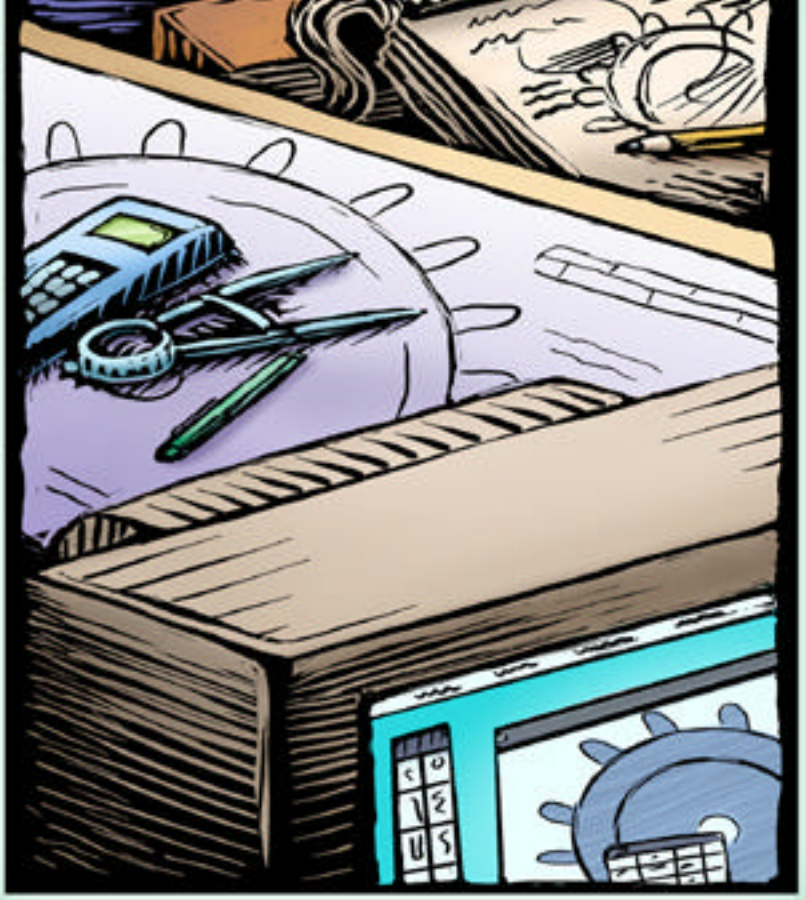

A new century of engineering

Viewpoints on a changing profession

Envision the workplace of the 21st century–the home office or laboratory with the ability to access all human technical knowledge at your fingertips, to conduct full virtual reality experiments and confer with experts around the world. Information technology eradicates time and place barriers in a global economy, transforming the way we live and work. The impact on the engineering profession? Experts from different fields speculate on what the future has in store.

BY KAREN HAWTHORNE

The accelerating pace of technological change requires that all professionals undertake continuous technical education to keep working in a competitive marketplace, says Paul Tinari, PhD, P.Eng.

Tinari, director of the Pacific Institute for Advanced Study, predicts that learning activities could take 20 to 30 per cent of an engineer's time. A second consequence of technological change will be an increasing need for engineers, who are broadly educated in several engineering subspecialties and many other fields, to bring together various areas of disparate specialist knowledge. "Many of the most significant innovations of the 21st century will arise from new combinations of knowledge from different and often widely separated areas," says Tinari.

Tyseer Aboulnasr, PhD, P.Eng., dean of engineering at the University of Ottawa, agrees that the rate of change means engineers will have to keep on learning after they graduate or rapidly

become obsolete. She also notes that "as the complexity of the projects and the scope of possible applications increase exponentially, collaboration with other disciplines, particularly computer science, will become a necessity," recognizing that information technology will have to be integrated into engineering education in much the same way mathematics has been.

John Mann, P.Eng., who heads up engineering at DaimlerChrysler Canada, expects the profession to become even more specialized, with current disciplines broken down into many new specialties. For example, DaimlerChrysler has been working with the University of Windsor on a new automotive program within its mechanical engineering department. "Similar specializations are already underway elsewhere, and we can expect many more to come," says Mann, an advocate for partnerships between industry and education.

In 1998, the University of Windsor and DaimlerChrysler Canada announced Canada's first Automotive Research and Development Centre in Windsor, launching a model for industry and academe to collaborate and prepare youth for the future.

Toward a real-world education

To prepare tomorrow's engineers, Mann is calling for a "real-world education," in which education and industry practice are integrated. "We simply cannot afford to continue the practice whereby education and industry operate in their own separate worlds," he says. "The simple fact is that industry needs are changing faster than current educational practices can respond to them. The feedback time needs to be real-time. Although current co-op programs are a big step in the right direction, they are simply not enough to be globally competitive. The classroom experience must change as rapidly as the changing world around it."

Aboulnasr cautions that engineering schools can never incorporate every recent technology into the curriculum–"nor should we try," suggesting that engineering schools must ensure that future engineers are well equipped to work with any technology that comes their way, by learning fundamental concepts.

Engineering educators expect the future to bring new digital teaching tools, including broader use of the Internet, new collaborative methods and tools, and new kinds of reference materials and teaching laboratories. There will also be more specialization, with renewed emphasis on practical experiences.

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DaimlerChrysler has spearheaded its own plan with the automotive research centre and the creation of a unique industrial chair–Canada's first chair in mechanical engineering design–which will develop a new education model, since design engineering education is almost nonexistent in North America.

"Design engineering itself is all about the synthesis of a broad range of experiences and knowledge into innovative new solutions to technical problems that are of practical value," Mann says, pointing to its fundamental link to the future competitiveness of product-focused Canadian companies.

Tina Traini, president of the Engineering Student Societies' Council of Ontario, also advocates change in engineering education, with stronger ties with industry and instruction in "soft skills," like communication and project management. "Students want the education system to change," she says. "They want to see their education not just stay up to date with technology, but also produce top-notch members of the engineering profession."

Virtual engineering from home

In the years to come, engineering work will become more interesting and creative, as engineers will have at their disposal computational, modeling and simulation facilities far superior to even the most well-funded government research institutions of the 20th century, Paul Tinari predicts. As a result, all small firm or home-based scientists and engineers will be able to work at the leading edges of knowledge and technology.

"Because of aggressive competition from well-equipped engineers in home-based practice, full-time jobs in large firms will gradually be phased out in favour of hiring engineering contractors and consultants for time-limited, project-based work," he says. He foresees corporations with only three full-time individuals, in finance, marketing and engineering. All of the other workers will be contractors, who will "dock" with a firm and be paid to achieve specific aims for projects. When the work is complete, the contract engineer will "undock" and move on to work with another firm, after having spent time on relevant educational activities, Tinari explains.

He envisions a well-connected, home-based office for these independent engineering consultants. Full virtual reality interfaces will allow engineers to conduct virtual experiments using simulations of wind tunnels, acoustic labs, and marine, zero-g and high pressure environments. Models of new devices will be produced in minutes, by virtual prototyping machines linked to workstations, cutting months from product development times. "By the mid-21st century, the first Nobel prizes will be awarded for research conducted in someone's home office/virtual laboratory," Tinari says.

"Information technology has already changed the way we do our business," says Mohan Mathur, PhD, P.Eng., vice president of the Ontario Power Generation's nuclear division and former dean of engineering at the University of Western Ontario. He expects telecommuting to

become an important part of business operation, combined appropriately with highly automated production sites.

Collaboration in design through problem-solving teams, where members are dispersed geographically, and examination of component and system performance through simulations prior to committing any physical resources will become the norm, he says. The engineering profession will need to reexamine accountability and liability issues in light of these new work methods, Mathur speculates.

A new era for female engineers

These experts agree that, as engineering transforms itself into a profession of entrepreneurs engaged in interesting, creative and globally networked work, more women will join the profession, pushing the envelope in what has been a traditionally male profession. "Engineering will eventually become a profession of choice like medicine, law and dentistry, because women will find it to be a creative and caring profession," says Mathur.

Canadian women are starting their own businesses at twice the rate of men because of the appeal of being their own boss and the challenges associated with independent creative work, says Tinari. "When women see engineering as a profession where they can do their own thing, and where they feel free to change systems and procedures to suit their own particular preferences, they will embrace engineering just as they have medicine and law," he says.

The women in engineering at the University of Ottawa don't see themselves as "unusual," and they invariably fit very well within the student body, says Aboulnasr, also applauding the cultural diversity of the university's engineering faculty. "I firmly believe that engineering, as a profession, has grown into one of the most liberal professions, integrating men and women of various backgrounds on an equal basis."

Solutions for urban populations

With the spread of densely-populated cities around the world, concerns about pollution, water, sanitation, power, transportation, housing and food supply systems are now paramount for engineers–the planners and problem-solvers of urban infrastructure.

As the number of home-based businesses rises, service-providers will compete to bring services to our front doors, further limiting the need to travel distances for work and recreation.

"Urban communities, megacities especially, need to do a lot of planning if they are to be 'humanly pleasant places to live,'" says Monique Frize, PhD, P.Eng., chair of Women in Science and Engineering at Carleton University and the University of Ottawa. This means providing new and improved transportation systems, as well as telework, parks and meeting spaces for people to enjoy, she says.

Tinari predicts that engineers in the developing world will learn from the experiences of the west, and adopt significantly different models for urban development. For example, rather than installing copper phone wires, cities in developing nations will install fibre optic communication systems.

He also suggests that the pollution and congestion problems so evident in late 20th century Bangkok or Lagos will eventually lead, by necessity, to massive shifts toward alternative energy technologies and next generation mass transit systems. "Sustainability of design and environmental compatibility," Tinari says, "will become the key yardsticks used in judging the quality of engineering work in the 21st century." ◆

Coping with technological stress

E-commerce, email, and videoconferencing have catapulted us into the 21st century at breakneck speed. There are hazards along this information highway, says Monique Frize, PhD, P.Eng., the chair of Women in Science and Engineering at Carleton University and the University of Ottawa.

Increasingly, engineers will have to keep up with information technology developments to stay competitive and keep communication channels open for business, she says, stressing that there's a downside to a technologically-determined pace of life.

"The problem, I think, is that humans are already stressed with the speed at which we need to operate, and this is just going to get worse," Frize notes, citing the example of mailing five letters 10 years ago as a good day's work. "Now, we do 100 emails a day, more or less, in the same time speed. One big problem, I think, is that we have little time to reflect before engaging in communication. We have only a short time to react, and this may produce much more shallow solutions or responses. So I see instant voice, pictures and messages, which can be an advantage, but much more stress and less downtime to think things through."

Another hazard is that social responsibility sometimes gets lost in the information age, with its emphasis on quick turnaround times. "As technology grows and becomes more complex, I think we realize just how small this world is and how the decisions engineers make affect everyone," says Tina Traini, president of the Engineering Student Societies' Council of Ontario.

The solution? Engineers, as the innovators of the 21st century, will need to temper the power of their new digital tools with a sound social conscience, ushering in a new standard of living without negative impacts, she says. "The challenge here is in the questions we ask ourselves and our teams. Can 'why' and 'what' become as important as 'when' and 'how'? Can engineers see their space in a global community?"