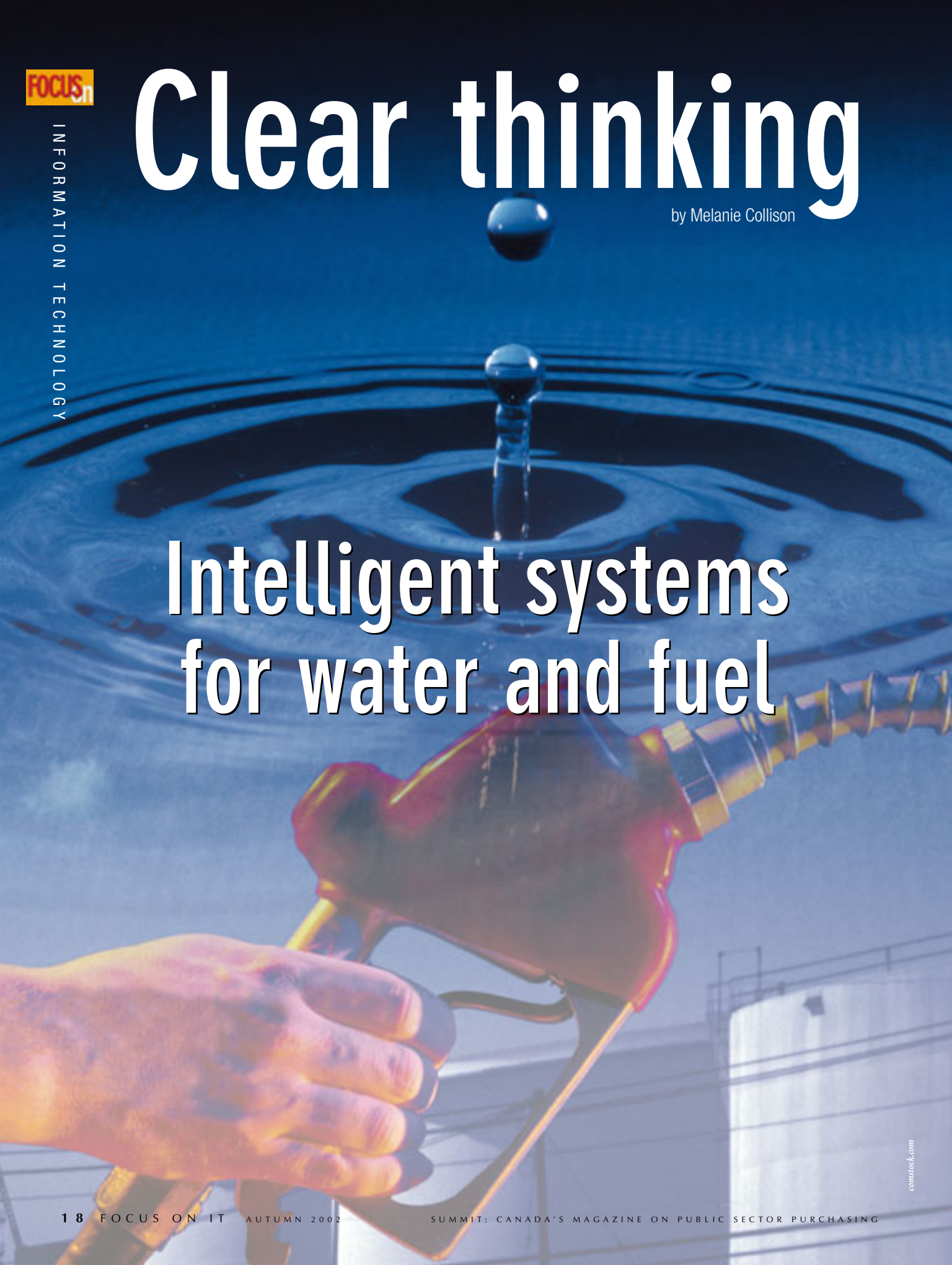
Clear thinking

by Melanie Collison

Intelligent systems for water and fuel



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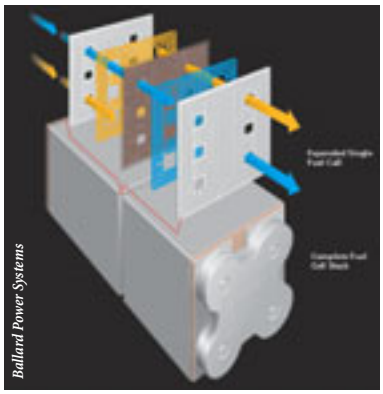
Technology is stripping tedium and danger from industrial processes and giving better tools to physicians. It is boosting system safety at remote oil and gas sites through remote-controlled self-analyzing instrumentation and improving the state of the environment. All this and more is being accomplished through advances in intelligent systems – technology that enables machines and devices to deal with complex and unpredictable environments by mimicking the human ability to perceive, reason, make decisions and act.

"Intelligent systems are ubiquitous," Anthony Eyton, president and CEO of Precarn Inc. (**precarn.ca**) told this year's 12th annual Canadian Conference on Intelligent Systems in Calgary. The conference was a showcase for projects spawned by the not-for-profit industrial consortium, which links academic and government researchers to industry. The goal is to produce commercial applications for technological innovations.

The founders of Precarn perceived that Canadian universities were not well connected to companies, which hampered the country's competitiveness, Eyton told *Summit*. "Multinationals – but not Canadian companies – would pick up [universities'] ideas." In its 14 years, Precarn "has had quite an extraordinary success in finding, funding and managing projects that are making a difference for all Canadians," Eyton says.



Detail of a Ballard® fuel cell stack showing the flow field plates which supply the bodies of fuel and air to either side of the proton exchange membrane.

At the conference, Precarn's concern for the environment was exemplified by two projects:

- A water monitoring system presented by Stephen Brown, of the Centre for Water and the Environment at Queen's University; and,
- Phase II of a project developing intelligent control systems for fuel cells and natural gas vehicles, presented by Mike Sulatisky of the Saskatchewan Research Council (SRC).

The political will to develop foolproof water monitoring systems was ensured by the Walkerton disaster in which seven people died and hundreds became ill from drinking water contaminated by E. Coli. With early support from Precarn Inc. and lead partner Hall Coastal Engineering Ltd. of Kingston – Thompson-Rosemount Group of Cornwall, Qubit Systems Inc. and I-M Innovations Inc. of Kingston formed a coalition with the three-year-old interdisciplinary Centre for Water and the Environment at Queen's.

Brown said the three-phase "Rapid Detection and Intelligent System for Continuous Monitoring of Drinking Water" project is to roll out over roughly three years, by which time a pilot system will be installed in an existing water monitoring plant, although there may also be a manual system ready before then. Currently, the length of time from testing to reporting results is a major problem in water monitoring. Transporting water samples to a lab, plus 18 to 24 hours to run bacterial

tests, can allow a huge number of people to be infected before contamination is detected. The process can be disrupted each time human intervention is required.

The proposed solution is to develop an automated, on-site monitoring system that can be installed at every water treatment plant to sample large amounts of water continuously. The greater the degree of contamination, the faster the probe would detect it and the sooner the system could trigger an alarm or shut down the treatment plant. Objective – pre-established criteria would replace human judgement in issuing warnings.

Brown said Phase 1 is to develop a new fibre-optic probe for E. Coli and total coliform monitoring that will provide a continuous signal and operate automatically. Phase 2 is to design an intelligent system that includes a bacterial probe for automated on-line water monitoring. The idea is to have it track and assess various signal inputs, and modify results gained from testing it in a pilot plant. Phase 3 is to test the complete system in a field situation overseen by a computer network that will monitor probes in various places and issue a warning when required. Such a setup "is more difficult to tamper with (than current human handling chains), and you can have multiple levels of warning posted on a website," Brown adds.

The team now has a probe that detects E. Coli. The next step is to make it reliable and reproducible. In more than 100 samples to date there have been no false negatives. Paired tests with the existing system are being organized, and work is proceeding on developing a total coliform probe. A sample chamber was built early in Phase 2. The City of Cornwall is poised to be the test site for Phase 3.

Besides doing hourly testing with quick and less expensive results, automation can also provide a measure of the degree of contamination, where current reporting simply says contamination does or does not exist. Other goals of the project will be to develop methods to identify microbes and chemical contaminants, including chemical markers for fecal contamination.

Because clean air is as important as clean water, Precarn is also involved with intelligent systems for vehicles using alternative fuels. Three decades ago, the energy crisis of the early '70s accelerated the search for alternatives to gasoline. While the post-petroleum world has not yet arrived, fuel efficiency has at least improved in Canada's 17 million licensed vehicles.

Courtesy Queen's University GIS Lab

Several degrees above normal – at the Queen's University Centre for Water and the Environment, from left to right, (back row) Dr. Moe Hussain, Dr. Kevin Hall, Dr. Art Ley; (front row) Dr. Steve Brown, Dr. Peter Hodson.

On one hand, the design of the internal combustion engine has been greatly refined. On the other, research has intensified into hydrogen-powered fuel cells, and such fuels as steam, compressed air, electricity and solar power, along with bio-oils or bio-diesels such as canola and pulp and paper mill effluent. Hybrids that run on both gas and electricity are finally gaining a toe-hold in the US market, although their sticker price is a deterrent to many.

The SRC has been working with companies across the country on Phase II of an intelligent control system for vehicles powered by fuel cells and natural gas. Researchers are applying artificial intelligence to system components, such as gas regulators, valves and fittings, instrumentation and storage tanks to optimize engine performance. Electronic diagnostics tie into the on-board system of a Ford or Chrysler pickup truck to detect damage to hydrogen storage tanks, which are tested for integrity in case of fire and durability under continuous vibration.

The SRC's Sulatisky, whose expertise includes natural gas vehicles, fuel control systems and fuel cell auxiliaries, explained that an integral part of the intelligent system is an electronic gas regulator that reduces high-pressure hydrogen to the much lower operating pressures of a fuel cell. A fuel cell requires a flow of hydrogen in a range from seven psi to 30 psi, but hydrogen is stored at pressure as high as 6,000 psi to maximize the distance it can fuel the vehicle. Sulatisky said technology is moving pressures towards 10,000 psi. This phase of the project allows for a monitor on the regulator and on the tank.

Current speculation is that fuel cell technology is 20 years away from practical application, but Sulatisky points out that exponential growth in technology means progress that used to take 100 years can now be achieved in a mere 10. He says fuel cell technology is available for commercialization now, but the cost of conversion is daunting. The federal government provides a $500 subsidy, but a conversion costs $3,000 to $5,000. "We have to get sales numbers up to get the prices down; it's chicken and egg," Sulatisky says. "There are currently 200 engines on the market that could be converted, but people don't do it because there has not previously been an intelligent system to adapt the vehicle to natural gas properties. There are not many natural gas [refueling] facilities, so you need to be able to change from one fuel to another at the flick of a switch, to go as far as you can on natural gas, then switch to gasoline."

Principal of Write Right Communications, Melanie Collison is a Calgary-based freelance writer.