VEHICLES OF TOMORROW DESIGNED TODAY

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TEXT CHRISTIAN AAGAARD | PHOTOGRAPHY JONATHAN BIELASKI
Automotive research at Waterloo leads to safer, smarter, greener cars

Sebastian Fischmeister paused to consider a question as he packed for a canoe trip. “I have no clue whether my minivan can get there,” says Fischmeister, an associate professor in the Department of Electrical and Computer Engineering at the University of Waterloo. “It would be fantastic if I had information from the vehicles that are driving there right now, or that drove there just yesterday, that gave me information on the road conditions.”

Fischmeister finds the idea of thousands of cars digitally conversing on a range of topics, from traffic jams and black ice, to washouts and fallen trees, particularly tantalizing. He is the scientific lead on the vehicle that is the Connected Vehicle Technology Showcase, better known by its pet name, the Connected Lexus.

Inside the CONNECTED LEXUS, 13 companies are test-driving technology that aims to enhance information, safety and comfort for drivers. Housed at Waterloo, the car is a travelling showcase of next-generation automotive innovation.
Above, SEBASTIAN FISCHMEISTER, a professor of electrical and computer engineering at the University of Waterloo studies the infotainment display that helps connect car and driver in the Connected Vehicle Technology Showcase, with RAGHUNATH GANNAMARAJU, a Waterloo research engineer and technology manager for the project.

Sponsored by the Automotive Parts Manufacturers’ Association, the program’s rolling display — a 2014 Lexus RX350 donated by Toyota Motor Manufacturing Canada Inc. in Cambridge, Ont. — travels to auto shows and tech days across North America. Thirteen companies have filled it with technology that makes drivers more aware of conditions for a safe and comfortable ride.

The fact that the Connected Lexus parks in Engineering 5 between trips underscores Waterloo's heft in the automotive field.

"Waterloo has the largest group of automotive researchers in the country," says Ross McKenzie, managing director of the Waterloo Centre for Automotive Research (WatCAR). "Working alongside industry partners, we create new automotive technologies in Canada, with the North American driver in mind.

"This approach, combined with our experiential learning philosophy that has undergraduates assembling motors, and graduates engaged in advanced transportation research, positions Waterloo as a leading North American institution in the automotive sector."

Shapes of things to come

On any given day, researchers crumple doors and bend bits of frame. They immerse parts in salty solutions. They study stamping and hot-forming processes to make components out of reluctant combinations of metals, such as lightweight magnesium and ultra-high strength steel.

These punishing experiments lead to lighter, stronger, fuel-saving assemblies.

And they fuss about welds. Welds?

"You have thousands of welds in a car, and if one of them is giving you a problem, it's still an issue," says Adrian Gerlich, an associate professor in the Department of Mechanical and Mechatronics Engineering.

Gerlich carries out research at Waterloo's Centre for Advanced Materials Joining. Spot welding remains the most common method of putting a car together; but automakers are looking for new technology as they combine different types of metals to reduce the weight of vehicles.

Gerlich and his colleagues have been making advances in friction stir spot welding, which forges pieces of metal together by deformation and friction.

"The wow factor is this: the new Honda Accord has friction stir welds between steel and aluminum," Gerlich says. "Ten years ago, we would have said that is totally impractical. Now, it is in production."

Elsewhere on campus, researchers examine how people drive now, how they will drive in the future and what they will drive on.

Some examples:

» Among other areas of interest, Anita Myers and Alexander Crizzle — faculty with the School of Public Health and Health Systems — study issues around the aging driver.

» Amir Khajepour, an engineering professor, heads the Green Intelligent Transportation Systems (Green ITS) research program. This initiative's projects explore such issues as the infrastructure needed to keep electric cars...
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ROSS MCKENZIE, managing director, Waterloo Centre for Automotive Research

The Sedra Student Design Centre in Engineering 5 is home to numerous automotive research projects, including the Connected Vehicle Technology Showcase.
WatCAR Driving Innovation for Tomorrow's Drivers

How will we drive? What will we drive?

Those are the kinds of questions explored by Waterloo faculty and students sharing ideas under WatCAR — the Waterloo Centre for Automotive Research.

“WatCAR wasn’t just established to generate automotive research. It was initially created because the automotive research activity was already here,” said Duane Cronin, a professor of engineering and WatCAR’s executive director.

WatCAR links researchers across Faculties and stays on top of trends and developments in the automotive field. Moreover, Cronin said, “it connects manufacturers to researchers.”

Here’s a quick sketch of WatCAR:

» Formed in 2003; Senate recognition in 2006;
» Brings together 125 faculty and their projects. Automotive research at Waterloo involves all five automakers in Ontario and many of Ontario’s more than 350 parts manufacturers and materials suppliers;
» Aids the work of more than 260 graduate students;
» Promotes nine student teams examining such automotive interests as solar cars, alternative fuel vehicles and electric and hybrid powertrains. Teams are based in the Sedra Student Design Centre in Engineering 5.

charged and how road information can be communicated to cars to moderate traffic flow and avoid congestion.

» Susan Tighe, a professor in the Department of Civil and Environmental Engineering, seeks longer-lasting pavement in her research as director of the Centre for Pavement and Transportation Technology (CPATT) — not only for better highways, but airport runways, too.

Equipment is key

Down tight corridors, some of which students have used for 50 years, laboratories clatter and clang in the search for solutions to problems facing today’s automakers.

New equipment, meanwhile, keeps Waterloo in the passing lane of automotive research.

In September 2013, a $15-million facility that included an anechoic (echo-deadening) chamber opened in Engineering 5, part of the Centre for Intelligent Antenna and Radio Systems (CIARS). CIARS advances work in wireless technologies behind the operations of such things as smartphones and intelligent-vehicle electronics.

Students and faculty on mechanical and mechatronics engineering professor Michael Worswick’s Forming and Impact Mechanics Research team use a two-and-a-half-storey press to stamp out components of auto frames. By strategically heating regions of parts during forming, researchers can make single, multi-function parts with both rigid and flexible zones.

Then they smash them with a crash sled, measuring the destruction split second by split second with high-speed cameras and sensors. The sled and the press were installed in 2012.

Next year, construction begins on a $10-million, Green and Intelligent Automotive (GAIA) Research Facility for hybrid and electric vehicles (HEVs). GAIA will have three cells or labs: one focusing on engine efficiency; another on longer-lasting batteries for electric cars and a third for testing research-modified HEVs on a rolling platform.

Computers and algorithms make up another kind of laboratory.

Systems design engineering professor John McPhee, who heads the GAIA project, develops computer models to try new concepts in vehicles, including suspension modifications and controllers that improve safety and reduce emissions. He collaborates with Toyota and Maplesoft, a software company with University of Waterloo roots.

Waterloo researchers have also made a virtual crash-test dummy out of strings of computer code.

“It costs several hundred thousand dollars to build a real prototype,” says Duane Cronin, a professor of mechanical engineering and WatCAR’s executive director. “To crash-test it is a very expensive option. When you investigate it in the virtual world, you also reduce the design cycle.”

Cronin works with engineering colleague Naveen Chandrashekar and Jack Callaghan in the Department of Kinesiology to put virtual drivers in harm’s way so the real ones have a better chance of surviving crashes.

It takes a team

Unveiled in May this year, the Connected Lexus marks another milestone in collaborative research at Waterloo. This connected vehicle demonstrator functions as a platform for companies to show off technology that enhances the experience of driving.

And it serves as a moving laboratory for faculty and students to see how the technology works, and how it might be improved.

“When I sat in it, I saw the potential for future industry partners to participate, show their technology and build something even greater than the vehicle we already have,” Fischmeister says.

For all of the buzz about cars driving themselves in the near future, the Lexus demonstrator is not about disconnected drivers.
“As a driver, the most interesting thing for me is how the car communicates with other cars around it. Long before you hear an ambulance, you’ll get a message through the speakers telling you to pull over ...”

**Lucas Schmidt**, a second-year computer science student who worked on the Connected Lexus project during a co-op work term

Technologies from 13 participating companies provide the driver with additional built-in safety features, such as camera views around the car, and information about road conditions and weather shared among other vehicles.

The features include a breathalyzer lockout system to keep drivers from driving drunk. Another system logs driving habits and vehicle performance.

The car also offers drivers hand-gesture commands for the dashboard monitor, multiple options for interior lighting and an induction charger that wirelessly tops up smartphones.

All of that inbound and outbound information is integrated, flowing through an operating system from QNX Software Systems. QNX’s embedded product is in 60 per cent of vehicle infotainment systems. Now part of the BlackBerry family, QNX was founded by Waterloo students Dan Dodge and Gordon Bell in 1980.

“The good thing is the car doesn’t feel different, so it reduces the cognitive load on your brain,” says Raghunath Gannamaraju, a Waterloo research engineer and technology manager of the Connected Vehicle project.

“With these additional technologies, the aim is to have them seamlessly integrate with the vehicle and communicate with the driver in a non-distractive way.”

This is useful technology available now, says McKenzie, WatCAR’s managing director. Insurance companies are starting to reward clients who install ignition lockout features and systems that track how drivers drive.

“People sometimes fear computers taking over,” he says. “However, what if you are over-tired and fall asleep at the wheel? What if you’re intoxicated and shouldn’t be driving? I believe drivers will come to trust enhanced technologies in their vehicle, and in the others on the road.”

Between events, the Connected Lexus stops at Engineering 5 for some tender loving care. One of the people routing wires and tweaking systems in the car this summer was Lucas Schmidt.

Now in his second year as a computer science student at Waterloo, Schmidt says his co-op placement with the Connected Lexus team was a dream job. There have been more than 1,200 Waterloo co-op placements in the automotive sector in the last three years.

“As a driver, the most interesting thing for me is how the car communicates with other cars around it,” Schmidt says. “Long before you hear an ambulance, you’ll get a message through the speakers telling you to pull over because there is an ambulance approaching behind you.”

The co-op experience, he added, introduced him to how the auto industry works, and the ingenuity poured into building a vehicle.

“I don’t think we’ll be driving cars the same way we do now,” Schmidt says. “That’s on its way out.” 🤔

WEB see Driving Ambition at uwaterloo.ca/alumni/links

**WATERLOO COMPANY HELPS MAKE DRIVERS SMARTER**


IMS (Intelligent Mechatronic Systems Inc.) developed a connected-car platform, DriveSync, that keeps track of driver and automobile performance. A little behaviour modification — drivers can review their road skills on their smartphones — pays off.

“Some of the services and solutions we have in the market today include the ability for you to take your driving information and use it to gain benefits from an insurance perspective,” said Ben Miners, vice-president, innovation, at IMS. “You can use that information to coach and encourage better driving behaviour for new drivers or young drivers.”

Founded in 1999 by Otman Basir, a University of Waterloo professor in electrical and computing engineering, Waterloo-based IMS is one of the 13 companies contributing to the modified car known as the Connected Vehicle Technology Showcase. The vehicle, a 2014 Lexus RX350 crossover also known as the “Connected Lexus,” stays in Engineering 5 between demonstration events.

Basir, president and chief executive officer, started IMS after a family member was involved in a serious crash. He wondered whether driving would be safer if cars featured trip-tracking technology similar to the black boxes wired into commercial aircraft.

Today, IMS has more than 145 patents. Key consumer products enabled by the DriveSync platform include usage-based insurance (UBI) technology; smartphone-enabled voice control over such “infotainment” functions as email, text messages and music; and Young Drivers Intelligence to help parents coach new drivers.

The company also has a range of fleet-service products to log driving habits and track the performance of vehicles.

The goal setting and rewards of gamification present another emerging element. Miners said. Safe-driving feedback, he adds, benefits not only drivers who use it, but everyone sharing the road with them.
WatCAR at Waterloo offers more than 30 leading-edge automotive research competencies.

UWaterloo’s Centre for Intelligent Antenna and Radio Systems (CIARS) is Canada’s leading RESEARCH FACILITY FOR NEXT-GENERATION WIRELESS, with massive potential for automotive sensors, plus vehicle-to-vehicle and vehicle-to-cloud communication.

3D PRINTING on campus of auto parts and prototypes for both our student research teams and researchers.

More than 125 professors in the LARGEST concentration OF AUTO RESEARCHERS of any university in Canada.