Into the passing lane

Automotive research across the country is helping create the cars of the future

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By Harold Eastman

The green flag has dropped, and the race is on to create tomorrow's smarter, safer and greener cars. To the winners go the spoils of quality jobs, lucrative intellectual property and economic momentum.

Automotive Partnership Canada is a pedal-to-the-metal effort to accelerate the country into the front ranks of the race. It's a collaborative effort involving industry, academic institutions and some of Canada's major research funding organizations. And it sets an ambitious target: revolutionary applications in real cars in just a few years.

The Canada Foundation for Innovation has supported the initiative by helping to fund crucial research infrastructure in labs across Canada, from specialized supercomputers and computed tomography (CT) scanners to industrial-scale assembly line components.

The equipment will help put better cars in Canadian showrooms and driveways — and put Canadian thinking into automotives around the world.

Here are some snapshots of how this is happening.

Better cooling — through better heating

"The stuff can be miserable. It likes to crack and tear during manufacturing."

Michael Worswick of the University of Waterloo is describing the aluminum alloy used in the manufacture of car radiators. The alloy is designed so that individual radiator parts can be assembled and then hot-fused together in a process called brazing.

Unfortunately, aluminum alloys that braze well don't bend well. And bending is important: Complex shapes tend to enhance coolant flow and heat exchange.

The solution is to apply heat when the individual heat exchanger parts are formed, allowing the metal to stretch and flow more easily. Worswick and his colleagues, along with industrial partner Dana Canada Corporation, are finding ways to make this work on a pilot high-speed manufacturing line by heating the alloy sheet while it's being shaped.

This "warm forming" technique also works with the metal cooling plates that dissipate heat from the large batteries required by electric cars. The plates must have intricate coolant channels incorporated into them, but the resulting residual stress causes them to curl. Warm forming keeps the plates flat.

The Waterloo researchers have set themselves a challenging objective: warm forming technology in place on assembly lines by 2017. Will they make it? Worswick is confident they will. "But it's a real stretch play," he says, without a trace of irony.

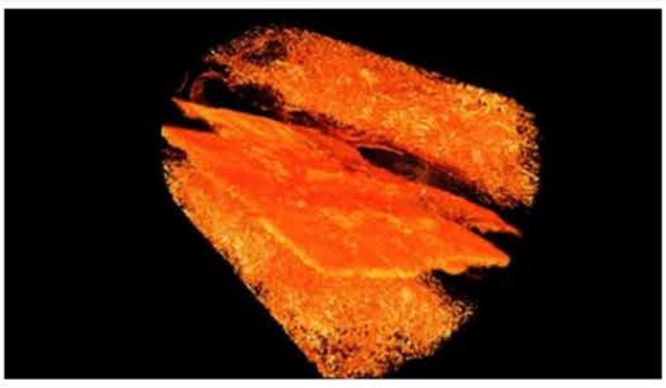
Fuel cells: beyond autopsies

Fuel cells have the potential to eliminate the need for gasoline to power the cars of the future, but making this technology widely available presents a number of challenges, including cost. This is partly because fuel cells eventually degrade and reach the end of their lives. What often fails is the membrane electrode assembly that breaks down hydrogen into electricity and water. This deterioration occurs through several complex chemical, mechanical and thermal processes that are difficult to study.

Until recently, scientists who wanted to understand these processes were limited to "autopsies" that involved cutting up or otherwise damaging the cell to see inside.

Now, however, Erik Kjeang and his colleagues at Simon Fraser University are pioneering the use of specialized CT scanners to non-destructively reveal details of deterioration right down to the nanometre scale. What they're learning will help industry partner Ballard Power Systems come up with designs and materials to make longer-lasting fuel cells.

"The longer the life," explains Kjeang, "the lower the total cost of ownership."



CT scans enable researchers to "see" into a fuel cell without damaging it, allowing them to study how it deteriorates with age. This image of a section of fuel cell is less than a millimetre across.
Photo credit: Image courtesy of Erik Kjeang

Electric cars: melting resistance

"What's the main thing that keeps you from buying an electric car?" asks Gregory Patience of École Polytechnique de Montréal.

The answer is easy: cost.

But that may not be a prohibitive factor for long. Patience and his team, along with industrial partner Clariant (Canada) Inc., are working on a new technology that will halve the cost of cathodes, a major component of lithium-ion batteries for electric cars.

The process involves heating the main cathode ingredients — iron, lithium and phosphorus — to a molten state, then letting the mix cool into solid form. The approach allows the use of less expensive materials and produces superior performance. And the melting stage provides a way to reuse materials from old batteries to make new ones. New research equipment is helping the team scale up the process to industrial quantities.

Once these batteries are on the market, the resulting savings will help melt a lot of resistance to electric cars: roughly $3,000 to $4,000 shaved off the sticker price.

Furnaces like this one at Clariant (Canada) Inc. are helping researchers translate a high-temperature process for making lithium-ion batteries from the lab to the factory.
Photo credit: Photo by Michel Gauthier

Lighten up, save fuel

You may not know what "front rails" are, but they can save your life.

They're the two steel columns that extend from your car's engine cradle to just behind the front bumper, and their job is to protect you in the event of a front-end collision.

Steel, however, is heavy, so Kaan Inal of the University of Waterloo is designing high-strength rails with aluminum to shed kilograms and, as a result, save fuel.

With the help of powerful new supercomputers, Inal is able to work on the problem right from the atomic structure of the aluminum alloy through to the final shape of the rails. The computers allow him, along with industrial partners General Motors and aluminum manufacturer Sapa, to explore a wide variety of options by building them and crushing them — all in cyberspace.

But it's not just about front rails. "The project is a whole technology platform," says Inal. "This is the future of automotive engineering, playing with materials and geometries together. Today, front rails; tomorrow, a door or an engine cradle."