MMRI
McMaster Manufacturing Research Institute

CONNECTION

Connecting University, Industry, and Government Spring 2003

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

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McMaster University

Synergy Prize awarded for intelligent machining

NSERC and The Conference Board of Canada recently presented a $25,000 Synergy Award for Innovation to Dr. Mo Elbestawi of McMaster University and MMRI industrial partners for their work in finding ways to improve and advance the science of intelligent machining. While the prize also honours University partner Siemens-Westinghouse, the cash goes to the university. Engineering Dean Mo Elbestawi says that the award "is a recognition of our efforts to develop a strong and lasting partnership with industry".

The collaborative project involved "smart" monitoring sensors, computer programming and a wealth of studies that deal with the problems in machining certain materials. The research focused on metallurgy, computer software and predictive modeling, machining expertise and working with exotic materials such as titanium alloys and hardened steel. It included the study of the physics of what is happening to the materials as they are being worked on.

"McMaster has helped us with the development of machine-tool testing and acceptance standards," says Mazhar Khan,

Professor Mo Elbestawi, Dean, Faculty of Engineering, Director, Machining Systems Laboratory, MMRI

manager of technical services for Siemens-Westinghouse. "We're very pleased with the improvement we've seen in the operations of our Hamilton plant. We attribute them directly to results generated from our collaboration with McMaster."

Elbestawi believes the award demonstrates the effectiveness of developing industry partnerships. By working with industry, the Faculty of Engineering can

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MMRI participates in AUTO21 research projects

AUTO21, a newly founded Network of Centres of Excellence (NCE), is working to help position Canada as a leader in automotive research and development. The automotive industry is Canada's largest industry and the biggest provider of export earnings. An initial four-year grant of more than $23 million, plus industrial and institutional contributions of more than $11 million, help to fund 28 research projects involving more than 200 researchers in 28 Canadian universities and over 100 industry and government partners. Research projects are managed by Project Leaders, who coordinate the work of at least three other researchers in at least three institutions in at least two provinces.

The MMRI is pleased to participate in Auto21 research activity in the following two areas:

C2 Project: Foam Processes for Automotive Parts

Project Leader: A. Hrymak (McMaster)

In the area of polymers within automotive parts – there are 3 key areas: composites for structural components, light weight materials for interior components and fascia, and advanced high temperature polymeric materials for engine and wear components. Because of the importance of reduced fuel consumption, foamed polymers are a key element in the strategy to

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AUTO21

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reduce weight without sacrificing strength and dimensional stability.

By developing, for example, a microcellular-foamed structure in the automotive plastic parts, the plastic material cost and weight will be reduced, and the mechanical properties will be enhanced. Products will become lighter and more inexpensive without compromising required properties. Because, the material cost for any automotive plastic parts constitutes a large portion (typically 50 to 60%) of the total component cost, the reduction of material will have a great impact on the market. Furthermore, a number of thin-walled automotive plastic parts such as the dashboard which have never been foamed before because of the cell size limit with the conventional foaming technologies may be replaced with microcellular foams.

The microcellular processing technology will also replace the conventional foaming technologies used for manufacturing foamed automotive plastic parts such as bumpers, door panels, etc. Because of the technological limit, most foamed automotive plastic parts are manufactured typically in a two-stage process: extrusion and thermoforming. If a one-stage process such as injection molding can be used, the processing cost will also be reduced significantly for large volume items.

PHOTO COURTESY OF AUTO21

Dr. Eu-Gene Ng, Dr. Mo Elbestawi, and Dr. Philip Koshy – members of the MMRI team in front of the 5-axis Makino Milling Center used to machine high silicon aluminum alloys at 5,000 m/min and above.

The AUTO21 Project Leader, Dr. Peter Frise, of the University of Windsor and his team visited MMRI in conjunction with a meeting of the Auto21 Board of Directors. A tour of the MMRI Laboratories followed the meeting. Warren Reynolds, Research Engineer-Facilities Manager, stands in front of the ARBURG Injection Molding Machine in the Polymer Processing Lab.

AUTO21's Mission

"To create and foster a network of world class Canadian scientists, researchers and engineers, who will make unique contributions to the development of the automobile of the 21st century, its systems and its impact on the health and on societal and environmental issues."

AUTO21's Vision

"Through this network of centres of excellence Canada will strengthen its global competitive position, as well as create the environment, the highly qualified people, the skilled workforce and the jobs that will ensure that Canada is among the leaders in the automotive industry."

The team involves a number of researchers from academia and industry. Professors John Vlachopoulos, Mike Thompson and Andy Hrymak (MMRI, McMaster) have worked in the area of extrusion and rotomolding, with experience in chemically initiated blowing agents and foamed rotomolding technologies. Professor Costas Tzoganakis (Waterloo) works in the area of reactive extrusion using supercritical fluids to achieve enhanced properties not possible with standard technologies. Professors Park and Venter (Toronto) collaborate on microcellular foaming of plastics in various projects. Professors Pierre Carreau, Marie-Claude Heuzey and Steven Dufours (Ecole Polytechnique) are developing novel rheological methods for multiphase polymeric systems, in particular blend emulsions and filled polymers.

C8 Project: Machining of light weight materials for the automotive industry

Project Leader: M. Elbestawi (McMaster)

The objective of Dr. Elbestawi's research team is to develop/improve machining methods for automotive parts that constitute essential components in lightweight vehicles. These parts, manufactured out of lightweight alloys, are suitable for the evolving field of high speed and ultra high speed machining, and cover a broad spectrum of both materials and machining operations. Teams from Ecole Polytechnique, Montreal, University of Waterloo, University of New Brunswick, and MMRI/McMaster University are successfully collaborating in performing experimental and theoretical work – modeling of machining processes using finite element analysis (FEA) and analytical models.

High speed machining (HSM) presents special interest to both academic and industrial researchers, because its' advantages are evident in terms of productivity and machining accuracy. A key factor in economic implementation of this technology is the cost and robustness of tool materials and manufacturing processes. The potential for increasing high speeds in machining aluminium alloys at speeds up to 5000 m/min is real and represents one order of magnitude increase over the current common practice in the automotive industry, and is the main focus for one of the McMaster – MMRI teams, while the other one is focusing on machinability issues of very promising intermetallic compounds based on titanium aluminides, light and high-temperature-resistant materials with potential application in the automotive, aircraft, military, and aerospace industry.

Detailed research on the potential benefits of aggressive drilling (AD) of aluminium alloys, such as higher productivity and quality at competitive costs, is performed at the University of Waterloo, while complex approaches on machinability of Metal Matrix Composite materials is carried out at Ecole Polytechnique, Montreal, University of New Brunswick, and McMaster. ■

Metal forming lab – the shape of things to come

When Dr. Mukesh Jain left his position in the Research & Development Centre at Alcan International in 2001 to join the Department of Mechanical Engineering at McMaster University, one of the key attractions was the freedom at Mac to develop his own research agendas.

As a technical leader at Alcan, Dr. Jain had been instrumental in establishing the company's state-of-the-art sheet forming laboratory. But after 11 years with the company, it was time to look for new challenges – and he has found plenty at McMaster.

As head of the Metal Forming Lab in the MMRI, Dr. Jain enjoys the opportunity to explore a wide range of research interests, from the hydroforming of advanced steels for the auto industry to the shaping of aluminum for multiple industrial applications. In collaboration with his colleagues in the MMRI, he is also involved in the search to find new manufacturing processes and materials to build lighter-weight, fuel-efficient automobiles.

"The New Steel"

The quest by the North American auto industry to build fuel-efficient cars has placed demands on auto parts manufacturers to reduce vehicle component weights, which in turn challenges materials suppliers, like the steel industry, to do the same. The steel industry has responded with efforts to develop new alloys that provide greater strength and structural integrity, allowing thinner gauges of steel to be used in component parts.

Enter Dr. Jain's metal forming lab. Bending and shaping these thinner gauges of high-strength, low-alloy steel involves manufacturing problems that must be solved if industry goals are to be achieved. The work at McMaster, which is supported by industrial partners like Stelco and Dofasco, focuses on two critical issues – the physical properties of the new alloys themselves, and the manufacturing processes needed to shape them into the myriad parts that make up the modern automobile.

Alternative materials

While the steel industry wrestles with these problems, other industries are mounting a challenge. Aluminum is one of the alternative materials that is making inroads in the auto industry because of its lighter weight and resistance to rust. Aluminum manufacturers would dearly like to make greater gains in the auto market, however for that to happen, aluminum's cost differential with steel must be reduced.

One way to make aluminum cheaper is through continuous casting – a technique that allows manufacturers to produce sheets of aluminum that are much thinner than the traditional slabs and ingots, and thus do not require a lot of secondary processing. Unfortunately, while continuous casting makes aluminum more price competitive with steel, it also leads to formability problems stemming from the altered microstructure of the aluminum in the continuous casting process. Research into the formability of continuously-cast aluminum, therefore, may help to open up new markets for aluminum in automobiles and other consumer products.

Dr. Mukesh Jain holds an aluminum S-Rail, which has undergone bending and twisting in the lab's new press.

Sheet Forming Press

The importance that government and industry accords these manufacturing research issues was underscored recently by a multi-million dollar grant from the Canada Foundation for Innovation, which allowed MMRI to acquire a new automotive sheet metal forming press, now installed in Dr. Jain's lab at McMaster. This press is a fully-functional unit similar to those currently in use at major automobile manufacturing companies like Ford Canada.

Standing 30 feet tall, and weighing 74,250 kilograms, this 900-tonne press can simulate real-world manufacturing situations, allowing researchers to study how different materials and alloys behave under a variety of metal forming conditions. Dr. Jain and his associates can now carry out computer simulations based on their theoretical models and test their results on a state-of-the-art press that has been specially equipped with sophisticated instrumentation that records the actual motions and forces at work during the metal forming process.

Dr. Jain is currently working to acquire a set of automotive production dies for the new press and is seeking industry partners for research projects. An engineer at heart, he prefers the challenge of real-world problems to purely theoretical ones. Companies interested in his research can contact Dr. Mukesh Jain, Associate Professor, Department of Mechanical Engineering, McMaster University, at *jainmk@mcmaster.ca*. ■

Internships – bringing companies and students together

Do you have a research project for a research internship at MMRI?

The McMaster Manufacturing Research Institute is offering a unique internship approach within the research area. We are specifically looking for 3 to 4 month research projects suitable for our undergraduate students to work on within MMRI. These research projects could be in the areas of machining systems, polymer processing, grinding technology, metal forming and robotics. If you have any interest please contact: Janet Murphy, Administrator, MMRI at 905-525-9140 or email to: *jmurphy@mcmaster.ca*

Internship Opportunities for Undergraduates

Continually looking for companies to sponsor and become involved in internship opportunities, the Engineering Career Services & Internships department is a joint venture between the McMaster Engineering Society and the Faculty of Engineering. Their primary objective is to bring companies and students together, thereby providing students with the necessary tools and resources to study the job market, gain experience and be successful in it. Also, new this year – Engineering Summer Co-op. To post positions for engineering students, or more information on internships, please contact: Anne Markey, Manager, Engineering Career Services at 905-525-9140 Ext. 27283 or email to: *markeya@mcmaster.ca*

Future Events in MMRI

May 19th to 20th, 2003
6th CIRP International Workshop on Modeling of Machining Processes

World renowned experts will be presenting about 20 papers on recent advances in modeling of machining processes. Workshop is co-sponsored by CIRP (International Institution for Production Research) and NAMRI (North American Manufacturing Research Institute). More details available on our MMRI website.

May 20th to 23rd, 2003
31st NAMRC – North American Manufacturing Research Conference

International Forum for the presentation and critical discussion of research results and applications carried out at universities and industry. Leaders in manufacturing research come to this conference to exchange findings and leading edge technological information. More details available on our MMRI website.

Thursday, June 19th, 2003
***Partnerships 2003 – The Power of Knowledge in Action* at the Toronto Congress Centre, 650 Dixon Rd., Toronto**

It's the Materials and Manufacturing (MMO) R&D event of the year. What are the top minds in the industry thinking? Where is new research heading? Who is setting the trends? And why? Find the answers to these questions and more at *Partnerships 2003*. Over 1,000 of Ontario's top minds, all sharing a common goal: to network and learn about new opportunities. Please plan to visit the MMRI booth when you are there. For more information go to: *www.mmo.on.ca* or call (905) 823-2020 ext. 241.

McMaster University

MMRI graduate student poster competition

A Poster Competition among MMRI Graduate Students took place the day of the MMRI Board Meeting and was judged by members of the MMRI Board of Advisors. Student Dan Centea received a $200 Cheque as winner of the competition for his poster "TIARA Hexapod". ■

Ian O'Reilly, General Manager, Research & Development, Dofasco and Iryna Bilovous, student.

Don McIntosh, Mgr. Manufacturing Technology, Pratt & Whitney, Canada and Diaa Elkott, student.

Joe Liburdi, President, Liburdi Engineering and Taiyong Guo, student.

Art Tinson, student, with Dr. Carlton Fuerst Chief Scientist, General Motors, Canada

Synergy Award

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assist with the development of technology while at the same time offering an expanded real-world education for its students.

"We're always looking to expand our relationships," said Elbestawi. "There are many companies we haven't worked with before. Each has a different set of problems and different research challenges." In addition to Siemens, other companies that have begun research partnerships with McMaster include General Motors Canada, Pratt & Whitney Canada and United Technologies, as well as Hamilton-based firms Orlick Industries and Liburdi Engineering.

Elbestawi, who is an authority on advanced machining technology, heads the Machining Systems Lab at the McMaster Manufacturing Research Institute (MMRI). The MMRI is the largest centre of its kind in Canada, with more than 20,000 square feet in two locations. ■

Article courtesy of MacEngineer

Dr. Trevor Lewis, Technical Leader, Alcan International with Elizabeth Takacs Lab Manager, CAPPA-D and Mike Thompson, Assistant Professor.

Welcome to MMRI

The McMaster Manufacturing Research Institute takes pleasure in welcoming: Dr. Maher Al Dojayli, Post Doctoral Fellow, Meshless Finite Element Analysis