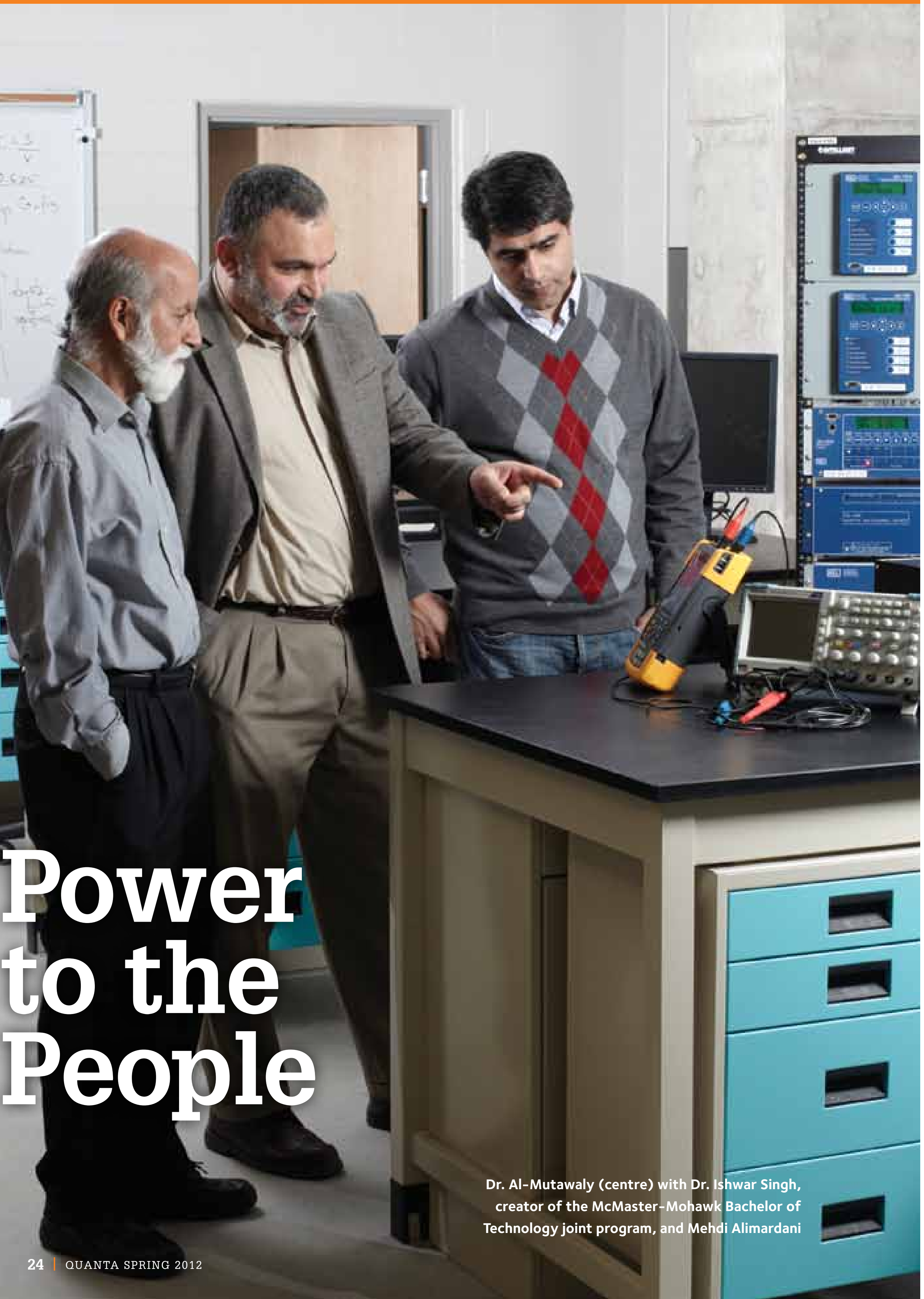

Power to the People

Dr. Al-Mutawaly (centre) with Dr. Ishwar Singh, creator of the McMaster-Mohawk Bachelor of Technology joint program, and Mehdi Alimardani

An Interview with Nafia Al-Mutawaly on a model for protection and control of the power grid

Ontario's energy customers are changing their ways. They're equipping their homes and businesses with smart meters, shifting patterns of consumption, and generating and contributing new energy sources to Ontario's power grid. But Ontario's grid is built on a 100-year-old foundation. Should we be worried?

Nafia Al-Mutawaly, PhD Eng, is a Professor in the Department of Electrotechnology at Mohawk College and Program Chair, Energy Engineering Technologies at McMaster University. He chats here with **Pamela Hensley,** Director of Research and Innovation at Mohawk's iDeaWORKS, about his model for protection and control of smart grids. In his lab, with his team of students quietly working nearby, he explains how critical it is to modernize today's power grids, why academia and industry make a good match, and how his research will provide utilities around the world with a model they can adapt for the future.

Pamela Hensley: As part of your research, you're building a model of Ontario's power grid. Why are you doing that?

Nafia Al-Mutawaly: Actually, it's not just a model for Ontario's power grid. It's a model for protection and control adoptable by virtually any power grid in the world. Why we are doing this? The power industry was the last to get involved and implement computer capabilities into their operations. Even as recently as the late 90s, power grids were managed using electro-mechanical devices invented in the 40s or 50s! With computers, we now have the ability to create networks between different devices, different systems and different locations. This networking capability is a big asset moving forward for protection and control.

Another improvement is in the area of data management. With the new bi-directional data transfer capabilities, we can now upload, download, collect, store, interpret and react to enormous amounts of data from any system(s) in real time.

Which leads to a third improvement - speed. When we look at computers and networking we are talking about high-speed response and activation capabilities. Before, when we looked at a power system, we looked at it as a vertical system. At the top were the generating stations (that is, nuclear, coal, etc.), and at the bottom was the load. The part in between was the grid. It was intuitive - a natural flow from the generator to the grid to the load.

But now, with many new sources of energy (including wind, solar, geothermal, etc.), there are all kinds of power-generating sources popping up in every corner of the grid. These new inputs are creating a new type of topology, which we call horizontal. To control the massive number of energy sources, and to make sure we have a proper/sustainable flow of power (because the flow cannot be allowed to become random), we need to have full, real time control. To achieve that, we need a new combination of equipment and networking to help us meet these kinds of challenges. This is what electrical engineers call a smart grid.

PH: What is a smart grid? And is it new?

NA: The term 'smart' started appearing in all manner of devices and applications over the last decade or so. We have smart phones, smart meters, smart cars... and smart grids. In the case of smart grids, the name refers to a grid that is equipped and networked with the ability to make data-based decisions and adjustments without the use of physical devices. We call it smart because the system gives us the ability to make decisions based on the demand and conditions within the grid. It is definitely the way to go.

PH: How much of the grid is currently supplied by renewable sources and how quickly is that changing?

NA: The latest numbers show that solar and wind power generation went up over the last two to three years, in response to the Green Energy Act presented by the Ontario government [numbers for Ontario]. For example, wind generation doubled over one year. We expect growth in that sector to continue. Photovoltaic power generation also increased, but not at the same rate as wind power. As far as total power from green energy, it meets about 3-4% of the province's demand. There's a plan to shut down all coal plants within Ontario by 2014 and, obviously, that energy has to be replaced. Current thinking is that refurbishments and new installations within nuclear generating stations, and increased green energy options, will replace lost coal-produced power. Each of these options comes with its own challenges. The nuclear industry, for instance, is going through tough times, but when we look at the power grid, nuclear energy is what we call the base, providing the bulk of energy produced in Ontario. We're talking about 45-50% of grid power.

PH: Germany recently shut down 40% of their nuclear capacity. How are they going to manage this?

NA: Germany is a leader when it comes to green energy. When you look at photovoltaic or wind generation, Germany is ahead of the rest of the world. It's no surprise though, because they have been working on green energy since the late 80s and early 90s. Their vision is to replace nuclear stations with wind and solar. That's their ultimate objective.

PH: What about Ontario? Are we progressive? Are we driven by regulation?

NA: We are driven by the political environment. Just prior to this election, one party was supporting green energy 100% and one was promising to terminate green initiatives. The problem with this kind of uncertainty is that it scares investors and manufacturers. This kind of uncertainty is not good, not healthy.

PH: That impacts you as a researcher.

NA: Yes, of course. Sustainability and stability are crucial factors in pursuing successful research. Also, research progress must be driven by the industry needs and should be independent of the political environment. We have recognized the critical need to create a modern protection and control system, first, to replace the existing (old and obsolete) infrastructure and, second, to meet the requirements of new energy sources (wind, solar) recently introduced in Ontario.

> **So it makes good business sense for private industry to collaborate with colleges and universities utilizing the expertise of faculty and supervisors to undertake these projects and produce unbiased, highly ethical solutions.**

PH: Why does industry need support from academic researchers?

NA: There are many reasons. To start with, resources. In Ontario, you have Hydro One, who have their own group to do research. But then there are local distribution companies who don't have access to such resources and yet are responsible for maintaining and upgrading local grids. For example, a nearby local distributor operates with a total staff of 30 people. That includes the lineman, the dispatcher, the manager and the CEO. For this firm, research and development require an investment in expertise, experienced manpower and equipment. This is where academia can help.

After personnel, there is also the equipment itself. McMaster University and Mohawk College are building a laboratory at a cost of $1million, which, from a business perspective, would be prohibitive for many local distributors. Furthermore, in the private sector, these research contracts would be the equivalent to that of 10 or 15 full time staff. On the other hand, students working toward their PhDs and Masters can deliver massive contributions at a minimal cost. So it makes good business sense for private industry to collaborate with colleges and universities utilizing the expertise of faculty and supervisors to undertake these projects and produce unbiased, highly ethical solutions.

PH: How do you hope or expect the results of your research to impact national and international communities?

NA: Many companies are producing new computers and equipment critical to the power industry and each one has its own topology – its own line of products, its own software, etc. My research will be to evaluate these various systems and to determine the advantages and disadvantages of each. The second phase of my research will be to integrate this equipment and ensure all components can find common ground to communicate and work together effectively. The challenge will be to identify that common ground, both in hardware and software solutions.

PH: And your findings will become a recommendation for the power industry?

NA: That will be the model. We'll present a power protection model to the utilities that can be evaluated and adopted by the industry. It will be a model that is fully tested, not only through computer simulation, with all the issues addressed. Utilities will be able to use the model to evaluate and optimise new load, demand or technology issues that arise in the future. In another year or two, if a new load or generation source is offered, they can add it to the model and retest for a solution, with real results. Where real includes real time, real response, real system and real equipment.

PH: You are a professor at both Mohawk College and McMaster University. How is research different at colleges and universities?

NA: Mohawk, as a college, usually applies a how-to and hands-on philosophy. [Lab work] is a big component in any course, especially in engineering. It is equivalent [to class time] as far as number of hours, and it's on a weekly basis. At university, in contrast, courses tend to be more theoretical in nature. There is a lab component, but as far as weight, as far as impact, as far as value of that course, it's significantly less, maybe 20-25%.

PH: Do you think applied research makes a difference in the education of students?

NA: Absolutely. Typically, the students involved in applied research are the ones who stay after normal working hours and on weekends. Passion drives them and satisfaction is fulfilled by their research findings.

THE RESEARCH TEAM INCLUDES: PROFESSORS NAFIA AL-MUTAWALY, JOHN VAN LOON, AND VIJAY KHATRI; TECHNICAL SUPPORT FROM JOHN ANGER AND MEHDI ALIMARDANI; AND CO-OP STUDENTS ALI AL-ZUBAIDI AND LAITH AL-MUSAWI.