Ontario Rotomolding Working Group holds first workshop

The Ontario Rotomolding Working Group held their first workshop with 85 attendees on November 23, 2004 in Toronto. This event focused on advances in materials for rotational molding and on marketing. The workshop was organized by Elizabeth Soos Takacs, John Vlachopoulos, MMRI Centre for Advanced Polymer Processing and Design (CAPPA-D), Ross Bradsen, Materials and Manufacturing Ontario (MMO) – A Division of Ontario Centres of Excellence Inc. (OCE Inc.) and Ontario RotoMoulding Working Group.

The one-day program featured several distinguished international speakers.

The morning session focused on “Progress in Rotomolding Materials”. Einar Voldner of Synergy Polymers Inc. gave an overview of the rotomolding process and selection of materials. Eric Maziers of Total Petrochemicals and Ron Partridge of Arkema gave an update on the metallocene polyolefin and engineering polymers.

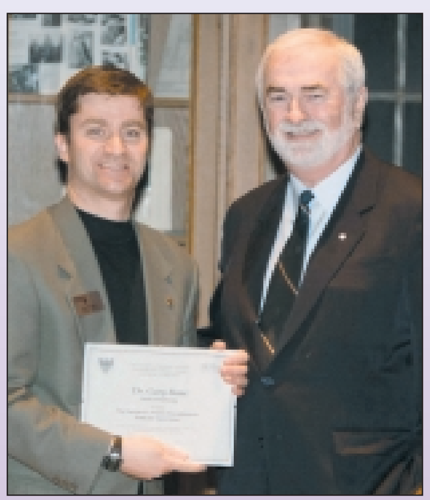
Dr. Jing Wang of Cyclics Corp. introduced CBT engineering resins which can be processed as a high-density polyethylene but exhibit mechanical properties of the engineering polymers. Chris Rosenbusch of Expancel Inc. and David D’Agostino from McMaster University talked about Expandable Polymer Microspheres for Weight Reduction. Alan Dubin & Duane Emerson of Ticona talked about the Celcon® acetal copolymers and Ladd J. Horvath of Polymer Services & Innovations gave an overview of Vinyl Compounds for rotational molding.

The afternoon session dealt with marketing issues. Dr. Paul Nugent, independent consultant, gave an overview of markets and materials around the world.

Gary Svoboda, Adventus Research, talked about the importance of market research and reviewed the recent rotomolding market trend. ■

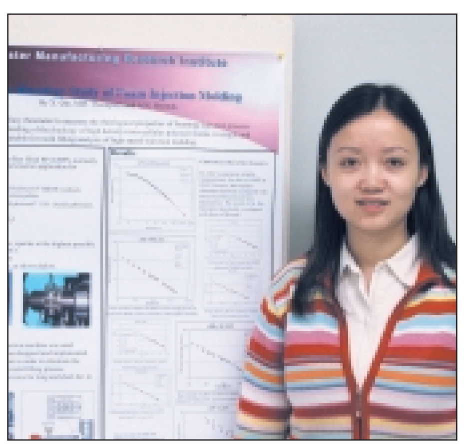
Finally, Dry Hands

Engineering design students of Dr. Mucksh Jain, Associate professor, mechanical engineering (MMRI faculty member),participated in a competition organized by the Away From Home division of Scott Paper Limited in Mississauga. They developed a hands-free roll-towel dispensing machine that presents the customer with a folded towel. The double thickness of the towel eliminates the problem of wet hands weakening the towel strength and tearing, resullting in partially dry hands. 1st place students received $7,500, 2nd place received $5,000 and 3rd place received $2,500.



Dr. Gary Bone

McMaster President Dr. Peter George presented ***Dr. Gary M. Bone*** *(MMRI faculty member) with the President’s Award for Excellence in Graduate Supervision at the Graduate Students Recognition Day reception on March 15th. Dr. Bone was selected for this prestigious award from a field of candidates from the Faculties of Engineering, Science, and Health Sciences. His nomination was supported by strong letters of support and appreciation for his outstanding supervisory and mentoring skills from his current students, graduate alumni, and the Department of Mechanical Engineering. Congratulations Dr. Bone!*



Xiaonan Qin

The Ontario Section of Society of Plastics Engineers held their 7th Annual Industry University night on March 17th, 2005. Graduate student Xiaonan Qin, Chemical Engineering, supervised by Dr. Andy Hrymak and Dr. Michael Thompson was awarded Second Prize ($150) in the poster competition for her entry In Line Rheology Study of Foam Injection Molding.

ASM Poster Competition

The ASM Ontario Chapter Education Night Poster competition was hosted at the University of Toronto on March 7th, 2005 and included posters from the University of Toronto, University of Waterloo and McMaster University. Akbar Ahmad, Daryl Scheerer, and John Yarnell won third place with their poster titled Characterization of Liquid-Cooled Heat Sinks *which was part of their 4th year project carried out this year at the Thermal Processing Laboratory under the supervision of Dr. Mohamed Hamed, Assistant Professor, Mechanical Engineering.*

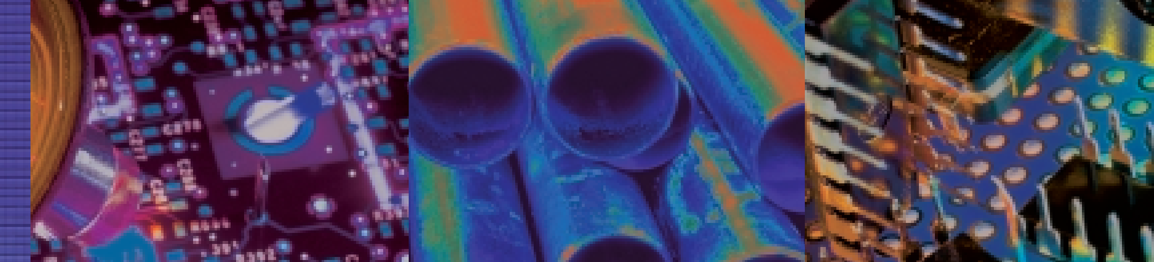
MMRI
McMaster Manufacturing Research Institute

The McMaster Manufacturing Research Institute – one of the country’s most advanced and best equipped research laboratories – combines research excellence with state-of-the-art equipment to meet the sophisticated research and development needs of leading manufacturers. Created in 2000 with more than $10 million in funding from its founding sponsors – the Canadian Foundation for Innovation (CFI), the Ontario Innovation Trust (OIT) and the Ontario Research and Development Challenge Fund (ORDCF) and industry partners – the MMRI provides a focus for high-profile research and serves as a vehicle for university-industry-government interaction. In addition, the institute promotes, encourages, and performs fundamental and applied research in cooperation with its industrial partners and provides systematic mechanisms for technology transfer and infusion of knowledge and research results.

For more information

McMaster Manufacturing Research Institute (MMRI)
John Hodgins Engineering Building
Offices JHE 326, Mail Stop JHE 316
1280 Main Street West
Hamilton, Ontario L8S 4L7
Phone: 905-525-9140 Ext. 24285
Fax: 905-521-9742
Email: mmri@mcmaster.ca
Website: mmri.mcmaster.ca

McMaster University



CONNECTION
Connecting University, Industry, and Government June 2005

Letter from the Director

“A pessimist sees the difficulty in every opportunity; an optimist sees the opportunity in every difficulty.” – Sir Winston Churchill

A little over five years ago a group of faculty members, interested in manufacturing research and working with industry, came together under the leadership of Mo Elbestawi. We proposed creating an interdisciplinary manufacturing research group and building a research facility that would rival that available in any academic institution in North America. Opportunities appeared through the Canadian Foundation for Innovation, Ontario Investment Trust and the Ontario Research and Development Challenge Fund. We were successful in getting the core funding for construction of new laboratories, major equipment acquisition, graduate student support, and academic and staff expansion. We built on the core research areas that existed in the Faculty of Engineering in advanced machining, polymer processing, robotics, and metal forming. Industrial sponsors and partners provided important financial support and critical advice for our proposals to the funding agencies. That start has led to continued growth. Over 120 graduate students and postdoctoral fellows worked with MMRI faculty and facilities in 2004, producing more than 120 refereed journal publications and generating $2.6M of funded research

MMRI has welcomed new faculty members: Philip Koshy (grinding), Stephen Veldhuis (advanced machining and coatings), Michael Thompson (polymer processing), Mohamed Hamed (heat treating), and Mukesh Jain (metal forming). Sumanth Shankar holds the Braley-Orlick Chair in Advanced Manufacturing in the area of solidification and casting. Joe McDermid, Stelco/NSERC Industrial Research Chair in Steel Product Application, is leading projects that link MMRI with the Steel Research Centre. Growth in the number of faculty in manufacturing has fostered the development of an interdisciplinary manufacturing engineering undergraduate program that will allow our students to gain industrial experience and have the opportunity to do

Dr. Andrew Hrymak

a one year Master of Engineering degree in manufacturing. MMRI faculty are actively involved in national initiatives such as AUTO21 The Automobile of the 21st Century, a national research initiative supported by the Government of Canada through the Networks of Centres of Excellence Directorate and more than 120 industry, government and institutional partners.

“The future ain’t what it used to be.” – Yogi Berra

As part of our vision and desired impact, MMRI must be relevant on the shop floor. The industrial landscape has changed dramatically over the last five years, as competitive pressures have hit the manufacturing sector: off-shore sourcing, downsizing of technical and research groups, and out sourcing of components and services. Our industrial partner base is changing and so

continued on page 2

Innovative Process for Cylindrical Grinding of Brittle Materials

Productivity in grinding of brittle materials such as glass and engineering ceramics is limited by microcracking of the work material that has an adverse influence on component strength and reliability. Material removal rates currently employed are therefore highly conservative with a view to controlling surface integrity, which adds to the machining costs that are already prohibitive. In this context, Dr. Phil Koshy, Assistant Professor at the MMRI, and Graduate Student Mr. Yongsheng Zhou, in collaboration with Dr. Guo (United Technologies Research Centre, Hartford, CT) and Dr. Chand (Prematech Chand, Worcester, MA), have developed a novel, material-adapted process for cylindrical grinding of brittle materials, to facilitate enhanced material removal rates with the least detriment to strength.

A feature that is technologically significant in the grinding of brittle materials is the dependency of strength on the grinding direction. Surface grinding of brittle materials is accomplished such that the grinding lay is along the length of the component (longitudinal) rather than across (transverse), in the interest of flexural strength (see Figure 1). This is because there are two populations of grinding-induced cracks: the ones parallel to the grinding lay are usually larger than the ones created across. The flexural strength of components ground in the longitudinal direction would be higher in comparison to those ground transversely, on account of the tensile stress activating the smaller cracks, rather than the larger cracks that are at 90° to the former.

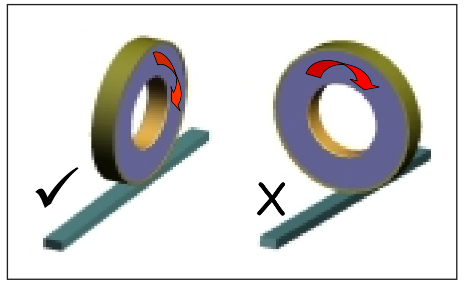


Figure 1: Longitudinal and Transverse Surface Grinding

In contrast to surface grinding, the strategy of orienting the grinding direction so as to exploit the phenomenon of strength anisotropy is not practicable in cylindrical grinding. This is due to the intrinsic kinematics of conventional machine tools rendering the grinding lay to be perpendicular to the longitudinal axis of the component (see Figure 2), which refers to transverse grinding. Appropriate as they are for grinding metals, the unfavourable implication for brittle materials ground on such machine tools is that the larger cracks would actuate failure in flexure, resulting in severe strength degradation.

To this end, the novel process that is a variant of conventional cylindrical grinding, is realized by the relative rotation of the wheel in the horizontal plane such that the grinding lay is along the longitudinal axis of the component. Unlike conventional traverse cylindrical grinding, wherein wheel wear is localized at the leading edge of the wheel, wear in the novel process would tend to occur along a thin circumferential band. Wear can however be distributed uniformly over the wheel width by inclining the workpiece in the horizontal plane in relation to the feed direction, so as to engage different sections of the wheel as the workpiece traverses past it; alternatively, an appropriate cross feed could be implemented. The reduced contact area is further beneficial in terms of promoting effective cooling due to facilitated access of grinding fluid into the grinding zone.

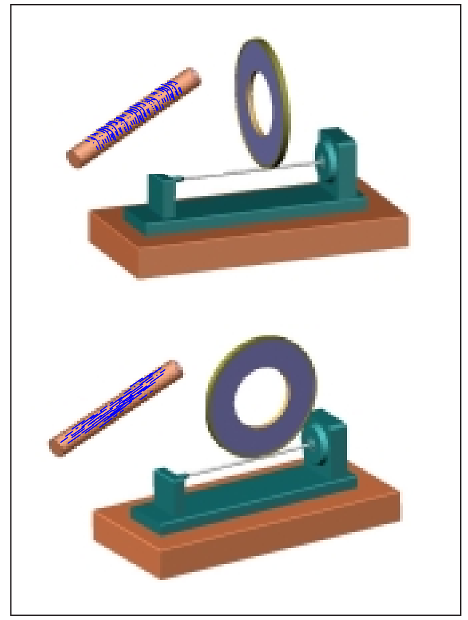


Figure 2: Conventional and Novel Cylindrical Grinding

Strength testing of 6mm diameter quartz rods ground in the novel and conventional processes under identical cycle times has indicated that the novel process corresponds to not only a phenomenal increase in strength in the order of 30%, but also reduced variability. ■

For further information contact Dr. Philip Koshy, Assistant Professor, Department of Mechanical Engineering, McMaster University: koshy@mcmaster.ca

MMRI-MMO Distinguished Lecturer Series

On April 13, 2005, Dr. James Lee, Professor of Chemical Engineering (left) at The Ohio State University, spoke on "Polymer Processing at the Micro/Nanoscale". On April 28, Dr. David Stephenson, Technical Fellow and Manager of Manufacturing Process Analysis at GM Powertrain, Pontiac, Michigan, spoke about "Ongoing Challenges in Powertrain Machining".

Director's letter

continued from page 1

we too have to change. We are looking at a number of opportunities that will address our industrial impact goals over the next five years.

I will complete four years as Director of MMRI in June. I am very proud of the accomplishments of the faculty, staff and students that have contributed so much to achieve our vision. Thanks to our industrial supporters, the members of our industrial advisory board and Materials and Manufacturing Ontario for their contributions and advice. We look forward to the next phase in achieving our vision of being recognized internationally for our research accomplishments as the leading manufacturing research center in Canada. ■

Ultrasonic Assisted Drilling

Burr Reduction Using Ultrasonic Assisted Drilling

Accuracy and surface finish of machined parts play an important role in the assembly process and in the quality and useful life of the final product. However, the deformability of ductile materials induces challenges in achieving high accuracy and surface finish. Undesired projections of material, which result from plastic deformation, are produced during conventional machining process. These projections of material, known as burrs, significantly reduce the accuracy of the parts and affect both the assembly process and the part's quality. Around 30% of total production costs are used for deburring process. To reduce or even eliminate the deburring effort, the burr size must be reduced.

At MMRI, Dr. Gary Bone and his Ph.D. student Simon Chang (co-supervised by Dr. Mo Elbestawi) are working on methodologies to reduce burr size. One technique is known as ultrasonic assisted (UA) machining. This involves adding high frequency vibrations to a conventional machining process. The vibrations are typically added in the direction of the cutting velocity. They have designed and built a UA workpiece holder to investigate this technique in drilling, where vibrations are added in the feed direction of the drill. In particular, UA drilling of aluminum using TiN coated and uncoated high-speed twist drills has been investigated.

Burr size and thrust force reduction

Over 170 drilling tests were carried out using the developed UA workpiece holder. The group has found that under suitable vibration conditions, significant burr size and thrust force reduction was observed: burr height by up to 85% (see Fig. 1), burr width by up to 40% (see Fig. 2), and thrust force by 20% (see Fig. 3). One main cause of such reduction is that UA drilling has an intermittent cutting characteristic, breaking the chips formed during the drilling process.

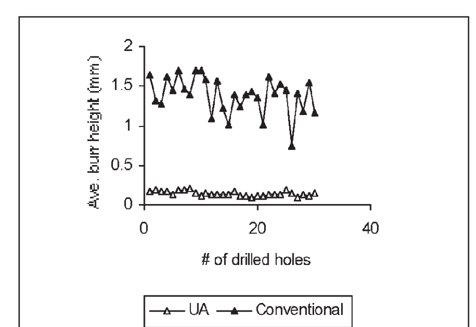


Figure 1: Experimental results demonstrating burr height reduction

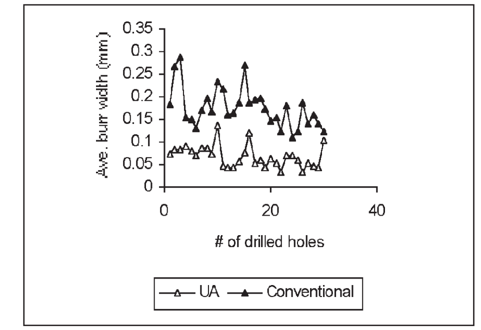


Figure 2: Experimental results demonstrating burr width reduction

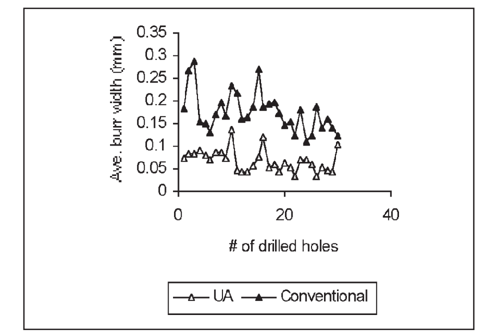


Figure 3: Experimental results demonstrating thrust force reduction

It was observed that UA drilling formed small, discontinuous chips (see Fig. 4), while conventional drilling formed long, continuous chips (see Fig. 5). The small chips are easier to remove, reducing their interference with the drill, hence reducing the thrust force. Lower thrust force results in less plastic deformation, hence reducing the burr size. Another interesting characteristic of UA drilling that the group has discovered is the existence of a suitable vibration condition, not necessarily the highest possible frequency and amplitude, for each cutting condition. With this vibration condition, burr size and thrust force reduction takes place. On the other hand, a carelessly chosen vibration condition can produce larger burrs.

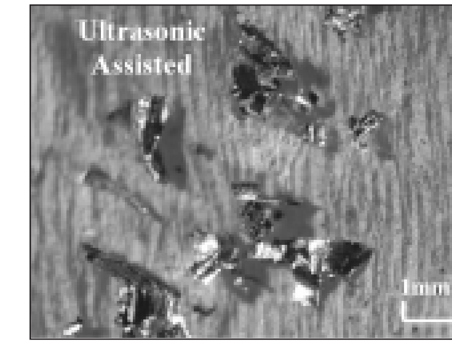


Figure 4: Small discontinuous chips formed using UA drilling

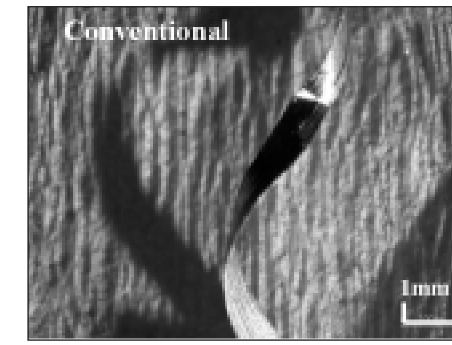


Figure 5: Long continuous chips formed by conventional drilling

Tool wear characteristics

The group has also investigated the tool wear characteristic of UA drilling. Compared with conventional drilling, UA drilling tends to produce larger tool wear. This is because of the fatigue resulting from the high frequency intermittent cutting. However, this problem was cured by using a suitable drill coating. TiN coated drill offers resistance to the wear caused by fatigue in UA drilling, and allows the practical use of this technique without significantly reducing tool life.

Next stages

With the successful development of UA drilling technique, the group has turned their attention to the development of two degrees-of-freedom UA drilling. In this technique, vibrations are added in the direction of drill feed, and the torsional direction of the drill as well. This should further reduce thrust force and burr size in dry drilling of aluminum. A special UA toolholder will be developed for this purpose. They also intend to apply this technique to the drilling of nickel based super alloys, such as Inconel 718. The intermittent cutting characteristic of UA drilling should allow better coolant flow, which will then reduce the tool wear caused by heat build up on the tool. ■

For more information contact Dr. Gary Bone, Associate Professor, Department of Mechanical Engineering, McMaster University: gary@mcmaster.ca.