



McMASTER UNIVERSITY
HAMILTON, ONTARIO, CANADA



NAMR

North American Metalworking
Research Conference

MAY 14, 15, 1973

AND

The Spring Meeting of

ASME

Production Engineering Division

MAY 16, 1973

AT

McMASTER UNIVERSITY
Hamilton, Ontario, Canada

METAL CUTTING, GRINDING, ELECTRICAL
MACHINING, FORGING, SHEET METAL
FORMING, MACHINE TOOLS, NUMERICAL
CONTROL, STATISTICS APPLIED TO
PRODUCTION RESEARCH.

NORTH AMERICAN METALWORKING RESEARCH CONFERENCE

Scientific Committee:

J. Bollinger,	University of Wisconsin
N. Cook,	Massachusetts Institute of Technology
L. Colwell,	University of Michigan
D. French,	Waterloo University
S. Kobayashi,	University of California
W. Rice,	Queen's University — CHAIRMAN
B. von Turkovich,	University of Vermont
J. Tlustý,	McMaster University

Organizing Committee:

M.F. DeVries	for ASME, Prod. Eng. Division
J.B. Watson	for CSME, Prod. Eng. Division
G. Churchill	for SME
J.L. Duncan	for McMaster University
R. Sowerby	for McMaster University
J. Tlustý	for McMaster University — CHAIRMAN

Acknowledgements:

Organized by McMaster University with the support of:

The National Research Council of Canada,

with the participation of:

American Society of Mechanical Engineers, Production Engineering Division,

and with the cooperation of:

Canadian Society of Mechanical Engineers, Production Engineering division, and
Society of Manufacturing Engineers.

Purpose and Scope of the NAMR Conference:

Presentation and discussion of results of research, carried out at universities and in industry, of processes and equipment of metalworking. Original monographic work as well as summarizing reports on larger projects will be presented which combine high scientific standard with a relevance to technology of metalworking.

Participation is expected both of research workers and of production engineers from industry. To the former, the conference gives an opportunity for an exchange of opinions and to the latter, both a chance to comment on research work and to get first hand information.

Speakers from all over North America will represent many of the renown and established research centers of metalworking.

The programme of the **ASME PRODUCTION ENGINEERING CONFERENCE** which follows is analogous and complementary to the programme of the NAMR Conference. It is a regular event of the production Engineering Division of ASME.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Production Engineering Division Executive Committee:

M.F. DeVries,	Chairman
W.B. Rice,	Vice-Chairman
R.L. Vaughan,	
G.F. Helgesen,	
B.F. von Turkovich,	

PROGRAMME OF THE NAMR CONFERENCE

Sunday, May 13, 1973.

For those accommodated on campus:

Check-in at Woodstock Hall and registration between 6 p.m. and 10 p.m. Cold snacks, tea and coffee will be available during this period in the Hall. For a regular evening meal various restaurants and bars are located near the campus.

Monday, May 14, 1973.

Registration: 8 a.m. to 9 a.m. at the entrance of Room B128 in Arts II Building.

Opening Session. Chairman: Dr. J. Tlustý.

9.00 a.m.	WELCOME TO PARTICIPANTS Dr. L.W. Shemilt, Dean of Engineering, McMaster University.
9.10 a.m.	OPENING ADDRESS Dr. R.D. Hiscocks, Vice-President, Industrial Research Assistance Promotion, National Research Council of Canada.
9.30 a.m.	Professor L.V. Colwell, University of Michigan, Ann Arbor: <i>An Era of Transition for Production Engineering.</i>
9.50 a.m.	Coffee Break
10.05 to 12.50 p.m.	In Parallel: Session 1A Tool Wear, Machinability of Metals. Chairman: Dr. M.C. Shaw, Carnegie Mellon University. Session 1B Material Behaviour in Forming. Chairman: Dr. J.L. Duncan, McMaster University.
1.00 p.m.	Lunch
2.30 to 5.30 p.m.	In Parallel: Session 2A Machine Tool Dynamics and Control. Chairman: Dr. J. Duncan, University of British Columbia. Session 2B1 Statistics in Production Engineering. Session 2B2 Electrical Machining. Chairman: Dr. M. DeVries, University of Wisconsin, Chairman of Prod. Eng. Division, ASME.
6.45 to 7.15 p.m.	Cocktails
7.15 p.m.	Conference Banquet.

Tuesday, May 15, 1973.

9.00 to 12.00 noon	In Parallel: Session 3A Metal Cutting Mechanics. Chairman: Mr. J. B. Watson, Chairman of Prod. Eng. Division of CSME. Session 3B Mechanics of Forming Processes. Chairman: Mr. F.W. Boulger, Battelle Columbus Laboratories.
-----------------------	--

Tuesday, May 15, 1973.

- 12.30 p.m. Lunch
2.00 to In Parallel:
5.00 p.m. **Session 4A** Grinding. Abrasive Processes.
Chairman: Dr. W.B. Rice, Queen's University.
- Session 4B** Forging.
Chairman: Mr. G. Churchill, Director, S.M.E.

6.30 p.m. Dinner

PROGRAMME OF THE ASME PRODUCTION ENGINEERING MEETING

Wednesday, May 16, 1973.

- 9.00 to **Session 5 Selected Topics in Material Processing**
12.00 noon **Analysis.**
Chairman: S.M. Wu, University of Wisconsin.
Vice-Chairman: S.P. Rogacki, Western Electric Co.,
Kearny, N.J.
- 12.30 p.m. Lunch
- 2.00 to **Session 6 Selected Topics in Non-Traditional**
5.00 p.m. **Machining Processes.**
Chairman: R.L. Edgar, Alcan International Ltd.
Res. Centre, Kingston, Ontario
Vice Chairman: H.W. Wevers, Queen's University,
Kingston, Ontario.
- 6.00 p.m. Dinner

DETAILED PROGRAMMES OF SESSIONS

Monday, May 14, morning

- Session 1A Tool Wear, Machinability of Metals.**
- 10.05 a.m. G.R. Adams, Cominco Ltd. Product Research
Sheridan Park, Ontario:
The Minimum Chip Producing Feed Rate Test.
- 10.30 a.m. G. Boothroyd, L.E. Reinhart, University of
Massachusetts, Amherst, Mass:
Effect of Chip Breaking Devices on Tool Wear.
- 10.55 a.m. N.P. Suh, Massachusetts Institute of Technology,
Cambridge, Mass:
*Surface Treatment and Coating Techniques for
Carbide Tools.*
- 11.20 a.m. *Discussion.*
- 11.40 a.m. P.J. Amaria, Memorial University, St. John's,
Newfoundland:
*Machining of Titanium Alloy Steel INCONEL 750
Using a Soft Metal Electrolyte as Cutting Fluid.*

- 12.05 p.m. M. Field, W.P. Koster, Met Cut Research Associates
Inc., Cincinnati, Ohio:
*Effect of Machining Variables on the Surface and
Structural Integrity of Titanium Alloys.*
- 12.30 p.m. *Discussion.*

Session 1B Material Behaviour in Forming

- 10.05 a.m. S. Ramalingam, A.C. Bell, State University, New
York, Buffalo, N.Y.:
Quality Aspects of Hole Processing
- 10.30 a.m. H.A. Kuhn, W.L. Otto, P.W. Lee, Drexel University,
Philadelphia, Pa:
*A Continuum Model of Localized Thinning and
Fracture in Forging and Sheet Forming.*
- 10.55 a.m. *Discussion.*
- 11.15 a.m. G. Schroder, Institut fur Umformtechnik,
University of Stuttgart, W. Germany:
*Anisotropic Plastic Behaviour of Hot Extruded
Bars of Hexagon Metals.*
- 11.40 a.m. V. Hasek, Institut fur Umformtechnik, University
of Stuttgart, W. Germany:
*Influence of Various Factors on the Position and
Form of Forming Limit Diagrams.*
- 12.05 a.m. *Discussion.*

Monday, May 14, afternoon

Session 2A Machine Tool Dynamics and Control

- 2.30 p.m. P.F. Mahr, Bell Laboratories, Whippany, N.J., J.
Frisch, University of California, Berkeley:
*On the Use of Analogue Digital Conversion During
DNC - Metal Cutting.*
- 2.55 p.m. D. French, K.G. Adams, University of Waterloo,
Waterloo, Ontario:
*Considerations Affecting the Design and
Utilization of Direct Computer Control of Machine
Tools and Processes*
- 3.20 p.m. J. Tlustý, McMaster University, Hamilton, Ontario,
Some Aspects of Chatter in Metal Cutting.
- 3.45 p.m. *Discussion.*
- 4.05 p.m. *Coffee Break.*
- 4.20 p.m. D.L. Brown, Jr., University of Cincinnati,
Cincinnati, Ohio, O. Susolik, Timken Co., Canton,
Ohio:
*Optimization of Machine Tool Dynamics Using
Structural Tuning Elements.*
- 4.45 p.m. J.B. Bryan, R.R. Donaldson, R.W. Clouser,
Lawrence Livermore Laboratory, University of
California, Livermore, Calif:
Reduction of Machine Tool Spindle Growth.
- 5.10 p.m. *Discussion.*

Session 2B1 Statistics in Production Engineering. Optimization in Cutting.

- 2.30 p.m. D.S. Ermer, University of Wisconsin, Madison, Wis:
Engineering Statistics Applied in Production Engineering.
- 2.55 p.m. S.M. Wu, H.J. Steudel, University of Wisconsin, Madison, Wis:
Statistics for Production Engineers.
- 3.20 p.m. Y. Koren, Technion, Haifa, Israel:
Dynamic and Static Optimization of the Cutting Process.
- 3.45 p.m. *Discussion*
- 4.05 p.m. *Coffee Break*

Session 2B2 Electrical Machining

- 4.20 p.m. L. Kops, V.B. Quach, McGill University, Montreal, Quebec:
On the Surface Phenomena of Metal Removal in Electrochemical Machining.
- 4.45 p.m. R. Snoeys, F. Van Dijck, Catholic University, Louvain, Belgium:
Physico Mathematical Analysis of the Electric Discharge Machining Process.
- 5.10 p.m. *Discussion*

Tuesday, May 15, morning

Session 3A Metal Cutting Mechanics.

- 9.00 a.m. B.F. von Turkovich, University of Vermont, Burlington Vermont:
The Role of Constitutive Equations in the Theory of Metal Cutting.
- 9.25 a.m. S. Ramalingam, J. Temple Black, A.C. Bell, State University of New York, Buffalo, N.Y.:
Dynamic Metal Cutting Studies as Performed in the Scanning Electron Microscope
- 9.50 a.m. *Discussion.*
- 10.10 a.m. *Coffee Break*
- 10.25 a.m. G. Boothroyd, J.F. Sarnicola, University of Massachusetts, Amherst, Mass:
Variation in Tool Forces During Wave Removing.
- 10.50 a.m. M.F. DeVries, S.M. Wu, University of Wisconsin, Madison, Wis:
On Drilling Research at the University of Wisconsin.
- 11.15 a.m. W.B.H. Cook, W.B. Rice, Queen's University, Kingston, Ontario:
Mechanics of Deformation in the Machining Process.
- 11.40 a.m. *Discussion*

Session 3B Mechanics of Forming Processes

- 9.00 a.m. R.G. Fenton, W.K.K. Ng, University of Toronto, Toronto, Ontario:
Finite Element Solution of Extrusion of Elasto Plastic, Work Hardening Materials.
- 9.25 a.m. B. Avitzur, G. Powell, Lehigh University, Bethlehem, Pa:
Forming of Tubes by Hydraulic Pressure.
- 9.50 a.m. *Discussion.*
- 10.10 a.m. *Coffee Break.*
- 10.25 a.m. J.A. Schey, P.H. Abramowitz, University of Illinois, Chicago:
Indentation of a Slab with Rectangular Anvils and Material Overhang.
- 10.50 a.m. T. Altan, C.H. Lee, N. Akgerman, Battelle's Columbus Laboratories:
Approximate Calculation of Velocity and Temperature Distribution in Axisymmetric Extrusion and Drawing.
- 11.15 a.m. S. Kalpakjian, A. Khilnani, A.L. Markunas, Illinois Institute of Technology, Chicago:
Surface Profiles in Wedge Indentation.
- 11.40 a.m. *Discussion.*

Tuesday, May 15, afternoon

Session 4A Grinding. Abrasive Processes.

- 2.00 p.m. L. Kops, L.M. Hucke, McGill University, Montreal, Quebec:
Thermal Simulation of the Grinding Process.
- 2.25 p.m. R.P. Lindsay, Cincinnati Milacron, Heald Division, Worcester, Mass:
Chatter-Free Grinding Time.
- 2.50 p.m. M.C. Shaw, W. Sauer, Carnegie - Mellon University, Pittsburgh, Pa:
Vertical Spindle Surface Grinding.
- 3.15 p.m. *Discussion.*
- 3.35 p.m. *Coffee Break.*
- 3.50 p.m. J.N. Brecker, Carnegie - Mellon University, Pittsburgh, Pa:
Grading Grinding Wheels by Elastic Modulus.
- 4.15 p.m. M. Younis, McMaster University, Hamilton, Ontario:
Surface Grinding with Special Regard to Heat Generated.
- 4.40 p.m. J.G. Bollinger, G.J. Kimmet, University of Wisconsin, Madison, Wis:
The Dynamics of Lapping.
- 5.05 p.m. *Discussion.*

Session 4B Forging.

- 2.00 p.m. C.S. Jain, Wyman - Gordon Company, Worcester, Mass:
Friction and Lubrication in Hot Forging; A Look at the Current State of the Art.
- 2.25 p.m. Taylan Altan, N. Akgerman, Battelle's Columbus Laboratories:
Computer Aided Design and Manufacturing of Forging Dies for Structural Parts.
- 2.50 p.m. C.H. Lee, S. Kobayshi, University of California, Berkeley, Calif:
The Deformation Mechanics and Workability in Upsetting Solid Circular Cylinders.
- 3.15 p.m. *Discussion.*
- 3.35 p.m. *Coffee Break.*
- 3.50 p.m. H.A. Kuhn, C.L. Downey, Drexel University, Philadelphia, Pa:
Mechanics of Forging Sintered Powder Materials.
- 4.15 p.m. A.H. Shabaik, University of California, Los Angeles:
Effect of Friction and Degree of Deformation on Bulge Formation During Compression.
- 4.40 p.m. *Discussion.*

ASME PRODUCTION ENGINEERING CONFERENCE

Wednesday, May 16, morning

Session 5 Selected Topics in Material Processing Analysis

- 9.00 a.m. M.Y. Friedman, Post Doctoral Fellow, University of Wisconsin, Madison, Wis:
A General Approach to the Geometrical Analysis of Cutting Tools with Curved Surfaces.
(Paper No. 73 - Prod - 7)
- 9.40 a.m. G. Boothroyd, Professor J.F. Sarnicola, Research Assistant, University of Massachusetts, Amherst, Mass:
Economics of Facing Operations.
(Paper No. 73 - Prod - 5)
- 10.30 a.m. *Coffee Break.*
- 10.45 p.m. F.W. Boulger, Director, T. Altan, Senior Scientist, Battelle Memorial Institute, Columbus, Ohio:
Flow Stress of Metals and Its Application in Metal Forming Analysis.
(Paper No. 73 - Prod - 4)
- 11.25 p.m. Y.I. El Gomayel, Assistant Professor, A.A. Zakaria, Ph.D. Candidate, Purdue University, Lafayette, Ind:
Statistical Correlation of Tool Wear Parameters.
(Paper No. 73 - Prod - 8)

Wednesday, May 16, afternoon

Session 6 Selected Topics in Non-Traditional Machining Processes

- 2.00 p.m. Y.E. Lee, Roselon Yarn Co., Danville Pa., Y.S. Kang, Pratt Institute, Brooklyn, N.Y:
The Drilling of a Metal Plate by a Laser Beam.
(Paper No. 73 - Prod - 6)
- 2.40 p.m. N.H. Cook, Professor, S.P. Loutrel, Assistant Professor, Massachusetts Institute of Technology, Cambridge, Mass:
A Theoretical Model for High Rate Electrochemical Machining.
(Paper No. 73 - Prod - 2)
- 3.20 p.m. *Coffee Break.*
- 3.35 p.m. N.H. Cook, Professor, S.P. Loutrel, Assistant Professor, Massachusetts Institute of Technology, Cambridge, Mass:
High Rate Electrochemical Machining.
(Paper No. 73 - Prod - 3)
- 4.15 p.m. N.H. Cook, Professor, S.P. Loutrel, Assistant Professor, Massachusetts Institute of Technology, Cambridge, Mass:
Sodium Chloride Electrolyte Data at High Temperature and Pressure.
(Paper No. 73 - Prod - 1)

GENERAL INFORMATION**HAMILTON. TRANSPORTATION**

Hamilton is situated midway between Toronto and Niagara Falls on the Queen Elizabeth Highway (QEW). It is a large center of metalworking, steel and industry. McMaster University campus is located at the west end of the town in a clean wooded area.

It can be reached:

By car: The QEW connects at the north end to the 401 highway and at the south to Interstate 90.

By air: The nearest large airport is Toronto. A limousine leaves every full and every half hour to downtown Hamilton. The ride takes one hour. From downtown Hamilton a taxi may be taken to the campus. Hamilton has its own airport served by only one airline, the Nordair which flies to Pittsburgh, Ottawa and Montreal.

PARKING:

Parking will be available on campus and is paid for at the entrance. There is no parking fee on Sundays.

ACCOMMODATION:

It is expected that the majority of participants will take accommodation in the Woodstock student hall on campus. Those who arrive alone will have single rooms, those accompanied by their wives will obtain double rooms. Bathrooms, Lounges and Kitchenets are common for each floor.

Those wishing to stay in a hotel will have to arrange their reservations themselves in any of the Hamilton hotels or motels. The largest of them are:

The Sheraton Connaught, Telephone: 416-527-5071
The Holiday Inn, Telephone: 416-528-3451

REGISTRATION

For advance registration use the enclosed registration form and return it as soon as possible. If your registration is obtained before April 30, 1973, you will obtain by mail, a map of the campus and further detailed instructions.

AVAILABILITY OF ASME PAPERS

Technical papers with numbers in this programme will be available and may be ordered before the conference. It is expected that the other papers will be available at the conference. Additional listing of available technical papers will be found in the changes to the programme distributed at the conference and in a future issue of MECHANICAL ENGINEERING.

All numbered ASME papers for this conference will be available in separate copy form until March 1, 1974. Prices are \$1.00 to members of ASME and \$3.00 to non-members, plus postage and handling charges. Payment may also be made by free coupons or coupons which may be purchased from the Society in lots of 10 at \$8.00 to members and \$24.00 to non-members. You can save the postage and handling charges by including your check or money order, made payable to ASME, and sending it to:

ASME Order Department
United Engineering Center
345 East 47th Street
New York, New York 10017.

Papers must be ordered by the paper numbers, otherwise the order will be returned.

REGISTRATION FEE

	a)	b)
A. For both NAMR and ASME Conferences	\$115.	\$95.
B. For NAMR Conference only	90.	70.
C. For ASME Conference only	25.	20.
D. Ladies, per day		\$20.
E. Participation at one day of conference		20.
F. Separate copy of NAMR Conference Proceedings		30.

The fees a) include accommodation on campus, three nights for A, two nights for B, one night for C, participation at meetings, all meals (breakfast, lunch, evening meal, coffee), the banquet ticket and one copy of NAMR Conference Proceedings (A and B)

The fees b) do not include accommodation, breakfast, evening meals but they include banquet.

The fee for D includes accommodation and all meals per day and also the banquet on Monday.

The fee for E is for participation at any one day of conference and it includes lunch and coffee.

The ASME papers have to be purchased separately.