MMRI CONNECTION

Connecting University, Industry, and Government October 2002

MMRI expands into Ancaster.... Move creates opportunities with industrial partners

Months after celebrating its first birthday, the MMRI, one of the largest university manufacturing research institutes in Canada, is expanding into the Computer Integrated Manufacturing (CIM) facility on Sandhill Drive in Ancaster. "The expansion into the Ancaster facility is because of some growth that has happened and because of some great opportunities," says Andy Hrymak, Director of the MMRI. Four recent successes partly contribute to the growth. Since the institute took up three labs in the John Hodgins Engineering building in May 2001, faculty members in the institute have received three New Opportunities Fund grants distributed by the Canada Foundation for Innovation, with additional funds from the Ontario Innovation Trust and industrial in-kind support.

The awards went to Philip Koshy, Assistant Professor, Mechanical Engineering ($844,000), Mukesh Jain, Associate Professor, Mechanical Engineering ($989,000) and Michael Thompson, Assistant Professor, Chemical Engineering ($341,335). MMRI also was recently awarded a $4.3-million CFI grant in micro manufacturing with Mo Elbestawi, Dean of Engineering, as principal investigator.

"With these four new projects we needed more space," says Hrymak. The space will also open opportunities to work with industrial partners, he says. "The kind of research we're doing at the manufacturing end, especially in the development of products and improvements of processes, required us to have equipment that was similar to what industry had. One of the key requirements was that we needed space and facilities to house this equipment so that we could tackle more complex projects."

Obtaining the Ancaster location, which has 5,000-square-feet of shop floor space and about 9,000-square-feet of office space, is a win-win situation, he says. "McMaster is able to use the Ancaster facility for activities that support academic and research objectives within the Faculty of Engineering and at the same time it gives us ready access to shop floor and office space so that we can get up and running quickly with these new CFI projects."

Photo Credit: CHANTALL VAN RAAY

MMRI Director Andy Hrymak looks through a single screw extruder in one of the MMRI labs in the John Hodgins Engineering Building.

The location will initially be dedicated to the areas of advanced machining, micro manufacturing and metal forming, Hrymak says. The official move is expected to start in September.

The need to expand did not come as a surprise, says Hrymak. "We knew that because of the caliber of the faculty that they would be successful, so it was just a question of how and where we were going to grow. The timing was perfect in that the Ancaster facility became available just as the grant announcements were made."

The next growth phase, expected within five years, will likely take place in areas that are complementary to existing research

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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

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McMaster University

Robots and vision systems help local companies do the job faster, cheaper and more reliably

For millions of North Americans, robots are a part of their daily life. They are co-workers in the candy factories, automobile plants and pharmaceutical labs. They work in nuclear plants and the electronics industry. Indifferent to long hours of tedious precision labor, their activity is essential to the productivity and success of some of our most vibrant and important industries.

Robotics Laboratory

At McMaster University's Robotics & Manufacturing Automation Laboratory (RMAL), Dr. Gary Bone and his associates are working to expand the range of useful things that robots do. An important research focus is the development of machine vision for automated inspection systems in manufacturing.

One of the beneficiaries of the work carried out by Dr. Bone's team is a Hamilton-based firm, Sandco Automotive, which supplies parts to the auto industry. In April 2001, Sandco approached Dr. Bone with a challenge – to develop an automated inspection system that could check the bearing surfaces on the engine rocker arms that they manufacture. At the time, Sandco quality control staff performed the visual inspection manually. The consistency and accuracy of this manual inspection varied, depending on the individual, the time of day, and other factors.

In order to automate the process and raise the quality standards, the Robotics Lab had to create a machine vision system that could precisely locate the bearing surfaces on the rocker arms as they passed by on the production line; examine these surfaces with specialized lighting designed to highlight surface defects; analyze the image data to determine whether defects were present; and divert defective parts off the line. After four months of effort by the Mac team, working closely with Sandco engineers, their efforts were rewarded. The system they developed was installed September 2001 and now inspects 250,000 parts per week – an amazing feat of rapid inspection with verifiable quality standards. (For a video of the system in operation, see *http://robotics.mcmaster.ca/Videos.htm*)

Project director, Dr. Gary Bone (left) and Ph.D. student Lucian Bulan (right), with the machine vision inspection system they developed for Sandco Automotive. The unit inspects approximately 250,000 parts per week.

Machine Vision

Inspecting 3-dimensional objects using machine vision is a technically challenging task. According to Dr. Bone, "the main problem is getting a digital camera and computer, acting in a 2-dimensional (2D) world, to mimic the eyes and brain of a human, working in a 3-dimensional (3D) space."

"Typically, visual inspection systems are limited to 2D tasks such as feature/part presence, planar dimensional analysis and optical character recognition. All these applications use algorithms that filter out subtle changes in light and shadow."

"However, the way people (and therefore machines) detect surface defects on 3D objects depends very critically on these subtle light/dark variations. We identify defects – pits, scratches, surface blemishes – as areas that differ from the norm, or what is expected. Thus, a major consideration in developing a machine inspection system is the lighting system that will provide the best contrast between defects and the rest of the surface."

> ***"Our customers were so pleased with the result that they have asked for information on Dr. Bone's group so that they may pursue similar projects."***
>
> ***Phil Moruzi, Quality Manager, Sandco Automotive Ltd.***

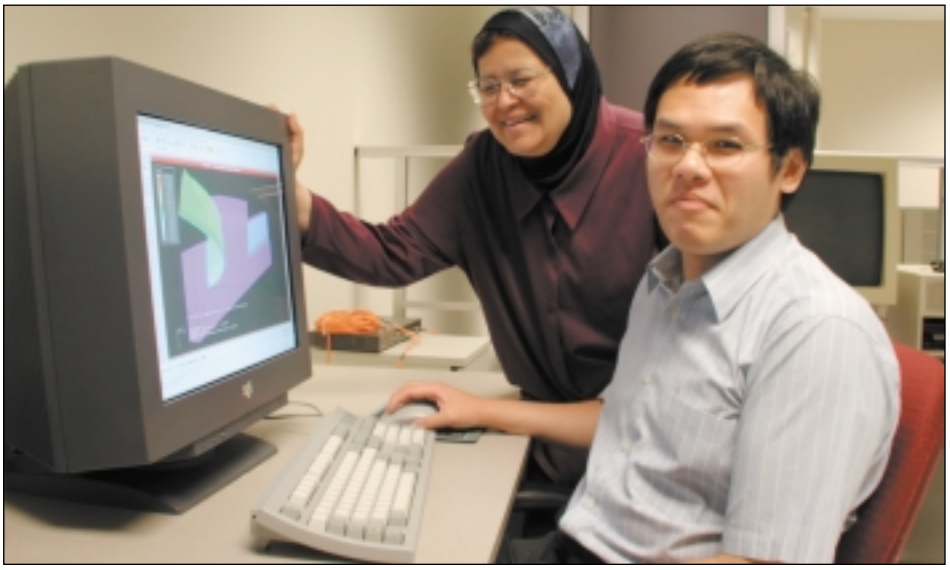
The other important issue is the analysis of the visual image. Dr. Bone's team has developed a set of strategies and algorithms that allow the computer to decide when and where a defect is present. This software is editable to allow the quality standards to be fine-tuned, as required.

In the wake of the successful Sandco project, the Robotics Lab is now turning its attention to new challenges. A feasibility study has recently been completed to develop a system that can inspect cast aluminum automotive wheels for surface defects. That study, carried out in partnership with Brampton-based Jacobsen X-Ray Machinery Inc., with funding assistance from Material Manufacturing Ontario (MMO), has established that a machine vision-based system is feasible. Funding is currently being sought to take the project to the next stage.

In addition to the Automated Inspection projects, the Lab carries out research in a number of other areas, including: Robotic Deburring; Control Systems Design; Pneumatic Servo Actuators; and Robotic Assembly using Force and Vision Feedback. ■

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

Coatings research enhances product performance



Research manager Dr. Tahany El-Wardany (left) and colleague Dr. Eu-Gene Ng, Post Doctoral Fellow and Finite Element Modeling Specialist, carry out a computer simulation of a machining operation.

Dr. Tahany El-Wardany was Principal Research Engineer at the United Technologies Research Centre in Hartford, Connecticut and came to McMaster University in September 2001 to accept the position of Research Manager for the McMaster Manufacturing Research Institute (MMRI). Dr. Eu-Gene Ng is a Specialist in Finite Element Modeling, and joined the McMaster Manufacturing Research Institute in November 2001 as a Post Doctoral Fellow after obtaining his PhD at the University of Birmingham, England. Both are experts in coating simulation and had backgrounds in metal cutting, modeling and simulation, as well as high speed machining processes.

In the winter of 2001 engineers at one of Canada's largest automotive manufacturing companies were faced with a problem that reduced tool life tremendously and consequently affected product quality and increased costs directly. The problem was related to the tool performance after re-sharpening and recoating… (tool life was reduced to one-third of that obtained by new tools).

To investigate the problem the company contacted Dr. El-Wardany and Dr. Ng at MMRI at McMaster University. The challenge they posed to them was... "why don't the refurbished tools perform as well as new tools?"

In investigating the cause of the problem the McMaster Researchers found that the methodology used to recoat the tools needed to be modified. It was the preparation of the cutting tools prior to applying the coating that was the issue. Changing the preparation process solved the problem.

Complexity

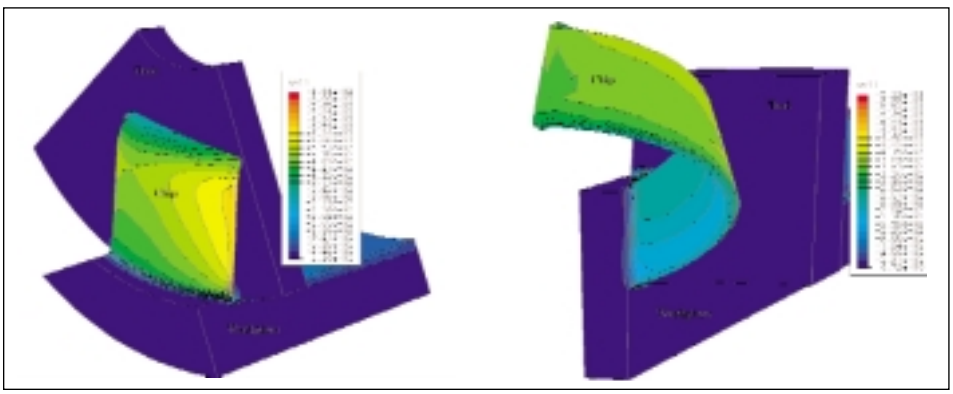
Not all problems lend themselves to such a straightforward solution. Indeed, the issues involved in applying coatings to tools, dies and other material surfaces are multiple and complex. In layman's terms, optimizing the coating process requires a "holistic" approach – using the right coating for a particular material substrate, applying the right thickness, preparing the substrate in a particular way, and applying the coating using the appropriate technology.

In the countries where the coating technologies were highly developed – Germany, Britain and Japan – much of this knowledge exists but it is closely guarded by the tool manufacturers. However, at McMaster, many aspects in coating research were collected from open literature and were utilized by the researchers to develop models that optimize the overall coating process. Aided by the tools of finite element analysis they are able to precisely determine the best way to prepare the material substrate and the optimum procedure for coating technology.

They are also developing models to predict the wear mechanisms on the cutting tool when it is used under various machining conditions. For an industrial company to optimize these processes by trial and error would be expensive and time consuming. Hence, the MMRI Research activity in tool wear prediction and coating has a great value for industry.

Coatings are particularly important in the manufacturing industry. When properly applied they increase the hardness of the cutting tools and reduce friction, allowing higher production speeds while reducing wear and tear on the tools. Coatings are also widely used in other industries where high temperatures and friction are involved – everything from turbines to aerospace components.

The importance of this research at McMaster has been recognized by government funding agencies. Support has come from Material and Manufacturing Ontario (MMO) and a significant grant application to NSERC is pending approval. ■



Computer simulation of two common machining operations – turning (left) and face milling (right) – demonstrate temperature distribution during high speed cutting.

For more information contact Dr. Tahany El-Wardany, Research Manager MMRI and Adjunct Professor, Department of Mechanical Engineering, McMaster University at tah@mmri.mcmaster.ca

Future Events in MMRI

31st North American Manufacturing Research Conference returns to McMaster University May 20-23, 2003.

Thirty-one years ago Professor Jiri Tlusty and his colleagues at McMaster created the North American Metalworking Research Conference, or NAMRC. Originally a 'metalworking' conference, the scope has been broadened over the years to include metal removal processes, metal forming and a wide variety of aspects of manufacturing systems. Each year NAMRC attracts the highest caliber of academic and industrial participants. The Call for Papers for the conference is included with this mailing.

Short Courses Planned for 2002

Grinding Technology
Dr. Philip Koshy
Postponed to Summer 2003

Fundamentals of Metal Cutting
Dr. Stephen Veldhuis and
Dr. Tahany El-Wardany
New Dates: Nov. 13, 14, 15

Rotational Molding
Elizabeth Takács
November 6 & 7, 2002

Location for courses
McMaster University
Centre for Continuing Education
Downtown Centre, 2nd floor
50 Main Street East
Hamilton, Ontario L8S 4L8
Website: *www.mcmastercce.com*

McMaster University

MMRI news digest

Micropelletization Project Underway

Plastics are usually supplied in the form of standard size 3mm x 3mm pellets that can be melted and subsequently extruded or molded into numerous products for automotive, packaging, housing, appliances and other applications. For many purposes, however, a smaller pellet size would have advantages.

At MMRI we are proud to announce that Gala Industries Inc. (Eagle Rock, VA., USA) gave us on a long term loan an Underwater Micropelletizer. We are thankful to Gala for their generosity and their foresight in supporting university research.

Hot die-face underwater micropelletizing technology was developed about 15 years ago. In this process the polymer melt is fed through a die with a series of holes in a circular pattern into a water chamber and then cut by rotating blades at the surface of die plate. The pellets are cooled and transported by the water to a dryer. Small pellet size (400-500 μm) and increased surface area, result in quicker melting, better dispersion, and faster cycle times in injection molding and extrusion. Micropellets also benefit rotomolders by eliminating the cost of pellet grinding and offer an opportunity for melt compounding during product formation.

Gala Industries Underwater Pelletizer

The Future of Manufacturing

In July MMRI and Cutting Edge CAD/CAM Solutions Inc. held an educational and interactive half-day Seminar on The Future of Manufacturing. Industry experts spoke on current advancements within their specific area of expertise. The session was designed to provide Ontario manufacturers with an opportunity to speak to the people directly involved with the development of future advancements and technology related to manufacturing. ■

Bob Birrell, Director of Applied Research Centre for Advanced Visualization, at Niagara College speaks on "R&D Through Visualization".

MMRI expands

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areas, he says. "The companies we work with are always suggesting new ways that we might want to structure our research and sometimes that will mean adding a new faculty member or growing in a new area."

The MMRI runs more than $1-million industry-relevant research projects a year, with faculty, staff and students from mechanical, chemical, electrical, and materials engineering and engineering physics. The 15,000-square-foot facility houses 13 industrial machines and a robot, and is designed to meet the sophisticated research and development needs of leading manufacturers, working with companies such as Siemens Westinghouse, GM Canada, Cobra Machine Tool, Husky Injection Molding Systems, Orlick Industries and Silicon Graphics Canada. ■

Written by Chantall Van Raay

Welcome to New MMRI Staff

The McMaster Manufacturing Research Institute takes pleasure in welcoming the following:

Dr. Moisei (Michael) Bruhis, Research Associate, Metal Forming

Dr. Eu-Gene Ng, Post Doctoral Fellow, Finite Element Modeling Specialist

Dr. Victor Bravo, Post-Doctoral Fellow, Polymer Processing

Dr. Aleksander Czekanski, Post-Doctoral Fellow, Dynamic Finite Element Analysis