



The future of engineer



Predicting the future is no science. Unforeseen factors can conspire to make one logical forecast look completely off-base in hindsight. One day the world is focused on dot.com meltdowns, the next on securing infrastructure, due to an act of terrorism directed from halfway around the world. What are the challenges and opportunities that lie ahead

for professional engineers? How can they prepare for them? Why will the P.Eng. licence still be relevant?

Engineering Dimensions recently spoke to some professional engineers in various disciplines and others involved in industry, academe and government about their thoughts on the profession's future. Here's what they had to say.

edited by Dwight Hamilton

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Norman Ball, PhD

In multicultural Canada, segregated education is out. Integration is in. Right? Wrong. Although engineer-



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ing classes have students from all over the world, one look at classroom composition dispels the myth of integration. Engineering students are separated from the rest of the campus. Many universities offer English for engineers, economics for engineers and technology and society studies for engineers. This is not integration; this is segregated education in an engineering ghetto.

And now for another myth: Engineering teaches team building. Yeah, right. Six students from the same department work together on a project. Is that a team or a herd of clones? Genuine team building means working with people who have different priorities and different perspectives. Yet, how many Canadian engineering schools encourage engineering students to work with students from other faculties who may see the world from a different viewpoint?

Most engineering schools are systematically robbing future engineers of opportunities to understand how others think. They segregate engineers from the rest of society, and more than any other single factor, this segregation reduces engineers' effectiveness.

Several years ago, I talked to engineers across Canada about the challenges facing them in the 21st century. Barry Lester, P.Eng., vice president and COO of Stantec in Calgary, summed it up best: "Understanding how others think—it's a core skill for engineering management." Increasingly, it's a core skill no matter what you do or where you are on the totem pole.

Canada needs engineers who can work with non-engineers and who understand and care about how others experience the technologies and structures they create. Unfortunately, intellectual segregation from other professions and the public at large is deeply ingrained in engineering education and engineering organizations. But that is what professional engineers most need to change to meet the future's challenges.

Michael Butt, P.Eng.

Before reading any further, you should know I am a civil engineer. Since graduating in 1963, I have worked entirely in the



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Barry Lester, P.Eng. quoted by Norman Ball

general contracting field, so if my thoughts seem biased toward civil engineering and construction, they probably are.

With well over 50 years of experience, I have come to believe engineers undervalue their services more than any other profession. All too often I hear: "There is not enough money in our fees to provide a full service"—and the result is less than the

best service. It is often easier to over-design, but in today's business climate of tight budgets and tough competition, it is important we provide the best possible solutions and are compensated accordingly. There should be no excuse for poor service. The reality is that we are all very competitive by nature and too often bid to win, instead of bidding to make money and provide excellent service.

To continue to enjoy the status of a self-regulated organization, PEO must improve on the timelines of its complaints and discipline actions by dealing with these fairly and quickly; we are not protecting the public if it takes us two years to rule on a complaint or to discipline a member.

We also need to reconsider the parameters of certification. The right of certification should apply only to a member's field of specialization and a minimum number of "refreshers" or years of continued experience should be required to maintain licensure.

Finally, our next challenge is to protect the environment through a single, consolidated environmental code that is accepted as a minimum standard, and would be used in the design of all new developments and processes. Environmental engineers would certify compliance, much like structural or electrical engineers certify structures and electrical systems to meet local or national building codes. As engineers, I believe it is up to us to set the standards and lead by example in protecting our planet for future generations.

Guy Félio, P.Eng.

Engineers today face complex and challenging times that provide unprecedented opportunities for innovation. Canada's



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Innovation Strategy, launched in February 2002 and involving sectoral and regional consultations, has provided a unique forum for the engineering community to express its views on our country's innovation needs, objectives and targets.

In today's context, a number of technology trends are emerging, too numerous to list here. One noteworthy trend will be the application of nanotechnology to a wide range of fields, not limited to life sciences, manufacturing, information and communications, but also in other less obvious areas such as construction.

Another emergence will be the increased use of significantly higher performance computing platforms, whether on stand-alone units, networks or grids. High performance applications for virtual manufacturing, process/product visualization, bioinformatics, and computational materials will provide tomorrow's engineers with extraordinary opportunities to exercise their inherent creativity while ensuring public health and safety.

Finally, in order to sustain Canada's high quality of life, one must not ignore the need to improve upon the backbone of the country: its physical infrastructure. Here again,

multidisciplined engineers are called on to use and develop innovative methodologies and technologies to oversee the delicate balance between economic constraints, social expectations, and environmental well being, all the while guarding against natural and human-produced hazards.

To succeed, as an individual and as a professional, the engineer will have to continue adapting to working in multidisciplinary settings and collaborating with non-engineers. Engineers are no strangers to these relationships, but it is up to us to choose whether we are to be in leadership and decision-making roles. For this, engineers will have to continue expanding their multidirectional, nonlinear thinking, always being reminded of their duty to the public. Educational and training programs have begun to adapt to this new reality and will have to continue evolving, in many instances at a much faster pace than has ever taken place. Flexibility will be key, not only to the individual but also to the institution. Non-engineering competencies in such fields as economics, finance, law, human relations and management will be even more critical than ever to leadership.

Challenging times indeed. The engineering profession is expected to—and will—rise to the occasion.

John Gamble, P.Eng.

The *Professional Engineers Act* exists to regulate the practice of professional engineers because of the potential impact of some



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engineering decisions on the public and other third parties not contractually bound to the professional engineer.

For instance, Consulting Engineers of Ontario (CEO) represents many firms that offer engineering services directly to the owners and managers of infrastructure. These consulting engineers owe an enormous duty of care to the public—a third party with a reasonable expectation that it may rely on the integrity of infrastructure. This responsibility is the single most important justification for regulating the

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engineering profession. As such, the relevance of the Act to the public is, and will continue to be, the most important challenge facing the profession. Ensuring the relevance of the *Professional Engineers Act* is our duty to the public.

To remain relevant to the public, PEO must fulfill the public's ever-increasing demand for accountability. Similarly, we expect CEO members and other engineers to fulfill their clients' ever-increasing demand for expertise. Yet, the licence to practise professional engineering provides no limit or indication of a professional engineer's area of expertise or practice. Further complicating this issue is that “public interest” is a subjective concept that the Act does not define.

The exclusive right to practise needs to be dealt with separately from “membership” in the engineering community. In fact, contrary to widespread public per-

ception, the Act only requires an engineer to be licensed if he or she is accepting public responsibility for engineering decisions. These issues have led to the exclusive right to practise being applied to engineering activities where there might be no justifiable public interest in doing so. Licensing is a responsibility to the public and a potential liability that need only be applied to those whose work involves a duty of care to the public. Bestowing an exclusive right to practise without adequately defining the area of practice (and the requisite qualifications) undermines the relevance of the licence.

To protect the relevance of the licence, we need to collaboratively define specific activities and areas of practice, for which there is a compelling public interest in limiting the right to practise. PEO can then establish objective and transparent criteria to ensure that licensed engineers who will be held accountable to the public command the appropriate theoretical and practical engineering knowledge within their chosen areas of practice. It would then be both viable and justifiable to protect the right to practise.

John Mann, P.Eng.

Globalization and free trade agreements between nations have provided an opportunity for industry to harmonize prod-



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ucts for numerous markets in order to reduce costs, speed development, and improve quality—all to the benefit of consumers worldwide. Of course, consumers also benefit from the industry competition that results from such open markets.

Clearly, the biggest challenges of globalization are regulatory harmonization and international competitiveness. In my own industry, the complexity of global automotive regulations is staggering. Unique regulations and requirements impede progress, and add significant cost that is ultimately borne by consumers. Countries must learn to cooperate to the benefit of consumers everywhere with regulations that make sense, and that are harmonized around the world. Tax structures, industrial regulations, employment costs, and the economic environment in Canada also directly impact industrial competitiveness. Regulations and the operating environment for business are some of the most difficult things to change. Nonetheless, change is absolutely imperative.

Unfortunately, laws and regulations governing engineering practice elsewhere around the world are not necessarily the same as ours. Not even the meaning of “engineer” is consistent elsewhere. More importantly, there are ethical differences around the world that are driven by cultural differences. Some might argue, but I personally think that it is important that we do not impose our ethical standards on engineers in other countries, any more than we would want them to impose their standards on us. What is important is that we uphold our own ethics in our own activities no matter where we are. Frankly, I doubt that international ethics can be harmonized or regulated in the world we know today. It’s something each of us must deal with ourselves. After all, at the end of the day, we must like the person we see looking back at us in the mirror, and we

“Unique regulations and requirements impede progress, and add significant cost”

John Mann, P.Eng.

must be proud of what we do.

While it is important to recognize and accept that different professional engineering requirements and regulations exist in other countries, we must also continue to uphold the integrity of our profession and the human values we protect. The challenge in the future will be to continue to regulate and maintain the integrity of what

it means to practise licensed professional engineering here in Ontario and Canada, while we interface with engineering practice throughout the rest of the global economy around us.

Moyra McDill, PhD, P.Eng.

Academic programs must continue to cover the fundamentals, which evolve as new areas emerge, while also giving train-



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ing in current software or similar tools. We will need to adapt to whatever emerging areas appear.

Change is inevitable. Our students need to learn, to predict, and to analyze problems based on an ever-increasing body of

knowledge. A key skill will be the ability to adjust to and cope with change whether it is change within an individual's career path or change within the profession. As the global economy develops further, it will be necessary to work with a variety of languages and cultures. Engineers who are multilingual and multicultural may well have an advantage.

The relationship between public safety and engineering should mean the P.Eng. licence is relevant in 2022. Certainly, I expect our medical doctors will still need licences in 20 years time.

Jennifer Neate, EIT

Like any scientific field, we can count on volatility and continuous change, and we will no doubt live to see more great upsets



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similar to those experienced by the dot.com and fibre-optic industries.

That said, we can draw some conclusions when we consider the nature of the current engineering environment. As we learn to live in a state of increasing ecological and human-produced turmoil, emerging areas of engineering practice might be:

- food production, including long term storage and preservation;
- alternative energy systems with an emphasis on simple dual/back-up systems;

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Jennifer Neate, EIT

- low maintenance infrastructure;
- security systems;
- back-up systems for energy, communications, logistics, water supply, food, etc.; and
- impact assessments on engineering projects, beyond just environmental impact, to determine their impact on infrastructure, energy supply and security.

Along with ongoing emphasis on conservation of energy, the environment and securing our food supply, we will see new challenges emerge linked to the continuing explosion of technology. As technology becomes more advanced and reaches more individuals not fully equipped to understand it, we must conclude that engineering ethics will come into the forefront. Engineers of tomorrow will be trusted to manage the technology for a society largely depending on systems that are relatively new and extremely powerful. As information technology and biotechnology become more a part of everyday life, we must have individuals with impeccable ethics managing them.

Improvement of our communication skills will also be key to success in the future. As a profession that serves a society that is relatively inexperienced with technology (in terms of in-depth understanding) and has an increasing dependence on engineering to survive on a shrinking globe, we will need to improve our ability to effectively communicate with a non-technical audience.

Current engineering advances in any specific field are based on the integration of a number of engineering disciplines, and engineers will be challenged to stay current in a much wider field of practice than was previously expected. We will be forced to improve our communication skills within our practice as we start to work with a larger network of colleagues from different disciplines and diverse backgrounds.

In many ways, the P.Eng. licence will become even more critical. There will be increased importance on continuous learning, and the engineering governing bodies will need to be restructured to reflect this need. New engineers will be increasingly dependent on mentoring, and proper certification and re-certification will draw from more discipline-specific resources than are currently available to PEO. Employers will need to take on a more active role in the training and licensing of engineers, as well as the continuous re-training and licence renewal.

Because of the growing emphasis on cross-discipline engineering, we will see a demand in many different sectors. More than ever before, the key to engineering success will be the continuous nurturing of wide expertise, excellent communication, and flawless ethics across the entire practice.

Judit Puskas, PhD, P.Eng.

At my 25th class reunion, I learned that more than one-third of my chemical engineering classmates worked outside of the



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traditional boundaries of engineering. Separately, if I ask my “lay” friends: “What do you think an engineer is?” The answer I received repeatedly was: “I have no idea.”

Herein lies the first challenge for the profession: to define and communicate what an engineer is today. University of Washington engineering dean, Denise D. Denton, once said that “the engineering degree is the liberal arts degree of the 21st century.” Engineering for me is problem solving and the reduction of theory to practice. The significance of engineering in today’s technology-based society would be fully appreciated only if all engineers suddenly disappeared. I guess it would not take long for modern life to screech to a halt.

Yet the profile and appreciation of engineering is behind that of such other professions as law or medicine—at least in North America. In contrast, my experience as a visiting professor in Germany showed me how much the engineering profession is appreciated in that country. We need to raise the profile of the profession and demonstrate its importance to society. This the key to making the P.Eng. licence more relevant than ever.

I believe that the engineers of the next millennium will be closer to the renaissance idea of engineering, with more flexibility and less rigid boundaries between traditional disciplines. Just think of Michelangelo, the quintessential renaissance engineer. There will have to be more innovation and art in engineering, and more involvement in the affairs of society. How should we prepare for this? My bet is on fundamental education. If we teach problem solving, common sense and the power of community—somewhat to the expense of individualism—we will have well-rounded engineers highly appreciated by society. Am I a dreamer? Maybe, but I am not the only one.

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Judit Puskas PhD, P.Eng.

Georges Salloum, P.Eng.

Canadian engineers will have to work more closely to exploit opportunities with the top R&D spenders, capitalizing on our



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well trained engineers, immense natural resources and national R&D infrastructure. New opportunities could be developed in other countries based on our well established engineering credibility in major international projects, such as space-related programs, offshore engineering, mineral exploration and telecommunications. In addition, our engineering know-how is well recognized in infrastructure projects

with several European countries, China, the Middle East and Australia. With our design and production engineering expertise, Canadian engineers can make a great contribution to the development of next generation vehicles in the automotive and aerospace industries, in biomedical engineering, and to the new programs being developed for our national defence and security.

Continuous education and distance learning are still among the critical factors that need to be addressed. There is a huge opportunity for engineers to develop Web-enabling production technologies and collaborative or distributed engineering design tools. To shape the future, Canadian engineers are faced with the challenge of recruiting and retaining other talented engineers and professionals. To succeed in a global economy, we have to develop opportunities for engineers to practise for maximum results, to rethink the organizational structures so that they are enabled to be more efficient in focusing on customer demands while providing excellent opportunities for career and professional development. Professional engineers will have to be kept abreast of the latest scientific and engineering developments on a global basis. Moreover, Canadian engineers will have to lead and foster the development of a competitive workforce and promote synergy with other professions. More engineers are graduating with concurrent and advanced degrees.

Perhaps our collective challenge will be to put to work our talents to provide new and exciting opportunities to the young generation of engineers to practise in Canada. The external environment and latest trends in the United States, Europe and Asia will impact positively on the engineering profession and will stimulate foreign companies to invest in Canada. The challenge will be to attract other multinationals to locate some of their production operations and research facilities in Canada so that their key suppliers will follow. Since our engineers must juggle global and local environments and adapt to working in virtual teams around the world, the need to maintain the P.Eng. licence is more apparent than ever. Engineers will have to explicitly value diversity and properly manage teams with cultural differences.

Norman Sterling, P.Eng.

In today's world, civil engineers literally lay the foundation of a modern and prosperous society. We dedicate our time to



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building safe and efficient highways and bridges to carry people, goods and services. In short, civil engineers play a large role in the quality of life of the people of Ontario.

As an engineer, I was especially gratified to read in the July/August 2002 issue of *Engineering Dimensions* that the recent trend toward declining enrolment in engineering programs appears to be

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Norman Sterling, P.Eng.

reversing. In 2000-2001, there was a 6.7 per cent enrolment increase from the previous academic year. Electrical, mechanical and computer engineering were the top choices for study. Civil engineering studies, once the third most popular program, dropped to fourth. But despite this, in 2000, 3 per cent more civil engineers received degrees than in 1999.

It is clear that our profession is undergoing some profound and exciting changes. Consider this: Highway design engineers will soon be able to call up topographic data on their laptops from an orbiting satellite and use it to create a digital terrain model for a proposed new highway. Traffic engineers will also soon be able to use automated video cameras on the highway network to count and classify vehicle types on existing highways in real time.

As well, in the near future, information gathering will be made much simpler. All highway data could soon be referenced using a highly accurate global positioning system, facilitating a more integrated analysis of engineering problems. For example, this system can electronically identify locations where there is a correlation between pavement conditions and collisions. This data could then allow for engineering management systems to identify and prioritize work projects, and limited funds could be earmarked for the highest priority areas.

What does all this mean for civil engineers? Recent technological growth is making civil engineering an even more interesting and challenging profession. Civil engineers, however, will need new skill sets to use smart highway technology, new land information systems, and new automated design and data collection systems.

I hope that today's engineers will spread the word that civil engineering is still an exciting and rewarding career, and becoming even more so as new technologies emerge.

Cam Vatandoust, P.Eng.

As reflected in PEO's Code of Ethics, a professional engineer's single most important duty is to the public's welfare.



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Engineers fulfil this critical role by their involvement in various diverse disciplines and exciting fields of practice. Whether regulating drinking water standards, setting air emission standards, managing construction projects, or researching and developing new medicines in the pharmaceuticals industry, as practitioners, we all place safeguarding the public as our highest responsibility.

In recent decades, the flourishing global industry has put great demands on our natural resources, and ecosystems. However, we now realize that our focus should be achieving development that can be sustained by the environment surrounding us, so that its negative effects are more manageable.

More recently, in most industrialized nations (with the exception of the United States), there has been a gradual but consistent transition from our “consumer lifestyles” toward sustainable development. Working directly or indirectly toward achieving sustainable development will be one of the most important emerging areas of engineering practice.

In government, engineers have been developing new regulations and adopting

policies to reflect this global awareness into practice, as well as establishing performance measures for each industrial sector. In industry, engineers have also been helping each sector meet these standards through innovation and technology.

The challenge for the future engineer will be to raise awareness and educate consumers on their choices, in order to keep our overall environmental stresses low. This is especially critical in sensitive developing countries with large population growth, where the desire to adopt the western “consumer lifestyle” has never been greater.

The professional engineering licence, and the work of engineers will continue to remain relevant in the future, as we move toward achieving sustainable development, and learn how to manage the planet’s resources ecologically and efficiently.

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Cam Uatandoust, P.Eng.

Professional engineers will continually work to improve our health and safety, and ultimately, to enhance the quality of life within our communities. There is not a more rewarding challenge than this. ◆

Editor’s note: David Young, Attorney General

of Ontario, Catherine Karakatsanis, P.Eng., chair, Ontario Society of Professional Engineers, and Venkatesh Kodur, PhD, P.Eng., research officer, National Research Council of Canada, were unable to meet *Engineering Dimensions*’ deadline for this article.