

Creating an experimental affinity for finite analysis

Engineers regularly employ the latest in high-tech hardware for designing various automotive components, only to fall back on traditional low-tech methods when it comes time to test the finished product. Dr. Faouzi Ghib is working to address this shortcoming by combining experimental techniques and computer simulation.

He expects such tools to take advantage of finite element analysis, a numerical modeling technique that has been hampered by a limited ability to capture the complexities of physical structures. As leader of the *Model-Based Damage Diagnosis of Components* project, Dr. Ghib is working with colleagues at the University of Windsor, University of Toronto and Université Laval to overcome those limitations.

According to Dr. Ghib, the analysis of components straddles two approaches. Typically a working prototype of a part is produced so it can be subjected to stress and strain, variations in temperature, and other loading sources that can ultimately determine the damage process and weak zones. This process is often time-consuming and expensive, making it all the more attractive to look for ways of carrying out some of those same experiments on a computer-generated model.

"It's cheaper, it's faster, but the disadvantage is that you are not produc-



Dr. Faouzi Ghib of the University of Windsor is leading the project *Model-Based Damage Diagnosis of Components*.

ing reality because you are working in a virtual world," says Dr. Ghib, who was approached by industry about five years ago to consider how finite element models could be better linked with their experimental equivalents. "We want these two worlds to talk to each other."

AUTO21 researchers are planning to jump-start that conversation by collecting finite-element data while they manipulate actual experimental results. Using computer vision based experimental techniques to create images of the displacement, deformation, temperature, and other relevant changes taking place in the component, they will store this information for later use in calibrating these same effects on a virtual model.

"You have to fine-tune the finite-element model by tuning the parameters you know that matter," he says. "What we want to do by the end of this project is to have a tool that will bridge between the experiment and the simulation." ■

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..... Network News

Teeter award winner

Congratulations to Dr. Charles Robert Koch, associate professor of mechanical engineering at the University of Alberta and researcher on the AUTO21 project *Electronic Controls for VVT and HCCI Combustion*. Dr. Koch was awarded the Ralph A. Teeter award at the Society of Automotive Engineers World Congress in April.



Dr. Charles Robert Koch

ects as seen by students poster session and networking; research in action: A demonstration session showing the concrete aspects of GEOIDE projects; the Operational Showcase session: taking the participants out of the traditional conference setting (including a geological sightseeing tour and site visits, the test of a van equipped with geomatics and new technologies for road network inventory and the demo of remote control and positioning technologies for mobile assets management); and keynote speaker, Dr. Michael F. Goodchild from UCSB, a pioneer in GIS and spatial analysis.

For more information, please visit www.geoide.ulaval.ca

AUTO21 research helps provide perspective on Canadian impaired driving

Research resulting from the previously-funded *Anti-Social Driving Behaviour* project was included in the recently released third edition of Alcohol, Trauma and Impaired Driving, issued by MADD Canada and the Centre for Addiction and Mental Health. This significant research document will be a valuable resource for Canadian health care researchers, lawmakers, media and those concerned with the current trends relating to alcohol-related trauma. AUTO21 researcher, Professor Robert Solomon of the University of Western Ontario is the senior author of the report. Professor Solomon contributed to the *Anti-Social Driving Behaviour* project and is a current contributor to the *Automobile-Linked Crime in Canada* project.

For more information, please visit www.madd.ca.

Helping older drivers maintain independence

Several AUTO21 researchers presented papers at the International Conference on Aging, Disability and Independence in St. Petersburg, Florida in February. The presentations focused on training and assessment programs developed for older drivers and the occupational therapists that often evaluate older drivers' abilities following medical issues. The research is part of the *Safe Transportation for Seniors* project, led by Dr. Michel Bédard of Lakehead University and Dr. Jan Miller Polgar of the University of Western Ontario.

Events of Interest:

Geomatics for Informed Decisions (GEOIDE) - 8th Annual Scientific Conference

Banff Centre, Banff, Alberta
May 31 to June 2, 2006.

Join top Canadian researchers in geomatics and leading edge organizations during this event. This year's conference will feature the students' perspective: GEOIDE 2005-2009 proj-

IS 2006 - 16th Annual Canadian Conference on Intelligent Systems

Victoria Conference Centre, Victoria, B.C.
May 31 - June 2, 2006

The IS 2006 conference will continue to deliver the high-quality knowledge transfer and networking opportunities that Precarn and IRIS members have come to expect. As Canada's showcase of research excellence in intelligent systems, the event will feature presentations and displays of all current Precarn and IRIS projects, as well as, demonstrations, research posters and workshops. We will celebrate academic excellence by presenting demonstration and poster awards to students, as well as the announcement of the 2006 Gordon M. MacNabb Scholarship recipient. Attendance is expected to be a mix of over 300 R&D and business people from industry, universities and research institutions.

For more information, please visit www.precarn.ca.

2006 CIPI Annual General Meeting

Quebec City Convention Centre, Quebec City, Quebec
June 7-9, 2006

The Canadian Institute for Photonic Innovations invite researchers in government and academia, scientists in industry, decision makers and students to attend the 2006 CIPI Annual General Meeting being held June 7 to 9 at the Quebec City Convention Centre. The event offers a once-a-year opportunity to network with the people who are accelerating the development and implementation of enabling technologies that will impact Canada's ability to compete and be more productive on the world stage.

For more information, please visit www.cipi.ulaval.ca.



**From the
*Scientific Director***

Peter R. Frise

Auto Innovations is AUTO21's way of sharing its exciting research stories. We hope you enjoy the profiles of the different researchers, projects and students featured in the issues. AUTO21's numbers tell a great story as well.

Since 2001, we have grown from 28 Canadian universities to 39. We count more than 120 private and public-sector companies and organizations as our partners, who have contributed over \$26 million in project support. Combined with the federal government support received through the Networks of Centres of Excellence, AUTO21 represents a total investment of \$67 million. This impressive amount is helping Canadian researchers and students gain experience and offer solutions to the automotive sector.

Speaking of students, AUTO21's total number of highly qualified people is close to 900, which includes current and graduated student researchers. That's 900 bright and highly talented young people who are equipped not just with their knowledge of scientific excellence, but are also armed with experience working with the automotive sector and an awareness of the issues it faces for future success. Many of these graduates have gone on to careers with automotive manufacturers, suppliers and related government departments and agencies.

Thanks to the 397 researchers who have participated in AUTO21 projects, the Network has completed 28 projects and currently supports 41. From this research portfolio, an impressive 29 patents have been filed, are in process or have been granted. Five licenses have also been granted or are under

negotiation. Clearly, AUTO21 research is having an impact on its user community. We're excited to see what the next two years brings!

If you would like to learn more about AUTO21's research first-hand, or meet the special people involved in the network, there's still time to register for AUTO21's Scientific Conference on June 13 and 14, 2006. This year's event will be held at the Sheraton Vancouver Wall Centre in beautiful British Columbia. We are pleased to have Dr. Gary Smyth, director of the powertrains research systems laboratory at General Motors R&D as our keynote speaker, as well as speakers from Ballard Power Systems, DaimlerChrysler Canada, Ford Motor Company of Canada, General Motors of Canada, Toyota Technical Center U.S.A., and many more. Visit www.auto21.ca for registration and program information. I hope to see you there! ■

**Peter R. Frise
Scientific Director and CEO**

**Still Time to Register!
AUTO21 2006 Scientific Conference**

"Leveraging Partnerships for Sustainability"

June 13 & 14, 2006, Sheraton Wall Centre, Vancouver B.C.

- Industry speakers from Ballard Power Systems, DaimlerChrysler Canada, Ford Motor Company of Canada, General Motors of Canada, QuestAir Technologies, Toyota Technical Centre U.S.A., the National Research Institute of Police Science in Japan and the Raufoss Technology and Management Institute in Norway
- AUTO21 research panels focusing on a variety of topics
- See and rides of fuel cell vehicles
- Networking opportunities
- The Showcase of Innovation, an exhibition of AUTO21 research projects and industry and public sector organizations.
- The final awards ceremony of the Honda Canada HQP Poster Competition

**Visit www.auto21.ca
for more details!**



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Connecting researchers to industry

A key role of the AUTO21 Administrative Centre is helping to connect researchers to industry. Without these partnerships, AUTO21 would not exist. With the busy spring season offering loads of opportunity at trade shows and conferences, AUTO21 administrative staff are often out on behalf of researchers exploring new opportunities and potential collaborations.

Globe 2006

The Globe conference in Vancouver, British Columbia draws delegates from around the world to discuss environmental and sustainable issues. AUTO21 partnered with the Networks of Centres of Excellence of Canada and the Canadian Water Network at the Trade Fair Exposition. Interest in AUTO21's research was high as the projects in the *Powertrains, Fuels and Emissions* and *Materials and Manufacturing* themes were showcased. Many of these projects are investigating hydrogen-related technologies, hybrid vehicles, enhancements to the internal combustion engine that will result in lower emission technologies, and using newer lightweight materials more effectively to reduce vehicle weight and increase fuel efficiency.

"The Globe conference presented several potential collaborations that we'll be sharing with researchers in the next few weeks," said Anne Cascadden, AUTO21 network manager. "It's always exciting to see the interest from various industry sectors."

SAE World Congress

For the fifth year in a row, AUTO21 research was showcased to the world at the Society of Automotive Engineers World Congress in Detroit, Michigan. Thirty AUTO21-related technical papers shared the leading-edge research conducted by the Network



Research Management Committee members, Lisa Graham of Environment Canada and Denis Gingras, of Université de Sherbrooke were joined by AUTO21 project leader, Xianquo Li at the SAE Networking Colloquium.

with thousands of conference delegates. As well, delegates were able to meet the researchers at the AUTO21 booth, which was part of the Canadian Pavilion organized by Industry Canada and the Canadian Consulate in Detroit. The four-day event kicked off with the AUTO21 SAE Networking Colloquium, where more than 90 researchers, student researchers, industry and government representatives enjoyed an informal evening focused on meeting new people and potential collaborators. AUTO21 appreciated the support of its SAE Networking Colloquium sponsors, the Windsor-Essex County Development Commission and Mr. Karl Richter, former chairman of the board of the Automotive Parts Manufacturers' Association (APMA).

"Attending the Congress is always a great learning experience, especially for the AUTO21 student researchers who take advantage of AUTO21 travel assistance to attend," said Lisa Graham, coordinator of the AUTO21

Powertrains, Fuels and Emissions theme and a senior scientist at Environment Canada.

APMA Conference and Exhibit

The APMA Conference and Exhibit is the premier automotive event in Canada, and AUTO21 had numerous inquiries at its booth regarding research in the areas of *Materials and Manufacturing* and *Design Processes*. AUTO21 research was also showcased in Innovation Alley, where several posters illustrated the latest in Network research. ■



APMA

THE VOICE OF THE AUTOMOTIVE ORIGINAL EQUIPMENT SUPPLIERS IN CANADA

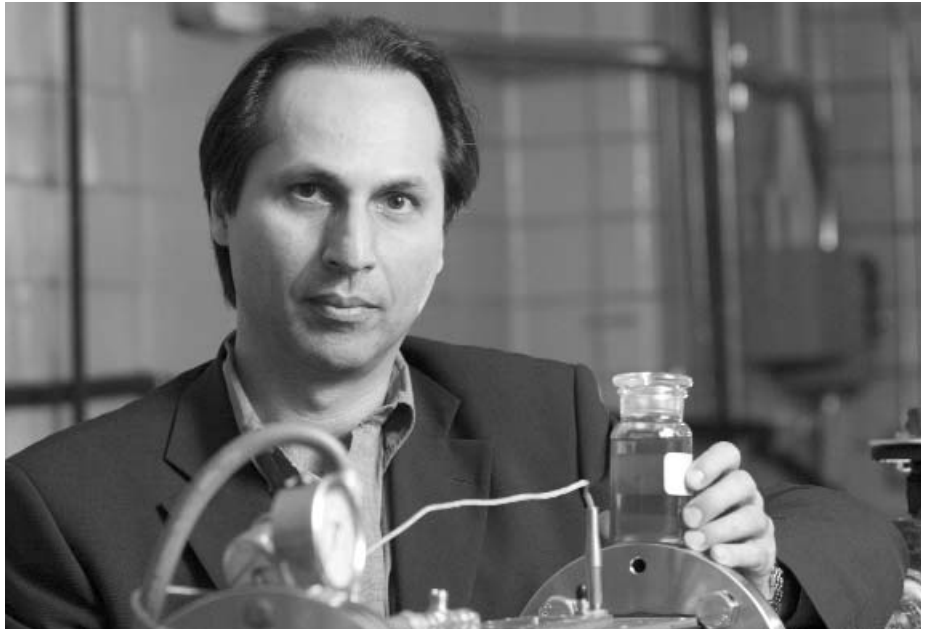
Making a clean fuel all the cleaner

The appeal of bio-fuel is further enhanced when its advantages as a sulphur-free, renewable energy source can be combined with the fuel efficiency and low emissions made possible by the latest generation of high pressure diesel engines. As their design continues to evolve, Dr. Nasser Ashgriz is working to ensure that the prospects for biodiesel will continue to be bright.

The University of Toronto engineering professor leads the AUTO21 *Ultra-Clean Biodiesel Engines* project, which is examining the various technical challenges that must be overcome for this fuel to start showing up in gas tanks across North America. Among the foremost of those challenges is the issue of atomization of bio-fuels as they enter the combustion chamber.

“Control of the droplet size distribution, and its mixing with the air inside the engine is the crucial thing in terms of combustion characteristics, engine performance, and emissions,” he says, noting that diesel technology has increased the internal operating pressure by several orders of magnitude, reducing the diameter of droplets by as much as two-thirds. “As the droplet size goes down, that allows for quicker evaporation and mixing between the fuel and air, and therefore emissions such as particulates reduces dramatically.”

Such progress can be offset by the specific characteristics of biodiesel, Dr. Ashgriz points out. “Viscosity of bio-oils is higher than petroleum diesel, and that viscosity causes the droplet sizes to go up,” he says.



Dr. Nasser Ashgriz of the University of Toronto leads the project *Ultra-Clean Biodiesel Engines*.

“Control of the droplet size distribution, and its mixing with the air inside the engine is the crucial thing in terms of combustion characteristics, engine performance, and emissions,” he says.

The researchers are assembling a detailed numerical model describing this mixing behaviour, which should point the way toward optimal settings and sizes of the nozzle that sprays fuel for combustion. In fact, Dr. Ashgriz explains, the use of pure biodiesel actually increases some emissions, as well as cold starting problems.

These shortcomings, combined with the likelihood that industrial production of biodiesel will remain

limited for the foreseeable future, mean this fuel will likely wind up being blended with its conventional counterpart. As part of their studies, the AUTO21 researchers are examining what blend of these fuels would be best, and what kind of engine configuration would best suit that blend. ■

Transforming vehicle communications into a two-way street

Apart from the tooting of horns, the flashing of lights, and the odd driver's hand gesture, very little communication takes place between vehicles on the road. That situation should change significantly in the coming years, thanks to the efforts of researchers in AUTO21's *Vehicle Communications and Applications* project.

"Vehicle-to-vehicle and roadside vehicle communications technologies offer the opportunity to deliver new added-value services to drivers," says Soumaya Cherkaoui, a professor of electrical and computer engineering at the Université de Sherbrooke. "The benefits could include improved emergency call services, better on-board control systems, position-related traffic information and roadside services, and even infotainment."

Before such progress can be made though, some challenging technology will have to be developed. The AUTO21 *Vehicle Communications and Applications* project, led by Dr. Cherkaoui and Université Laval computer science professor Brahim Chaib-draa, has started to do just that.

Their work starts with the framing of a cost effective infrastructure for sharing information between vehicles, based on models of traffic and driver behaviour to determine the most efficient types of telecommunication protocols. These simulations take advantage of technology that is already becoming common on the road, such as GPS, which can then be linked with geo-spatial information.

With the implementation of a communication infrastructure that can integrate factors such as the location and



Dr. Soumaya Cherkaoui of the Université de Sherbrooke co-leads the project, *Vehicle Communications and Applications*.

speed of vehicles on the highway in real time, while allowing to exchange information between cars, Dr. Chaib-draa sees the integration of cooperative adaptive cruise control with warning system as one of its most promising applications.

"These will likely be the first driver control assistance systems entering the Canadian market with the potential to influence traffic flow characteristics," he says.

As such systems become more sophisticated, he adds, they should make life considerably less stressful for drivers – relieving traffic congestion, reducing pollution, and helping everyone get to their destination more quickly.

"Vehicle communications will serve practical applications for drivers," notes Dr. Cherkaoui, who points out that partners on this project include the Centre de recherche sur les transports, Bell University Laboratories, as well as Globis Data; companies with an interest in commercial services to pro-

vide current traffic updates for drivers to avoid trouble spots on the highway. "This technology will be something that is inside the car but it will not be apparent to users," she says. "It can be invisible, but will enable so many useful services." ■

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