmann, Michigan Technological University

**F-5-2:** "An Approach to a New Forming Operation for Optical Drums," M. Saito, Suzuka College of Technology; K. Dohda, Gifu University

**F-5-3:** "Characterization of Glass Mat Thermoplastics at Forming Temperatures," Y.C. Shiau, P.J. Shih and R. Alluri, Oklahoma State University

**SESSION M-5** Carpenter Hall, Room 102

Panel Discussion: "Modeling, Design and Selection of Composite Materials"  
Chairman: H. Zbib, Washington State University

**SESSION S-5** Carpenter Hall, Room 212

Co-Chairmen: V. Venkatesh, Tennessee Technological University  
Q. Yu, St. Cloud State University

**S-5-1:** "Sensor-Based Supervision of CNC Machining," R.L. Wells, S. Smith, J. Tlustý, University of Florida

**S-5-2:** "Compensation of Non-Rigid Body Kinematic Effect on a Machining Center," J.S. Chen, J.X. Yuan, J. Ni, S.M. Wu, University of Michigan at Ann Arbor

**S-5-3:** "Restraint Analysis of Machining Fixtures," E.C. DeMeter, Pennsylvania State University

3:00 - 3:30 pm

**BREAK**

3:30 - 5:00 pm

**SESSION 6** Carpenter Hall, Room 102

**MANUFACTURING IN THE PACIFIC NORTHWEST**

Chairman: D.V. Hutton, Washington State University

This session is devoted to presentations by major manufacturing companies having significant operations in the host region: Boeing and Hewlett-Packard.

5:00 - 6:00 pm

**SOCIAL RECEPTION** Carpenter Hall Lobby

6:00 pm

**NAMRI/SME MEMBERSHIP MEETING** Electrical and Mechanical Engineering Building, Room 154

7:00 pm

**ASME PRODUCTION ENGINEERING DIVISION MEETING** Electrical and Mechanical Engineering Building, Room 154

Please note that this meeting will start immediately following the NAMRI/SME Membership Meeting.

**DINNER ON YOUR OWN**

Information on local restaurants will be provided.

---

## FRIDAY, MAY 22

---

8:30 - 10:00 am

**SESSION 7**

**SESSION F-7** Carpenter Hall, Room 101

Co-Chairmen: H. Zbib, Washington State University  
R. Shivpuri, The Ohio State University

**F-7-1:** "An Integrated Approach to Process Simulation and Die Stress Analysis in Forging," M. Knoerr, T. Lange and T. Altan, The Ohio State University

**F-7-2:** "Finite Element Simulation of Induction Heat Treatment and Quenching of Steels," K.F. Wang, S. Chandrasekar, H.T.Y. Yang, Purdue University



**F-7-3:** "A Review of Recent Experimental Results of Stress-Strain Curves at Large Plastic Strains," E.G. Thomsen, University of California at Berkeley; F.D. Negroni, Catholic University of Chile

**SESSION M-7** Carpenter Hall, Room 102

Co-Chairmen: M. Hashish, Quest Integrated Systems  
K.P. Rajurkar, University of Nebraska - Lincoln

**M-7-1:** "Orthogonal Cutting Characteristics of Graphite/Epoxy Composite Material," D.H. Wang, M. Ramulu and C.W. Wern, University of Washington

**M-7-2:** "Tool Path Determination for End Milling of Flat Star-Shaped Polygonal Surfaces," H.P. Bao and H. Yim, University of Missouri-Columbia

**M-7-3:** "Spindle Speed Regulation and Tracking in Interrupted Cutting," T.C. Tsao and K.C. Fong, University of Illinois at Urbana-Champaign

**SESSION S-7** Carpenter Hall, Room 212

Co-Chairmen: O. Eyada, Virginia Polytechnic Institute and State University  
O. Masory, Florida Atlantic University

**S-7-1:** "Symbolic and Computational Conjugate Geometry for the Manufacture of Helically Swept Surfaces," R.S. Voruganti, S.G. Dhande, and C.F. Reinholtz, Virginia Polytechnic Institute and State University

**S-7-2:** "Procrustes Analysis and its Application to Sensor Integration," J.W. Sutherland and K.S. Moon, Michigan Technological University

**S-7-3:** "Geometry Cotion in the Routing of Automated Guided Vehicles," J. Huang and U.S. Palekar, University of Illinois at Urbana-Champaign

10:00 - 10:30 am

**BREAK**

10:30 am - 12:00 noon

**SESSION 8**

**SESSION F-8** Carpenter Hall, Room 101

Co-Chairmen: S. Kalpakjian, Illinois Institute of Technology  
A.E. Bayoumi, Washington State University

**F-8-1:** "Effect of Metal Forming Parameters on Strength and Fatigue Behaviour of Extruded Workpiece," W. Muller, B. Hager and W. Schwab, Universitat Stuttgart

**F-8-2:** "A Friction Test Based on Combined Backward Can - Forward Bar Extrusion with Emphasis on Backward Flow," M.E. Popilek, Saginaw Division of General Motors, K.J. Weinmann and S.A. Majilessi, Michigan Technological University

**F-8-3:** "Investigating the Effect of Extrusion Power and the Lubricant Film Thickness on the Surface Quality of the Extrudate," S. Momin and R. Shivpuri, The Ohio State University

**SESSION M-8** Carpenter Hall, Room 102

Co-Chairmen: R.E. DeVor, University of Illinois at Urbana-Champaign  
H.P. Bao, University of Missouri - Columbia

**M-8-1:** "Radial Forces in Short Hole Drilling and Their Effects on Drill Performance," C. Nedess and U. Gunther, Technische Universitat Hamburg-Harburg

**M-8-2:** "Planar Micro-Drill Point Design and Grinding Methods," C. Lin, S.K. Kang and K.F. Ehmann, Northwestern University

**M-8-3:** "High Speed Tapping of 319 Aluminum Alloy," J.S. Agapiou and C.-H. Shen, General Motors

**SESSION S-8** Carpenter Hall, Room 212

Co-Chairmen: C. Reinholtz, Virginia Polytechnic Institute and State University  
E. DeMeter, Pennsylvania State University

**S-8-1:** "An Automatic Process Planner for Cold Extrusion of Components," Q. Sun and J.R. Dixon, University of Massachusetts at Amherst

**S-8-2:** "Optimal Process Plans for Multipass Turning Operations," A.N. Schuaib, S.O. Duffuea and M. Alam, King Faud University of Petroleum and Minerals

**S-8-3:** "Quantification of Part Mix Complexity Using an Entropy Measure," A. Deshmukh, J.J. Talavage and M.M. Barash, Purdue University

12:00 noon

**LUNCHEON** Quality Inn, Pullman

**ADJOURNMENT**

