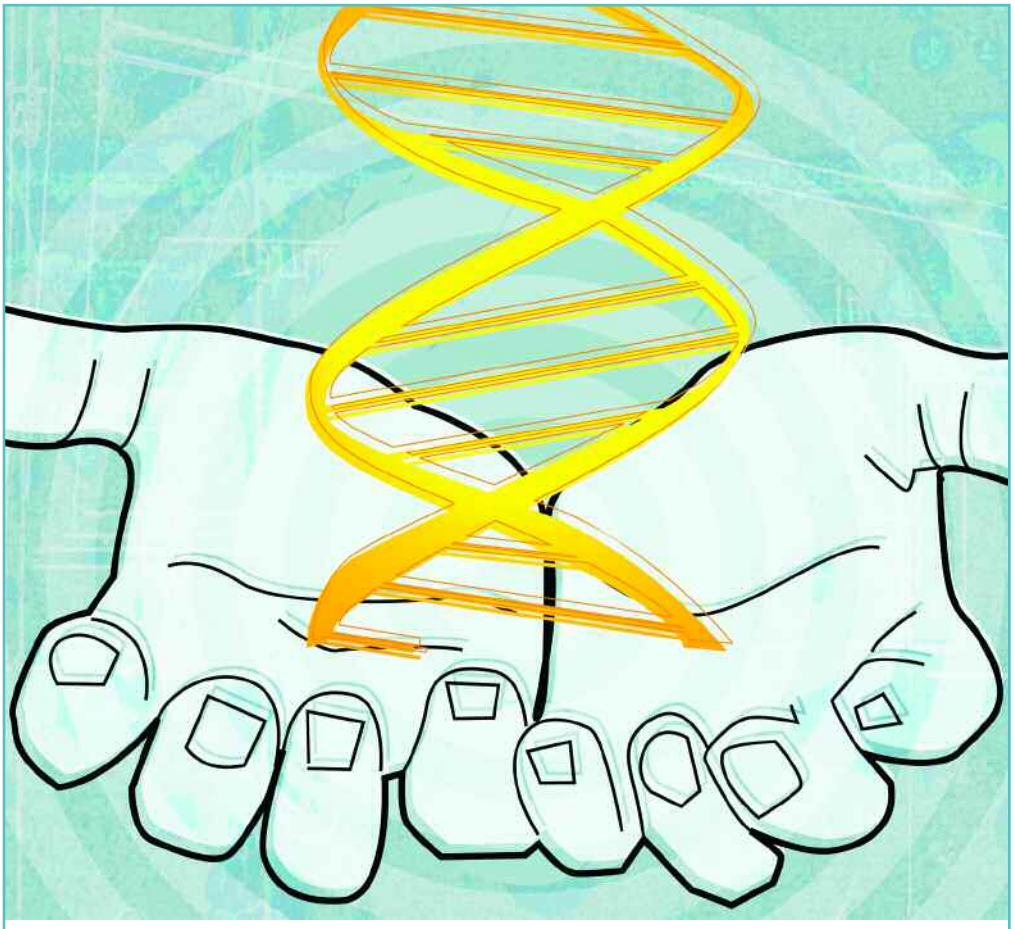
PROTECTING THE PUBLIC
IN THE PRESENCE OF EMERGING DISCIPLINES



By Bruno Di Stefano, P.Eng.

One of the most difficult challenges in regulating the practice of professional engineering is making sure that work emanating from new, incompletely defined disciplines does not endanger the public. It is especially difficult when disciplines do not necessarily emerge following a prescribed pattern. PEO's role is not to stand in the way of progress, but to ensure that new disciplines are introduced smoothly and, most importantly, to make sure the public is protected at all times–especially during the critical period of a discipline's infancy.

No professional engineer within traveling distance of the Art Gallery of Ontario in Toronto should have missed "Massive Change–the Future of Global Design" (March 11 to May 29, 2005). Despite being located in an art gallery, this was indeed an exhibition of professional engineering, and mostly of emerging areas of professional engineering. Exhibits included modern transportation technologies, civilian and military electronics, wireless communications, revolutionary new materials and their applications, energy-efficient devices, smart homes and buildings, equipment to improve health care, and much more. Still, professional engineering was visible only to those who knew what professional engineering is. For the public at large, professional engineering remained invisible.

This invisibility comes with the risk of hampering the protection of life, property and public welfare. For example, how can a

member of the public know when he or she requires the services of a professional engineer, when he or she may not understand that a certain service or technology is within the domain of the engineering profession?

Moreover, even when the words "engineer" or "engineering" appear in a job or product description, how does a member of the public know that it means "professional engineer" and "professional engineering?" Unfortunately, the English language is ambiguous with regard to the word "engineer." The noun "engineer" has two classical meanings (according to Princeton University's WordNet, http://wordnet.princeton.edu), that are "a person who uses scientific knowledge to solve practical problems" and "the operator of a railway locomotive." The emergence of so-called professions, such as "sanitary engineer," does not help. The proliferation of new types of engineering makes things even more challenging. The Wikipedia (www.wikipedia.org) lists 25 different engineering disciplines. A quick look at the press yields such terms as "cognitive engineering," "tissue engineering," and "nanoengineering." A very cursory look at the offerings of Canadian universities reveals the existence of a master of science, financial engineering (Université Laval), and a "risk management & financial engineering major" (University of Toronto).

Is it really engineering?

This problem is not new. In discussing the emerging areas of engineering in his article "Scanning the Emerging Areas" (*Engineering Dimensions*, November/December 2003, pp. 32-35), Perry J. Greenbaum wrote: "Are they really engineering? Or are they trading on the value of the term 'engineering?' And for those that have an engineering component, where do engineers fit within the practice, and what are the required education, training and standards for licensing in the public interest?"

To answer these questions, you must understand some essential characteristics of professional engineering. "The engineering profession is more dynamic than most other professions and engineering practices evolve more than the practices in other comparable professions (e.g. medicine, law, etc.). New areas in engineering tend to evolve prior to any established academic curricula. The engineer working in new areas is therefore usually or initially self-taught. Eventually, new graduates from established engineering disciplines join the new discipline, thus practising in a field other than the one of their formal education. Sometimes, new graduates from non-accredited (often foreign) engineering programs hold degrees in the new area of practice. In all of these cases, Professional Engineers Ontario has attempted to protect the public by licensing professionals according to its traditional process, which is not discipline specific, and involves four steps:

1. Ensure that the applicant has adequate academic qualifications;
2. Ensure that the applicant writes and passes the professional practice exam on engineering law, ethics and liability;
3. Verify that the applicant has engineering work experience that is consistent with his/her academic background; and
4. Ensure that the applicant meets PEO's other licensing criteria, e.g. good character."[1]

Task groups formed

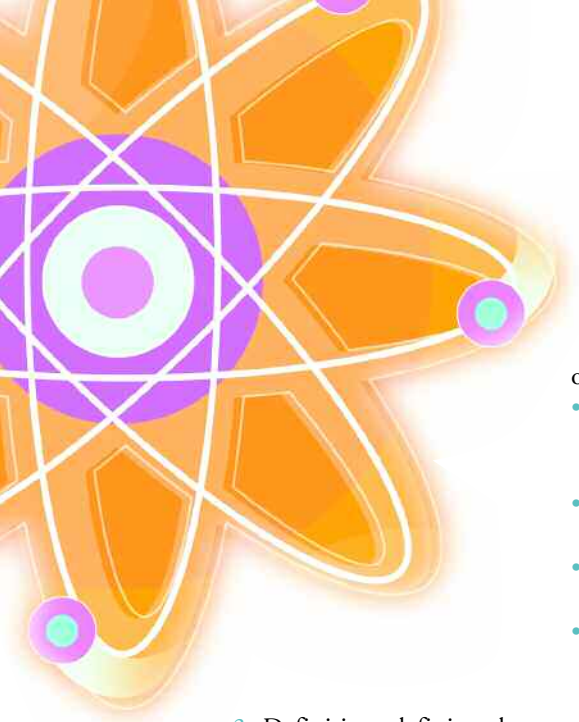
How can PEO verify "adequate academic qualifications" when an engineer working in a new area is self-taught? How can PEO verify that the applicant has engineering work experience that is consistent with his or her academic background when the engineer working in the new area is either self-taught or is a graduate from an established engineering discipline who has joined the new discipline?

In 1997, facing the above-mentioned problems–a large number of applicants claiming academic credentials from international non-accredited institutions, and a large number of applicants whose formal engineering education was not consistent with their academic background–PEO established the Task Group on Emerging Engineering and Multidisciplinary Groups. This task group issued a report, presented to Council in 2002, that recommended the establishment of a standing committee on emerging and non-traditional engineering. The desired outcomes for this new committee were to:

- increase PEO's understanding of new and emerging disciplines, and the qualifications required to practise these disciplines;
- identify where engineering principles and knowledge are being applied; and
- identify practitioners who need to be regulated.

In March 1998, these recommendations materialized into the appointment of the Engineering Disciplines Task Group (EDTG). EDTG, which I chaired from 1998 to 2002, decided to explore whether it could develop a process for licensing individuals practising in emerging areas that would be consistent with PEO's traditional licensing process. The steps the EDTG devised to identify new areas of practice, and to license those practising in these areas, were:

"1. Discovery: recognizing a new practice area and recommending a standing committee to assist in monitoring the new area;
2. Identification: identifying the knowledge that is necessary for competent practice in a new area of practice, i.e. its body of knowledge;



3. Definition: defining the body of knowledge in terms of the required and optional areas of study that would comprise an academic program in the new area;
4. Evaluation: reviewing the experience and educational qualifications of practitioners in the new areas to determine if they have provided practitioners that defined body of knowledge; and
5. Legislation: identifying the areas within the new area where an exclusive scope of practice for licensed P.Engs is necessary to protect the public interest, and working practice for licensed P.Engs is necessary to protect the public interest, and working with government to develop demand-side legislation for those areas."[1]

Putting theory to the test

To test its process, the EDTG applied it to the area of software engineering, which was an ideal test case because it is representative of many difficulties faced by PEO. Software engineering was not really a new discipline in 1998. The term "software engineering" was created for the 1968 NATO Conference on Software Engineering. Since 1968, "Chairs and curricula were created, specialist groups and working groups, books and periodicals devoted exclusively to software engineering were introduced." To commemorate the 25th anniversary of software engineering, the 4th European Software Engineering Conference took place in September 1993 in Garmisch, Germany. Examining software engineering using PEO's yardstick of established practice, "The task group concluded that software engineering comprises a new discipline of engineering because of the:

- large number of applicants to Professional Engineers Ontario who are practising in this area;
- large number of job advertisements for practitioners in this area;
- large number of foreign universities offering programs in this area; and
- appearance of Canadian non-accredited programs in this area."[1]

Members of the EDTG who practise software engineering, and/or hold academic positions in the area of software engineering, were then able to reach a consensus to establish "experience requirements for cross-discipline applicants practising in the software engineering field," which comprised the defined body of knowledge for the new discipline. The EDTG, PEO, and the engineering profession owe this important accomplishment to David Lorge Parnas, PhD, P.Eng., of McMaster University, an early pioneer of software engineering. This body of knowledge was consistent with the work carried out by professional societies and with degrees offered by international universities and with Canadian non-accredited programs in software engineering.

Software engineering was an ideal test case because it is representative of many difficulties faced by PEO.

Meanwhile, to test its process further, the EDTG struck a bioengineering subgroup to define bioengineering for licensing purposes. This process was completed on November 16, 2001 and approved by Council in 2002.

The final recommendations of the EDTG read: "Based on its experience with establishing software engineering as a new engineering discipline, the EDTG recommends that PEO:

1. Establish a permanent committee to monitor the qualifications and experience of applicants and job advertisements to identify new engineering disciplines or, alternatively, task staff to do this;
2. Apply the outlined process for defining a body of knowledge to identified new engineering disciplines;
3. Promptly identify an area of exclusive practice for the licensed practitioners of any new engineering discipline and work with government to secure appropriate demand-side legislation;
4. Implement enforcement processes in relation to new engineering disciplines with legislated exclusive scopes of practice; and
5. Establish a discipline-specific licensing model."[1]

In approving the recommendations, Council changed "establish" in the last recommendation to "examine."

The work on software engineering continued with the Ontario Software Engineering Task Force (OSWET), which had the mandate to develop PEO strategies as required on the issue of software engineering. The task force monitored activities in connection with this practice area and met with representatives of the Canadian Information Processing Society (CIPS). Eventually, OSWET spun off the External Groups Task Force–Software with the mandate to define "the world of software practice and standards of practice, and determine if there are areas that are amenable to licensing or certification for

the benefit of society." And, "At the request of Council, the work of the EDTG continues to examine the degree of market readiness for standards of software practice, licensure and/or certification of software practitioners." PEO's hard work on software engineering is ongoing, as can be seen from the *Briefing Report on Software Practice* by the External Groups Task Force–Software, May 19, 2004 (www.peo.on.ca/enforcement/Software_Briefing_Paper2004.pdf), and from a roundtable discussion sponsored by PEO and CIPS on "The Role of Standards, Certification and Licensing in Software Practice," held on May 4, 2005 (www.peo.on.ca/registrar/RegistrarsReport/RR_May27_2005.pdf and news item, p. 21).

Challenges ahead

What are the new emerging areas? Are we able to promptly identify them and to protect the public in a timely manner? What are the challenges ahead?

PEO is closely following some emerging areas, such as nanotechnology, for which there are Canadian university programs, even if they are not yet accredited. The University of Toronto has established a nanoengineering option in its engineering science program. Meanwhile, the University of Waterloo has launched a bachelor of science program in nanotechnology engineering, with the first batch of students to begin studies in the fall of 2005. Nanotechnology is discussed often in the pages of *Engineering Dimensions*. If a task group has not been formed, it is highly likely that action will be taken soon.

Other areas have not yet attracted PEO's attention. For instance, "knowledge engineering" does not yet seem to be on PEO's radar screen. Maybe it should be so because, despite the large number of scholarly journals and conferences on knowledge engineering, this discipline and area of practice could be just a subdomain of software engineering. However, knowledge engineering may branch on its own, just as software engineering was a spin-off of computer engineering, which itself was a spin-off of electrical/electronics engineering.

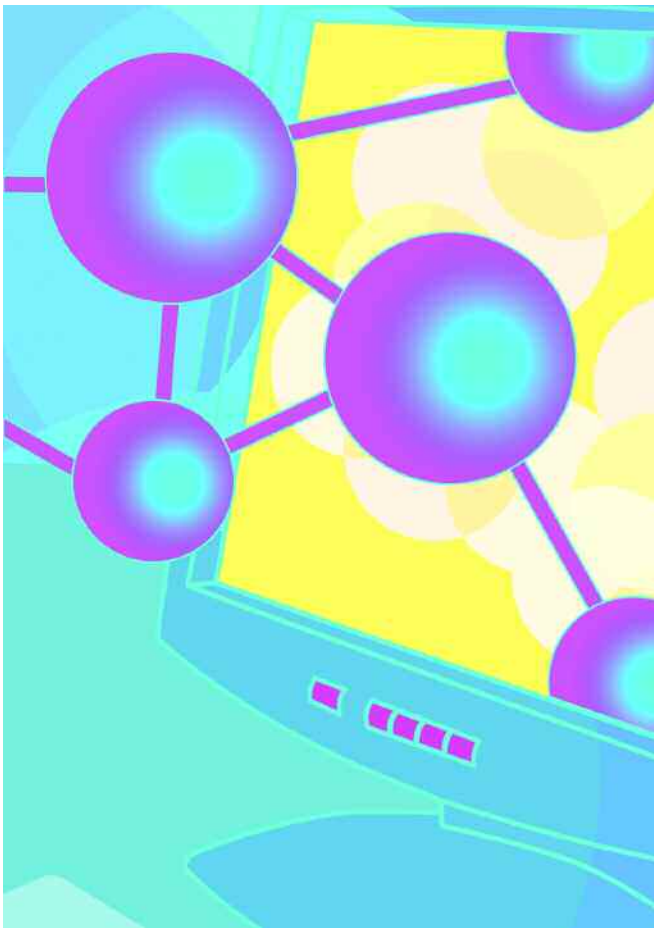
It could be that knowledge engineering is taking shape somewhere else. For instance, the University of Bristol in the U.K. lists three programs in this area: M.Eng. in knowledge engineering, B.Eng. in knowledge engineering, and M.Eng. in knowledge engineering with study abroad. Paraphrasing Perry J. Greenbaum once again, you could ask, is knowledge engineering really engineering? And, assuming that knowledge engineering has an engineering component, where do engineers fit within its practice, and what are the required education, training and standards for licensing in the public interest? I will not attempt to provide an answer. The same argument could hold for many types of engineering. Applying the five-step process (discovery, identification, definition, evaluation and legislation) suggested by the EDTG in 2002 (pp. 61-62), PEO can take care of all emerging areas of technology as they come along, at the most appropriate time.

Public protection at issue

Are there new challenges regarding protection of the public in the presence of emerging areas of technology? Yes, the emerging areas are much more affected than traditional types of engineering by the business practice of outsourcing, especially regarding the particular type of outsourcing called "offshoring," which is outsourcing to entities offshore. More and more, the product of an engineer's work travels on the Internet, as either email, an email attachment, or as data uploaded or downloaded to or from a server. This is true in all types of engineering, but much more with the emerging areas, born after the Internet became pervasive.

From PEO's point of view, outsourcing and offshoring are just business practices and, as such, are not part of the domain of what PEO can regulate, monitor, control, and intervene on. If outsourcing and offshoring make business sense, they will survive, thrive, and become standard business practice.

Outsourcing and offshoring have been part of the reality of the electrical, electronics, computer and software engineering professions for at least 25 years. The client is often a manufacturer that may or may not have professional engineers on staff. Often, the business behind an electronic product is a marketing organization, outsourcing (often offshoring) engineering, both as R&D and as detailed design and manufacturing. This business chooses contractors and suppliers. The design of these products is within the domain of professional engineering. Some of these products, when improperly designed and/or manufactured, have caused fires, with consequent loss of life and loss of wealth, and others have contributed to diseases such as cancer. The product of the work of professional engineers in these areas comprises files representing calculations, drawings, schematics, software source code, and photo tools (i.e. printed circuit board artwork, etc.). Whenever involved within the context of the business realities of outsourcing and offshoring, professional engineers must fulfill their duty to protect the public, as they are always expected to do.

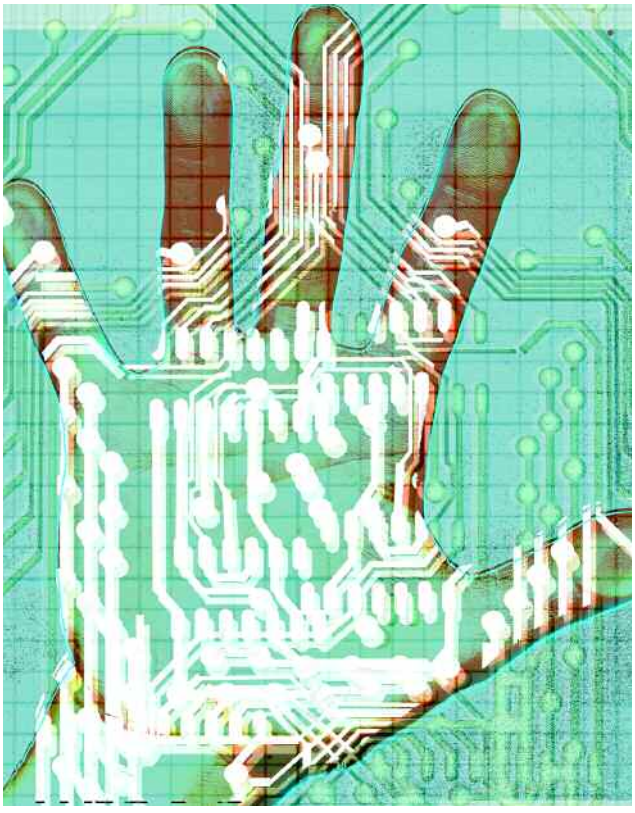


My experience is that almost all professional engineers in electrical, electronics, computer and software engineering do a good job of protecting the public, despite the geographically distributed nature of the overall engineering team. This is probably due to the fact that the job is always organized in the same way, regardless of where the members of a design team are located. This may not apply to other types of engineering work, as argued by Nigel Histon, P.Eng., in his article "Proceed with caution: outsourcing engineering services abroad" (*Engineering Dimensions*, November/December 2003, pp. 44-45).

What can be done to protect the public in these circumstances? Engineers should not take positions that are or could be perceived to be protectionist and self-serving. Corporations and employers will always go for the lowest cost. Any attempt to invoke "our advanced knowledge" is greeted with ridicule. If involved at all, we must do our job as we would do it if the other engineers or team members were located in Canada. If pressures exist to rubber-stamp somebody else's work, there is no difference between the case in which this pressure exists for work done in Canada or overseas. We know (or should know) how to deal with this situation.

As I suggested in my article "Exclusive scope of practice in non-traditional disciplines" (*Engineering Dimensions*, March/April 2004, pp. 50-51, 58), PEO can help professional engineers protect the public when outsourcing and offshoring by applying recommendations three and four of the five-step process recommended by the EDTG[1]. That is, identifying areas of exclusive practice for new engineering disciplines and working with government to secure appropriate demand-side legislation, and implementing enforcement processes in relation to the new disciplines. Indeed, in the newer, non-traditional areas we are still in the pre-1937 era. The public and the provincial government have not yet realized the magnitude of loss of life and wealth that can come from the failure of poorly engineered systems.

Proposals to establish new exclusive scopes of practice should not be perceived to be protectionist. In fact, this exclusive scope of practice could apply to foreign engineers living abroad but duly licensed. The process is already advanced within the medical profession and medical services in the United States. A popular offering is medical transcription, in which companies convert dictation by doctors in the U.S. into written medical records. It is estimated that India has about 200 medical transcription firms employing thousands of transcribers ("Back office to the world," *The Economist*, May 3, 2001). We also read about Indian doctors who provide remote diagnosis of patients, and where some U.S. states accept foreign licences while others require that the foreign doctor acquire a U.S. licence before moving abroad. Maybe this approach is applicable to professional engineering services.



I am of the opinion that matters of exclusive scope of practice, demand-side legislation, outsourcing and offshoring, will surface often in the near future with regard to new areas of engineering.

Under the *Professional Engineers Act*, PEO is responsible for protecting the public by various means, including licensing and disciplining engineers and companies practising professional engineering. PEO has always done this extremely well and protection of the public continues to be PEO's raison d'être. With the Task Group on Emerging Engineering and Multidisciplinary Groups, the Engineering Disciplines Task Group, the Ontario Software Engineering Task Force, and the External Groups Task Force, PEO has extended protection of the public to software engineering and bioengineering, testing a process that is easily applicable to other new areas of engineering. Volunteer engineers have always given generously of their time to serve on PEO committees and will continue to do so, when needed, to evaluate new engineering disciplines.

Some qualified volunteers will be needed to help draft new professional practice guidelines, which may be needed because of specific characteristics of the practice of new engineering disciplines. Communication between the engineering profession and the public will be an important part of the work ahead, so that engineering may be the "visible profession" in the 21st century.

BRUNO DI STEFANO IS PRESIDENT OF NUPTEK SYSTEMS LTD., AN ENGINEERING COMPANY SPECIALIZING IN REAL-TIME EMBEDDED SYSTEMS, FUZZY LOGIC, OOA/OOD, C AND C++. HE HAS PUBLISHED SEVERAL PAPERS IN HIS AREA OF EXPERTISE. HE IS ACTIVE IN PEO AND IEEE.

References

1. Bruno N. Di Stefano, "Engineering Disciplines Task Force (EDTG)–Final Report, 2002.