### Wisconsin Center) 8:00 a.m. (Lobby)

MONDAY, MAY 20 Welcome Registration

Afternoon Break Sessions Sessions

Lunch

Reception Sessions

3:30 p.m. 3:00 p.m. 1:30 p.m.

Tour of Laboratories

5:30 - 7:30 p.m.

(Engineering Campus)

Sessions Afternoon Break Sessions

**NEDNESDAY, MAY 22** 

(Wisconsin Center)

8:30 - 9:30 p.m. (Lowell Hall)

7:30 - 8:30 p.m. (Lowell Hall)

8:00 a.m. (Lobby)

Sessions

Registration

Morning Break

10:00 a.m.

8:30 a.m.

Sessions

**Program Concludes** 

12:00 Noon 10:30 a.m. Dinner

Reception

Morning Break Lunch

Registration Sessions

12:00 Noon (Wisconsin Center)

0:00 a.m. 8:30 a.m. 8:00 a.m. (Lobby)

**UESDAY, MAY 21** Banquet Wisconsin Center) 6:30 - 7:30 p.m. (Alumni Lounge) 7:30 - 9:30 p.m. (Wisconsin Center

3:30 p.m. 3:00 p.m.

1:30 p.m.

10:30 a.m. 2:00 Noon (Wisconsin Center) 0:00 a.m.

9:00 a.m. (Lakeshore Room)

Morning Break

ence. Additional copies may be purchased at the Road, Dearborn, MI 48128 at a cost of \$35.00. SME's Publication Sales Department 20501 Ford to each full paid registrant attending the Confer-1974, the PROCEEDINGS will be available from of registration for \$30.00. After May 23, A copy of the PROCEEDINGS will be given

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### PROCEEDINGS

### A761, SS-05 YAM MADISON, WISCONSIN HTAUN



With the

NAMRC-II

Second North American Metalworking Research Conference 1513 University Avenue

SITE

University of Wisconsin - Madison

Scientific, Engineering and **Research Personnel** in the Field of Metalworking Please take note:

An International Conference

on Metalworking

Madison, Wi 53706

REGISTRATION TIME & LOCATION MONDAY, MAY 20, 1974 8:00 a.m., The Wisconsin Center 8:00 a.m., The Wisconsin Center 8:00 a.m., The Wisconsin Center WEDNESDAY, MAY 22, 1974 **TUESDAY, MAY 21, 1974** 

# ADVANCED REGISTRATION

assure the possibility of attendance and accommodations. avoid congestion at the time of the Conference and to Registration by mail before May 6 is recommended to

tration card. The registration fee is \$120.00. A check in ing Research Conference should accompany the registration this amount payable to Second North American Metalwork-Please give a complete mailing address on the regis-

# REGISTRATION ON ARRIVAL

desk on Sunday evening in the Lobby of The Wisconsin urged to bring the completed registration card when you Center. If you do not register in advance by mail, you are Center on the first floor. There will also be a registration The desk will be located at the entrance of The Wisconsin The registration desk will be open during the sessions

mile from Lot No. 60 to the Memorial Union (within a versity Lot No. 60, located west of the campus on Walnut hour meters). Vistors' parking is also available at street cated on North Murray Street near State Street (with tenparking space at this location. A visitors' parking lot is lo building, Lake and Langdon streets, Madison. There is no block of The Wisconsin Center) at frequent intervals. The Street (for fifty cents per day). Campus buses travel the persons coming in automobiles may park their cars in Uni-Ramp) is located on N. Lake Street near State Street. Also level of the Helen C. White Hall, 600 N. Park Street (across bus fare is fifteen cents. (with ten-hour meters). A public parking ramp (Lake Street from the Memorial Union), with entrance on Park Street All sessions will be held in The Wisconsin Center

## TRANSPORTATION

connections via Minneapolis, Chicago and/or Milwaukee are tion in Columbus, Wisconsin). Direct service as well as many and North Central Airlines; Greyhound and Badger Bus available. Specific schedules should be verified in the trav lines; and Amtrak (via chartered bus from the railroad sta eler's own locality. Madison is served by the following: Northwest, Ozark

# REGISTRATION FEES

nesday only	day only or Tuesday only	Conference	Pai
50.	80.	\$120.	articipant
	20.	\$40.	Ladies

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on Wednesday. will be available at the Conference at \$ 30.00 per copy. The evening meals and one copy or the NAMRC-II PROCEED. fees do not include accommodations, breakfasts, or lunch INGS. Additional copies of the NAMRC-II PROCEEDINGS The fees include participation at sessions, breaks, lunches

obtain employer authorization. Companies may place reser advised. Space may be reserved by individuals required to wire. Your registration should be confirmed prior to attendthan two weeks prior to the Conference. Registrations after served" basis. Your registration should be received no later RESERVATIONS will be accepted on a "first come, first vations and send names at a later date. ing the program. To insure attendance, early registration is the two week deadline should be made by telephone or

and improve professional skills (see Treas. Reg. 1. 162-5) tration fees, travel, meals, lodging) undertaken to maintain tion is allowed for expenses of education (including regis TAX DEDUCTION OF EXPENSES: An income tax deduc

# LADIES PROGRAM

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NAMRC-II is being hosted by the College of Engineering, The University of Wisconsin-Madison with the participation of The American Society of Mechanical Engineers, Production Engineering Division ion, The Canadian Society for Mechanical Engineering, Production Division, and the Society of Manufacturing Engineers.



# CONFERENCE PROSPECTUS

metalworking research. The format of the conference is ation and discussion of the results of basic and applied ence (NAMRC-II) has as its purpose and scope the present-May at McMaster University. similar to the highly successful NAMR Conference held last The Second North American Metalworking Confer-

established metalworking research centers. America and Europe representing many of the renown and dards with a large relevance to metalworking technology. ports on larger projects, which combine high scientific stanboth original monographic works as well as summary re-INGS, and have been accepted from speakers from North The papers are contained in the Conference PROCEED-The papers presented at this conference represent

# CONFERENCE ORGANIZATION

in the field of production and manufacturing processes. furthering of knowledge, its dissemination and application been created by a group in North America dedicated to the The North American Metalworking Conferences have

out by the NAMRC-II Organizing Committee. the technical arrangements for this Conference were carried the North American Metalworking Research Group. All of ferences is the responsibility of the Scientific Committee of Invitations for and screening of papers for the Con-

# SCIENTIFIC COMMITTEE

- J. Bollinger, University of Wisconsin-
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- French Waterloo University
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# SECOND NORTH AMERICAN METALWORKING RESEARCH CONFERENCE

# UNIVERSITY OF WISCONSIN - MADISON

# MONDAY, MAY 20, 1974

SESSION 1 9:00 a.m. Lakeshore Room 8:00 a.m. Registration, Lobby, The Wisconsin Center

Welcome - Introduction - Opening Remarks Marvin F. DeVries, Chairman, Organizing Committee,

of Wisconsin-Madison; W. Robert Marshall, Dean, College of Engineering, University

and Head, Mechanical Engineering Department, Queen's William B. Rice, Chairman, Scientific Committee, NAMRC-II University, Kingston, Ontario.

SESSION 2 10:30 a.m. Lakeshore Room

CO-CHAIRMEN

Norman F. Snyder, General Motors Institute, Flint, Michigan; Michael Davis, Sundstrand Machine Tool, Belvidere, Illinois.

S. M. Pandit, University of Wisconsin-Madison, Madison, of a Grinding Spindle", Otto Susolik, The Timken Co., Dynamic Analysis and Evaluation of Design Improvements New Approach to Manufacturing Systems", S.M. Wu

DeVries, S. M. Wu, University of Wisconsin-Madison, North Canton, Ohio; Madison, Wisconsin. the Reduction of Noise in Circular Sawing", M. F.

SESSION 3 10:30 a.m. Room 109 CO-CHAIRMEN

Dell K. Allen, Brigham Young University, Provo, Utah; Orville Ehrhardt, Giddings and Lewis Machine Tool Co., Fond du Lac, Wisconsin.

Warren L. Dedich, Proctor and Gamble Co., Cincinnati, Ohio; Inyong Ham, Pennsylvania State University, University Park, Allan Soyster, Temple University, Philadelphia, Pennsylvania; The Optimal Formulation of Production Group Flowlines",

Kazuhiro Morishita, Hitachi Ltd., Yokohama, Japan; Robots", Geoffrey Boothroyd, University of Massachusetts, Amherst, Massachusetts; quencing of Machine Unloading by Industrial

Arbor, Michigan. , A. G. Atkins, University of Michigan, Ann

SESSION 4 10:30 a.m. Auditorium CO-CHAIRMEN

Botros M. Botros, North Carolina A & T State University, Francis W. Boulger, Battelle Columbus Laboratories, Greensboro, North Carolina; Columbus, Ohio.

Worcester, Massachusetts;
"On the Interaction of Solidification With Metal Shaping S. C. Jain, Norman G. Orrell, Wyman-Gordon Co., A. N. Bramley, University of Leeds, Leeds, England; ing Analysis - A New Approach", R. P. McDermott,

Processes", G. S. Cole, Ford Motor Co., Dearborn, Michigan SESSION 5 1:20 m i absolute Boom

Massachusetts, George S. Reichenbach, Norton Co., Worcester,

Cornell University, Ithaca, New York; Carbide Tool Materials", Daniel R. Deotto, K. K. Wang, "A Theoretical Study of Laser-Induced Thermal Fatigue of

Kahng, G. L. Viegelahn, Michigan Technological University, Houghton, Michigan; "The Effect of Thermoelectric Current on Tool Wear", C. H.

Cambridge, Massachusetts. Abrahamson, II, Massachusetts Institute of Technology, Low Speeds", N. P. Suh, S. Jahanmir, D. A. Colling, E. P. Theory for Wear of Metals Sliding at

SESSION 6 1:30 p.m. Auditorium CO-CHAIRMEN

R. G. Fenton, University of Toronto, Toronto, Ontario. Walter L. Dahl, Rock Island Arsenal, Rock Island, Illinois

Matrix Composites", H. A. Kuhn, T. Erturk, A. Lawley, Betzalel Avitzur, Lehigh University, Bethlehem, Pennsylvania; "Forging Complex Shapes from Fiber-Reinforced Metal-Approximation of Composite Material Strength"

Philadelphia, Pennsylvania. Postulate and Its Application to Metalforming Processes" Drexel University, Philadelphia, Pennsylvania; Lawrence Berkowitz, Howard A. Kuhn, Drexel University, A Simplified Minimum Internal Energy of Deformation

SESSION 7 3:30 p.m. Lakeshore Room CO-CHAIRMEN

Atlanta, Georgia; Joseph R. Roubik, Kearney and Trecker Corp., Milwaukee, Wisconsin. Stuart J. Deutsch, Georgia Institute of Technology

AUTHORS Moshe Y. Friedman, Norman Zlatin, Metcut Research Associates, Cincinnati, Ohio; "Variability of Tool Life as a Function of Its Mean Value",

Brian K. Lambert, Texas Tech University, Lubbock, Texas: "Experimental Investigation of Life of Circular Saws — Part I — Effect of Speed and Feed Using Statistical of Nebraska, Lincoln, Nebraska; Methods of Tool Life Testing", James L. Thomas, University "A Statistical Analysis of Accelerated Versus Conventional

SESSION 8 3:30 p.m. Auditorium CO-CHAIRMEN Friedman, Metcut Research Associates, Cincinnati, Ohio.

Methods", Vijay A. Tipnis, John D. Christopher, Moshe Y.

Steven Swetman, Huskey Injection Molding Systems, Ltd., Nathan H. Cook, Massachusetts Institute of Technology, Cambridge, Massachusetts;

Toronto, Ontario.

"Metallography and Chip Fractography of Free Machining Process", J. T. Black, University of Rhode Island, Kingston, von Turkovich, University of Vermont, Burlington, Vermont, 'Deformation Mechanics During Adiabatic Shear", B. F.

B. Lengyer, Imperial College of Science and Technology,

SESSION 13 1:30 p.m. Lakeshore Room

CO-CHAIRMEN Lester V. Colwell, University of Michigan, Ann Arbor

Clyde A. Sluhan, Master Chemical Corporation, Perrysburg Michigan;

AUTHORS

J. Tlusty, B. S. Goel, McMaster University, Hamilton, 'An Investigation of the Dynamic Cutting Force Coefficient",

on Shear Angle During Wave Generating and Regenerative Binghamton, Binghamton, New York; Chatter", J. F. Sarnicola, State University of New York at Machine Tool Chatter: Effect of Equivalent Surface Slope

G. Boothroyd, University of Massachusetts, Amherst, Massachusetts;

"Consideration and Representation of Errors in the Three Dimensional Working Area of Machine Tools", R. Schultschik,

SESSION 14 1:30 p.m. Auditorium CO-CHAIRMEN Eidgenossische Technische Hochschule, Zurich, Switzerland,

J. J. Waller, Canadair, Ltd., Montreal, Quebec; T. L. Subramanian, Battelle Columbus Laboratories, Columbus, Ohio,

AUTHORS

Rolf Gelger, University of Stuttgart, Stuttgart, W. Germany. of Simultaneous Forward and Backward Extrusion of Cans" Lugosi, Westinghouse Electric Corporation, Pittsburgh, "Hydrostatic Extrusion of Electrical Conductors", Robert Joseph Pepe, Watervliet Arsenal, Watervliet, New York; Some Studies on Force Requirements and Flow Behavior The Formation of Central Bursts During Cold Extrusion",

SESSION 15 3:30 p.m. Lakeshore Room CO-CHAIRMEN

Richard E. Devor, University of Illinois, Urbana, Illinois; Warren, Michigan. Arthur R. Disbrow, General Motors Technical Center, "A Computer Program for Optimization of Cutting

Conditions for Turning and Milling", D. French, G. Quinn,

by Linear Programming and Sensitivity Analysis", D. S. University of Waterloo, Waterloo, Onterio; "Maximization of the Production Rate with Constraints Ermer, University of Wisconsin-Madison, Madison,

Jr., D. J. Stauffer, S. S. Cowell, Ford Motor Co., Dearborn Optimizing Production Machining Operations", J. E. Mayer, D. C. Patel, Miller Compressing Co., Milwaukee, Wisconsin; "Application of Computer Simulation Method for

SESSION 16 3:30 p.m, Auditorium CO-CHAIRMEN

E. W. Mielnik, University of lowa, lowa City, lowa. Brian K. Lembert, Texas Tech University, Lubbock, Texas;

Cubic Metals", M. G. Wong, H. El-Maraghy, R. Sowerby, Orientation Dependence of the Taylor Factor, M. For McMaster University, Hamilton, Ontario; "A Note Describing a Computer Program for Evaluating the "The Extreme Points of Melting in Step Input of Heat",

Y. S. Lee, Westinghouse Electric Corp., Pittsburgh,

Y. S. Keng, Pratt Institute of Technology, Brooklyn, New

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Amrit L. Goel, Syracuse Univers Ulrich Rembold, Whirlpool Corp UTHORS  "Spectral Analysis of Modulation Physical Behavior", J. G. Bolling of Wisconsin-Madison, Madison, Malison, "From Adaptive Control Construction", G. Stute, H. Eitz Sturtgart, W. Germany; "A Constrained Search Adaptive Cutting", B. R. Beadle, Gidding Co., Fond du Lac, Wisconsin; J. G. Bollinger, University of Wisconsin.  J. J. G. Bollinger, University of Wisconsin.  J. J	Gary J. Kim AUTHORS "Practical De Machine Stru Machine Toc "Computer-4 H. Eitel, Uni "Evaluation of Tool Applica Machine Too SSION 10 s Ernest J. Du St. Paul, Min Iain LeMay, Saskarchewa AUTHORS "Prediction of Using a Velo Lahoti, T. A Ohio; "Analysis of Using a Gene Ervin E. Unc Atlanta, Geo "The Use of for the Study Hopson, K Technologica G. W. Rowe, England. SSION 11 .
Amrit L. Goel, Syracuse University, S. Ulrich Rembold, Whirlpool Corp., Ber THORS "Spectral Analysis of Modulation Pher Physical Behavior", J. G. Bollinger, D. of Wisconsin-Madison, Madison, Wisco "From Adaptive Control Constraint to Optimization", G. State, H. Eitel, University of Misconsin; Startgart, W. Germany; "A Constrained Search Adaptive Cont Coutting", B. R. Beadle, Giddings and Co., Fond du Lac, Wisconsin; J. G. Bollinger, University of Wisconsi Wisconsin.  J. G. Bollinger, University of Wisconsi Wisconsin.  J. G. Bollinger, University of Wisconsi Wisconsin.  J. G. Bollinger, University of Galifor CHAIRMEN  ION 12 10:30 a.m. Auditorium CHAIRMEN  Laboratories, Columbus, Ohio; Stat North Carolina.  THORS "Flat-Tool Forging", G. D. Lahoti, Be Laboratories, Columbus, Ohio; Shiro Kobayashi, University of Califor Berkeley, California; "In the High Speed Cylindrical Billets", M. Mohitpour, Ar Technology, Tehran, Iran; B. Langyel, Imperial College of Science College of Science Florianopolis, Brazili; "Temperature Distribution in the Rad Disc", Arno Blass, University of Santa Florianopolis, Brazili;	THORS "Practical Design of Externally Flan Machine Structures", B. C. Cuppan, Machine Tool Co., Fond du Lac, W "Computer-Aided Design of Hydrau H. Eitel, University of Stuttgart, St "Evaluation of Non-Metallic Way Be Tool Applications", S. M. Marathe, Machine Tool Co., Fond du Lac, W "Computer-Aided Design of Hydrau H. Eitel, University of Stuttgart, St "Evaluation of Non-Metallic Way Be Tool Applications", S. M. Marathe, WION 10 8:30 a.m. Auditorium CHAIRMEN  Ernest J. Duwell, Minnesota Mining St. Paul, Minnesota; St. Paul, Minnesota; St. Paul, Minnesota Mining St. Paul, Minnesota; St. Paul, Minnesota Mining St. Paul, Minnesota; Iain LeMay, University of Saskatche Saskatchewan.  THORS "Prediction of Temperature Distributing a Velocity Field Without Disc. Lahoti, T. Altan, Battelle Columbus Ohio; "Analysis of Axisymmetric Flow Thus Saskatchewood, Georgia Instit Atlanta, Georgia; "The Use of the Fiber Structure of for the Study of Metal Flow in Plas Hopson, K. J. Weinmann, A. A. Her Technological University, Houghton G. W. Rowe, University of Birmingt England.  ION 11 10:30 a.m. Lakeshore R.
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L. Goel, Syracuse University, S. Rembold, Whiripool Corp., Ber Il Behavior", J. G. Bollinger, D. Donsin-Madison, Madison, Wisco Adaptive Control Constraint to zation", G. Stute, H. Eitel, University of Misconsin ollinger, University of Wisconsin ollinger, University of Wisconsis sin.  12 10:30 a.m. Auditorium G. Dalal, Iniand Steel Co., Eas Zorowski, North Carolina Stat Carolina.  S. Zorowski, University of Califor Stat Carolina.  S. Zorowski, University of Califor Sy, California; W. Mohitpour, Arology, Tehran, Iran; gyel, Imperial College of Science, England: erature Rise in the High Speed ical Billets", M. Mohitpour, Arology, Tehran, Iran; gyel, Imperial College of Science, England: erature Distribution in the Rad Arno Blass, University of Santa opolis, Brazil:	Kimmet, Gl al Design of Structures' Tool Co., 1 ter-Aided D. University tion of Non- plications'; Tool Co., 1 10 8:30 a.n MEN Duwell, M. Minnesota Any, University Velocity Fit T. Altan, Ba Velocity Fit T. Altan, Ba Study of Me K. J. Weinn ogical Unive owe, University K. J. Weinn ogical Unive owe, University Orderwood Georgia; R. J. Weinn ogical Unive owe, University Orderwood Georgia; R. J. Weinn ogical Unive
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iversity, Syracuse, New Yo Corp., Benton Harbor, Mic Corp., Benton Harbor, Mic Better III. L. Ewald, University of Stutton, Wisconsin; son, Wisconsin Plot System Eitel, University of Stutton Eitel, University of Stutton Hings and Lewis Machine 7 1; if Wisconsin-Madison, Madiatorium I Co., East Chicago, Indiatorium I Co., East Chicago, Indiatori	HORS  Practical Design of Externally Flanged Bolted Joints of Bachine Structures", B. C. Cuppan, Giddings and Lewis Bachine Tool Co., Fond du Lac, Wisconsin; Computer-Aided Design of Hydraulic Systems", G. Stuttgert, W. Germany Evaluation of Non-Metallic Way Bearings for Machine ool Applications", S. M. Marathe, Giddings and Lewis Bachine Tool Co., Fond du Lac, Wisconsin.  ON 10 8:30 s.m. Auditorium HAIRMEN  Trest J. Duwell, Minnesota Mining & Manufacturing Co., Fond du Lac, Wisconsin.  ON 10 8:30 s.m. Auditorium HAIRMEN  The LeMay, University of Saskatchewan, Saskatoon, sakatchewan.  HORS  Prediction of Temperature Distributions in Tube Extrusing a Velocity Field Without Discontinuities", C. D. ahoti, T. Altan, Battelle Columbus Laboratories, Columbis a Velocity Field Without Discontinuities", C. D. ahoti, T. Altan, Battelle Columbus Laboratories, Columbis of Axisymmetric Flow Through Curved Dies Sing a Generalized Upper Bound Approach", Vijay Narvin E. Underwood, Georgia Institute of Technology, tlanta, Georgia; The Use of the Fiber Structure of High-Purity Alumin or the Study of Metal Flow in Plastic Deformation", Nopson, K. J. Weinmann, A. A. Hendrickson, Michigan echnological University of Birmingham, Birmingham, Number 10:30 s.m. Lakeshore Room
Goel, Syracuse University, Syracuse, New York; Rembold, Whirlpool Corp., Benton Harbor, Michigan  **Behavior", J. G. Bollinger, D. L. Ewald, University  **Onsin-Madison, Madison, Wisconsin;  **Adaptive Control Constraint to a Pilot System for  **ration", G. Stute, H. Eitel, University of Stuttgert,  **t, W. Germany;  **Strained Search Adaptive Controller for Metal  **", B. R. Beadle, Giddings and Lewis Machine Tool  **nd du Lac, Wisconsin;  **ollinger, University of Wisconsin-Madison, Madison,  **in.  **12 10:30 a.m. Auditorium  **MEN  **G. Dalal, Inland Steel Co., East Chicago, Indiana;  **Zorowski, North Carolina State University, Raleigh,  **arolina.**  **Stroina.**  **Obayashi, University of California, Berkeley,  **y, California;  **vel, Imperial College of Science and Technology,  **J. England;  **rature Distribution in the Radial Upsetting of a Flat  **Arno Blass, University of Santa Catarina,	Gleason Works, Rochester, New York.  of Externally Flanged Bolted Joints on  ss", B. C. Cuppan, Giddings and Lewis , Fond du Lac, Wisconsin;  Design of Hydraulic Systems", G. Stute, ty of Stuttgert, Stuttgert, W. Germany; on-Metallic Way Bearings for Machine s", S. M. Marathe, Giddings and Lewis , Fond du Lac, Wisconsin.  a.m. Auditorium  Minnesota Mining & Manufacturing Co., ta; ersity of Saskatchewan, Saskatoon,  mperature Distributions in Tube Extrusion Field Without Discontinuities", C. D.  Battelle Columbus Laboratories, Columbus symmetric Flow Through Curved Dies ed Upper Bound Approach", Vijay Nagpal ood, Georgia Institute of Technology, Fiber Structure of High-Purity Aluminum Metal Flow in Plastic Deformation", M. W sinmann, A. A. Hendrickson, Michigan iversity, Houghton, Michigan iversity of Birmingham, Birmingham,  Da.m. Lakeshore Room
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SESSION 17 8:30 a.m. Lakeshore Room CO-CHAIRMEN ..... , .....

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CO-CHAIRMEN

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K. G. Adams, University of Waterloo, Waterloo, Ontario;

Richard O. Lane, Frank Bancroft Co., Dearborn, Mcihigan; Milton C. Shaw, Carnegie-Wellon University, Pittsburgh,

Pennsylvania.

AUTHORS

Brecker, Carnegie-Nellon University, Pittsburgh, Pennsylvania "Wear Flats Generated During Grinding With Various Grind-"The Mechanics of Abrasive Conditioning", James N.

ing Fluids", M. E. Foerster, S. Malkin, University of Texas, Borazon (CBN) Wheels", R. P. Lindsay, Cincinnati Milacron Austin, Texas; Characteristics of Precision Production Grinding With

Heald Division, Worcester, Massachusetts.

SESSION 18 8:30 a.m. Auditorium CO-CHAIRMEN

Ontario; T. C. Greenhough, Frederick Parker, Ltd., Scarborough,

AUTHORS Orville D. Lascoe, Purdue University, W. Lafayette, Indiana

J. A. Schey, University of Illinois-Chicago Circle, Chicago Lonn, Caterpillar Tractor Co., Peoria, Illinois; "Development of the Plane-Strain Compression Test", A. H

Shaped Dies With Friction", B. I. Bachrach, S. K. Samanta Ford Motor Co., Dearborn, Michigan; "A Finite Element Analysis of the Plane Strain Drawing Siourill 'Plane Strain Sheet and Tube Extrusion Through Cosine-

Problem", J. L. Gordon, Westinghouse Electric Corp., A. S. Weinstein, Carnegie-Mellon University, Pittsburgh, Pittsburgh, Pennsylvania; Pennsylvania.

SESSION CO-CHAIRMEN 19 10:30 a.m. Lakeshore Boom

AUTHORS Michael Field, Metcut Research Associates, Cincinnati, Ohio John C. Cherna, McGill University, Montreal, Quebec;

mena for Determining

Quinto, Bernard S. Levy, Inland Steel Co., East Chicago, Spectroscopy Observations on the Role of Lead in the Machining of Steel", Robert W. Thompson, Dennis T. 'Grinding Wheel Surfaces", G. H. Pettee, B. H. Anderson, Scanning Electron Microscopy and Auger Electron

Studies of Single Crystal Aluminum-Oxide Vitrified Grinding W. D. Syniuta, Scientific Energy Systems Corp., Watertown Wheels During Dry Grinding of S.A.E. 4150 Steel", J. A. Kirk, University of Maryland, College Park, Maryland; Norton Co., Worcester, Massachusetts; Scanning Electron Microscopy and Microprobe Wear

SESSION 20 10:30 a.m. Auditorium CO-CHAIRMEN Massachusetts.

AUTHORS Robert A. Powell, Indal Canada, Ltd., Weston, Ontario; (llinois; Serope Kalpakjian, Illinois Institute of Technology, Chicago

Center, Warren, Michigan; Thin Sheets", A. K. Ghosh, General Motors Technical Michigan; Gerdeen, Michigan Technological University, Houghton, "A Criterion for Plastic Instability in Punch Stretching of "An Analysis of Exisymmetric Sheet Metal Forming", J. C

Skokie, Illinois. Metal Formability", J. C. Benedyk, Brunswick Corp., S. S. Hecker, Los Alamos Scientific Labs, Los Alamos, New The Significance of Tensile Necking Retardation on Sheet

Mexico;