Environmental scan for the Engineers Canada Strategic Plan 2022-2024

Questions concerning the content of this report should be directed to:

Gerard McDonald, MBA, P.Eng.
Chief Executive Officer
Engineers Canada
gerard@mcdonald@engineerscanada.ca
613.232.2474 Ext. 212

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About the environmental scan

Engineers Canada has undertaken the development of its upcoming 2022-2024 strategic plan. To inform decision-making, an assessment of current and anticipated political, economic, legal, environmental, and technological factors that will have an impact on the engineering regulators, Engineers Canada, and the profession, is presented. In summer 2020, an addendum was inserted to this document to reflect potential, new strategic context.

The methodology used to generate this scan was a literature review of internal and external reports, articles, regulator strategic plans, as well as minutes from national meetings.[1] Before finalizing the main document, feedback was sought from the Canadian Engineering Accreditation Board (CEAB), the Canadian Engineering Qualifications Board (CEQB), the Chief Executive Officers Group (CEO Group), and Engineering Deans Canada (EDC).

About Engineers Canada

When considering major trends, Engineers Canada needs a focused approach that aligns with its purposes[2] to:

1. Accredit undergraduate engineering programs.
2. Facilitate working relationships between the regulators.
3. Provide services and tools that enable the assessment of engineering qualifications, foster excellence in engineering practice and regulation, and facilitate mobility of practitioners within Canada.
4. Offer national programs.
5. Advocate to the federal government.
6. Actively monitor, research, and advise on changes and advances that impact the Canadian regulatory environment and the engineering profession.
7. Manage risks and opportunities associated with mobility of work and practitioners internationally.
8. Foster recognition of the value and contribution of the profession to society and spark interest in the next generation of professionals.
9. Promote diversity and inclusivity in the profession that reflects Canadian society.
10. Protect any word(s), mark, design, slogan, or logo, or any literary, or other work, as the case may be, pertaining to the engineering profession or to its objects.

Major current and future trends

The following section presents major trends that impact, or will likely impact, the engineering regulators, Engineers Canada, and the profession. The trends are discussed thematically, and their order should not be considered to reflect their priority.

Reviews of regulatory practices

Recent government and self-commissioned audit reports conducted by independent, third-party experts highlight the need for the profession to adopt governance, admission, discipline and enforcement, and practice changes[3] to further demonstrate how engineering regulators protect public interest. Principal recommendations include, but are not restricted to, the following:

- **Change in governance structure:** Concerns have been raised that the lack of public representation on some councils and their sub-committees does not demonstrate how the engineering profession responds, and keeps itself accountable, to the public's concerns as "elected volunteers are accountable to their electorate, not the public"[4] Reports also unveiled how difficult it can be for regulators to implement fee changes when the members under regulation retain the authority to vote against any adjustments, which can negatively impact regulators' revenues and abilities to fulfill their regulatory roles. In British Columbia, an overarching Office of the Superintendent of Professional Governance was recently implemented to provide additional oversight on various professional regulators within a single jurisdiction[5], which is a model similar to that used in Quebec.[6] Other self-regulated bodies are facing similar challenges[7].
- **Transition from membership services to a regulatory focus:** Changes to admission, practice, and discipline and enforcement decision-making processes were recommended.[8] Another area of concern was terminology associated with membership and not licensure (such as non-practising individuals having a title sometimes including "engineering," or "lifetime memberships") which can be confusing to the public S[9]. Several regulators are taking steps to change members designations to reduce potential confusion for the public[10].
- **Decrease reliance on volunteer committees:** Concerns have been expressed that the high number of committees is inefficient as it is costly and slows down decision-making. Meanwhile, volunteers making strategic and operational decisions can negatively impact the ability of staff to perform their regulatory role[11].
- **Use of risk-based* approach to manage processes:** Given limited resources, addressing concerns about over-regulation, and the need to communicate decisions transparently, regulators are encouraged to define risk categories to determine the level of scrutiny that admission and discipline and enforcement cases should be subjected to and allocate financial and human resources accordingly[12].
- **Increased transparency in decision-making:** Regulators are encouraged to demonstrate increased transparency by providing additional information to the public on discipline decisions, licensee lists, and admission criteria, including replacing the one-year Canadian environment experience requirement with competencies[13] and other alternatives[14].

* Also referred to as "confidence-based" or "right touch" approach.

- **Modernized IT systems and information management practices –** Regulators manage a substantial amount of personal information, often in a paper-based format. As regulators continue to transition from paper-based systems to electronic records, clear policies, with up-to-date IT systems, are desirable to optimize processes and minimize the risk of a security breach. Technological advancements might also increase regulators' susceptibility to cyberattacks due to the large amount of personal information for which they are responsible.[15]

The adoption of consistent requirements and processes are desirable to optimize inter-provincial mobility[16].

Erosion of the definition and regulation of engineering

At the national level, the definition of the practice of engineering means:

> …any act of planning, designing, composing, evaluating, advising, reporting, directing or supervising, or managing any of the foregoing, that requires the application of engineering principles and that concerns the safeguarding of life, health, property, economic interests, the public welfare or the environment.[17]

This definition varies across jurisdictions, depending on their respective acts. It is applied on a case-by-case basis, except for when there are national documents that define certain areas of practice,[18] or through the scope of practice of limited licenses.[19]

Issues arise when other professions seek the right to practice in areas that may fall under the national definition of engineering, as it is broadly defined. The definition also makes it difficult for the public and governments to understand under what circumstances they must hire an engineer and how the self-regulation of engineering protects the public interest. Jurisdiction-specific regulation of engineering, and what constitutes engineering, is also increasingly challenged by the globalization of markets, with production and labour forces (including the offshoring of engineering) more mobile than ever.[20]

Increased scrutiny and need to demonstrate the value of self-regulation

The purpose of self-regulation is to protect the public from a system that otherwise would pose a risk to them.[21] Despite this, "most regulators cannot demonstrate how their work makes a difference or enhances the situation of members or the public."[22]

In some provinces, specific bodies are mandated to oversee a number of self-regulated professions,[23] or to assess the fairness of regulatory practices (including engineering) and provide recommendations to their governments.[24] Unilateral changes from the governments, such as the recent move of the Government of Alberta government to force regulators to make an interim registration decision in respect within 6 months after receiving the application,[25] can increase pressure on regulators' processes. Court cases, such as Association of Professional Engineers and Geoscientists Alberta V. Ladislav Mihaly and the Alberta Human Rights Commission[26] could potentially challenge regulators. OIQ proactively set targets for admission timeframe (8 months) and licensure success rates (75%) for internationally trained applicants[27]. The burden of proof lies on regulators to justify standards,[28] not only compared with other engineering regulators, but also with other self-regulated professions. To the

extent possible, consistency across the country contributes toward legal defensibility and justification of regulators' processes and standards to their provincial/territorial governments.

Failures of practice or ethics involving engineers have increased media and public scrutiny on engineering regulators' ability to protect and serve the public.[29] Such failures, as well as public enquiries, including the Commission Charbonneau and Elliott Lake Enquiry[30], negatively impact the public's perception of engineers and self-regulation,[31] and trust and favourability ratings are below that of other professions such as nurses, doctors, and dentists.[32] Negative public perception is exacerbated by a fast-moving media environment with a global reach. Regulators challenged by preventing misconduct and moving swiftly on allegations, while having to follow due diligence and ensure that procedural fairness is respected.

Market drivers

Self-regulation creates a market barrier that theoretically results in higher costs for engineering products and services.[33] Only approximately 35 per cent of employed individuals in Canada who held a bachelor's degree in engineering or higher were working as engineers or engineering managers in 2011.[34]

While no national data was found, research shows that in Ontario, those with engineering degrees earned 15 per cent more than those without in 2011. It is anticipated that in Ontario, between 2015 to 2025, there will be 69,600 engineering graduates, and 29,900 engineering graduates coming from other provinces or countries. During that period, the provincial labour market will absorb 52,300 engineers, leaving the remainder 47,200 to work in non-engineering jobs.[35]

Also, in some instances, procurement policies are putting pressure on both governments and organizations to seek lowest-cost engineering solutions and to encourage public private partnerships. Engineers are accountable for abiding by their code of ethics and not recommending solutions that do not meet technical requirements or their broader professional obligations. It is in the interest of governments to use qualifications-based selection policies and processes for procuring engineering works to generate real savings in construction, operations, and maintenance, as well as to optimize public safety and ensure a high quality of life through reliable and effective service.[36] Governmental budget pressures have also driven the adoption of some demand-side legislation,[37] which defines overlapping areas of engineering work with other professions.

Factors impacting the long-term diversity and sustainability of the profession

The Canadian population is aging. Between 1921 and 2013, the median age of the Canadian population increased from 23.9 to 40.2 years.[38] By 2055, it is projected that 25 per cent of the population will be 65 years or older compared to 17 per cent in 2018. This reduced labour supply for the overall Canadian market is expected to negatively impact economic growth.[39] Also, across all sectors of employment, younger Canadians face a different labour market reality.[40] While achieving higher levels of education than previous generations, younger Canadians earn lower wages, and have delayed full-time employment.[41] These differences can impact their ability and/or willingness to seek licensure as an engineer.[42]

The proportion of CEAB graduates becoming licensed is decreasing.[43] Undergraduate student enrolment in accredited engineering programs totalled 82,480 in 2017, which is similar to 2016 but represents a 14.4 per cent decrease from 2013. The proportion of final year students who indicated that they definitely will be applying to their provincial regulator declined from 50 per cent in 2016 to 44 per cent in 2017, which is the lowest proportion over the past five years. The main reasons cited for not applying include that "they do not need it to work in their field" (30 per cent), they "plan on applying in a different province than they studied in" (26 per cent), and that they are "unsure/will not work in the field" (9 per cent).[44]

The engineering profession in Canada can better serve the public interest if it is representative of the Canadian population. This means engaging and attracting the best talent from all parts of society. This adds value to employers, increases innovation, and enables engineers to have a better chance of understanding the diversity of societal needs that exist across the country.

The recruitment, retention, and the professional development of women in the engineering profession was identified as a top priority for Engineers Canada in the 2019-2021 strategic plan.[45] In 2006, the percentage of engineers who were women was 12 per cent compared to 14 per cent in 2019.[46] Also, women account for 20.7 per cent of total undergraduate engineering enrolment; 20.6 per cent of undergraduate engineering degrees were presented to women.[47] In 2017, 17.9 per cent of newly licensed engineers were women. At the current growth rate, projections are that the engineering profession will not reach 30 per cent of newly licensed engineers being women by 2030.[48] Key barriers for women remain lack of awareness, fewer opportunities in the profession, the absence of role models, insufficient mentorship and sponsorship opportunities, and a scarcity of support networks. Data shows that post-secondary and workplace cultures are also a contributing factor.[49] While large businesses often have resources dedicated to diversity and inclusion practices, small- to medium-sized companies may need support to improve their practices.[50]

Another key diversity area of focus at the national level is the recruitment and retention of Indigenous peoples. While the overall Canadian population is aging, the Indigenous population is the youngest and fastest growing segment.[51] Indigenous peoples make up more than 4.9 per cent of the Canadian population, [52] and yet in 2016, Indigenous individuals represented 2.8 per cent of the total number of engineers and engineering technologists in Canada.[53] They also account for only 1.2 per cent of total undergraduate enrolment, and only 1.2 per cent of undergraduate engineering degrees were presented to Indigenous people.[54] Some regulators and other professions have taken action to address the Truth and Reconciliation Commission's calls to action, which attempt to address the engagement of Indigenous communities as well as inclusion practices that will attract and retain Indigenous professionals.[55]

Newcomers will be needed to compensate for the attrition associated with an aging population. Immigration will be necessary to maintain economic growth as it accounts for net labour force increase in Canada.[56] The overall number of highly skilled newcomers is expected to continue increasing.[57] International engineering graduates continue to face challenges when seeking an engineering license, especially with respect to the one year of Canadian environment experience requirement.[58] In Ontario

in 2011, "21.2 per cent of internationally trained engineers were working in their field of study, compared to 38.3 per cent of those with Canadian degrees."[59]

Pressure on the CEAB accreditation system

Among several criteria, the CEAB requires accredited programs to demonstrate that they meet:

- **Minimum curriculum content requirements:** These are primarily measured in accreditation units (AUs), defined as hourly activity that corresponds to the contact time between a student and a faculty member. The total number of required AUs is 1,950. There is also a requirement to meet a certain number of AUs within and across the categories of math, natural sciences, complementary studies, engineering science, and engineering design.[60]
- **Outcome-based requirements:** Graduate attributes (GAs) are 12 qualities a program is expected to instill in its graduates.[61] Evaluation of graduate attributes is more recent, as CEAB criteria were amended to include graduate attribute criteria and continual improvement criteria in 2008. A transition and development period was allowed such that no deficiencies were assessed under those criteria until 2015.[62] GAs are part of Canada's obligations under the Washington Accord[63] and similar outcomes-based measures will be or are being required by some provincial governments when allocating funding to higher education institutions (HEIs).[64]

There is pressure on the CEAB to reconsider the number of AUs, as there is a perception by some that higher AUs create high workload for both the HEI staff working to achieve or maintain accreditation, and for students, possibly contributing to mental health issues for them.[65] Internal issues at HEIs, such as a reluctance to remove content when new requirements arise, as well as concerns over the possibility of negative accreditation findings, have led to some HEIs including more AUs than necessary to ensure they meet the accreditation requirements. This also presents a barrier to entry into engineering, as the perceived high workload can deter individuals from pursuing an engineering education.[66] The fact that AUs are defined on an hourly basis for an activity that corresponds to the actual contact time between the student and faculty members[67] is a barrier to some HEIs from offering more innovative and diverse educational methodologies that encourage student-centred learning.

There is a perception that the AU definition does not allow for distance learning or innovative teaching methods.[68] It also can delay graduation for students who choose to study abroad. Some HEIs have seen a decrease in government funding and are increasingly relying on international tuition fees as a proportion of revenues.[69] The AU methodology can negatively impact foreign educated students transferring mid-program. The CEAB is currently looking into offering an alternative to AUs, currently called learning units (LUs).[70]

While there is a certain link between graduate attributes and the competencies embedded in the pan-Canadian competency framework,[71] the first measure is for programs, and the latter for individuals. A best practice is for education and experience to become increasingly intertwined.[72] Moving to LUs might help strengthen the link of CEAB program education to competencies.[73] A study has demonstrated that "for the six smaller population provinces… increases in undergraduate engineering enrolment are positively associated with GDP growth, productivity growth, and total factor productivity (innovation),

suggesting that faculties or schools of engineering are a source of knowledge spillovers that compensate for the lack of scale economies from agglomeration in the region."[74]

Pressure on assessment of non-CEAB applicants

The Washington Accord recognizes accreditation systems, CEAB accredits programs, and regulators individually assess education of non-CEAB applicants.[75] If immigration continues to increase, some regulators will be pressured to increase resources to process applications under tight timelines.[76]

Some international agreements signed by Engineers Canada on behalf of the regulators pertain solely to the recognition of academics while others also include recognizing professional competence;[77] this includes the Engineers Canada Mobility Register.[78] While Engineers Canada is the signatory to such international agreements, it is at the discretion of regulators to implement them or not. Concerns have been expressed that the increasing number of Washington Accord country members is eroding the trust of regulators in recognizing applicants' educational credentials, given regulators' lack of information on these new accreditation systems in comparison to the Canadian model[79].

To validate that the institution and the transcript of international engineering graduates are legitimate, six regulators use third-party credential evaluation services such as World Education Service (WES).[80] Also, seven regulators use the Engineers Canada International Institutions and Degrees Database (IIDD) to seek information on the programs and degrees offered by non-CEAB accredited institutions, as well as information on other countries' education system.

While the upcoming *Regulator Guideline on the Use of Syllabi* reduces the gap between CEAB and non-CEAB applicants, some differences remain. The CEAB does not prescribe discipline-specific content to its programs (beyond the categories of math, natural sciences, complementary studies, engineering science, and engineering design), while the non-CEAB syllabi used for individual applicants list compulsory and optional examinations[81] for its 20+ disciplines. While CEAB programs must demonstrate that they include at least 225 AUs of engineering design,[82] regulators cannot assess academic experience in engineering design to the same extent for non-CEAB applicants and instead do it through the technical competency component of experience assessment and reviewers do not ensure that the content was taught the result of contact hours and not online courses.[83] Several regulators are offering the Fundamentals of Engineering (FE) exam as an alternative examination for applicants that demonstrate a certain level of education content threshold, but the number of types of exams is limited to seven (including an "other discipline" category).[84]

Non-CEAB applicants continue facing challenges when applying to join the engineering profession, including varying admission requirements and tools between provincial and territorial jurisdictions[85].

Engineers' role in supporting long-term environmental stewardship

The United Nations have defined goals for a better future,[86] including priorities such as clean water and sanitation, sustainable cities and communities, climate action, industry, innovation and infrastructure, quality of education, and affordable and clean energy.[87] They can be achieved through building resiliency, reducing greenhouse gas emissions, and optimizing energy efficiency.[88] Engineers can

contribute and are entrusted by the public to help solve these issues[89] and through their codes of ethics are bound to "hold paramount the safety, health and welfare of the public and the protection of the environment…"[90] As part of their corporate social responsibility, organizations expected to balance social, environmental and financial considerations (triple bottom line)[91].

Technology trends

Artificial Intelligence (AI), the Internet of Things (IoT), and advanced data analytics are reshaping industries at unprecedented speed.[92] Change in technology is contributing to the development of emerging engineering disciplines and broadens responsibilities for engineers as demonstrated in the Boeing 737 Max Safety System incident[93]. This new paradigm challenges the existing licensure model that requires an experienced engineer to take responsibility for the engineering work in order to meet legal requirements, and for an applicant to count time toward meeting the experience requirement for licensure.[94] Emerging areas can create new engineering disciplines, for which there may not be a core group of engineers to promote licensure, mentor upcoming licensees, and look out for discipline and enforcement issues.

Pressure to foster innovation in technological sectors can cause governments to question the value of engineering self-regulation. The rise of autonomous systems will also enable engineers and engineering businesses to automate new processes[95] and engineers operating within this context will need to understand that they are also accountable to the public for the impact of their designs especially when these systems are performing tasks and making decisions that require the application of judgement that would previously have involved engineers.[96]

Long term funding of Engineers Canada

Presently, approximately 70 per cent of Engineers Canada's revenues derive from sponsorship payments received for administering and supporting group insurance programs (e.g. home and auto, life, health and dental) which are made available to professional engineers throughout the country. These revenues are shared with participating regulators. Certain regulators have expressed concern that the unimpeded growth of Engineers Canada's revenue from the sponsorship payments is diminishing the regulator's contribution to, and influence over, the national body. They see this leading to distortion in many expenditure decisions and a belief that the funding model is inherently broken. Recently, APEGA decided to leave the TD Insurance home and auto affinity program which will lead to downward pressure on Engineers Canada's revenues. In addition, this move may create an unhealthy environment in which Engineers Canada will compete against a regulator for insurance business in that jurisdiction.[97]

Conclusion

This environmental scan presents major current and future trends that are having or could have a significant impact on the engineering regulators, Engineers Canada, and the profession as well as the engineering regulators and profession. It will inform the development of the 2022-2024 Strategic Plan.

Addendum: New COVID-19 strategic context

After the publication of this environmental scan, the COVID-19 pandemic has upended governments and societies across the globe. While the ramifications of this pandemic are still reverberating and yet to be fully assessed, the potential impacts should be considered in the upcoming 2022-2024 strategic plan. It is expected that travel restrictions, physical distancing requirements, and other public health measures could potentially raise expectations for reviews of regulatory practices, negatively impact long-term sustainability and diversity of the profession, increase pressure on changes to the CEAB accreditation system and affect long-term funding of Engineers Canada. This section of the document highlights potential trends for consideration in the planning process.

Reviews of regulatory practices

Throughout the pandemic, only online exams were administered[98] causing delays to admission processes. The Ontario Superior Court of Justice ruled in *Association of Professional Engineers v. Paul Douglas Rew* that video conferencing for a hearing could proceed.[99] APEGA has lowered continuing professional development (CPD) annual requirement from 80 professional development hours (PDH) to 30, and from three categories to one category for one CPD reporting period.[100]

Factors impacting the long-term diversity and sustainability of the profession

COVID-19 disproportionally impacts groups that were already disadvantaged prior to the pandemic.[101] Women are further disadvantaged by their disproportionate role caring for children, parents, and other family members.[102] Women in skilled trades are more likely to be negatively impacted than men.[103] The situation also disproportionally affects businesses owned by women, Indigenous peoples, visible minorities, immigrants, and people with disabilities.[104] Meanwhile, physical distancing measures have challenged the traditional delivery of outreach activities and events to reach out stakeholders and partners.

Pressure on the CEAB accreditation system

Several higher education institutions (HEIs) have announced that in the fall of 2020 they will deliver their courses fully online or with a mix of in-person and online delivery.[105] In addition, fully remote or a mix of remote and in-person accreditation visits is a possible long-term option.[106]

Long term funding of Engineers Canada

Although the extent has yet to be determined, the economic impact of the pandemic is expected to reduce the number of license holders and participants in Engineers Canada's affinity programs.[107]

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