

ASSURING COMPETENCE IN THE CANADIAN ENGINEERING PROFESSION

**A report of the
Canadian Academy of Engineering**



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The mission of the Canadian Academy of Engineering is to enhance, through the application and adaptation of science and engineering principles, the promotion of well-being and the creation of wealth in Canada.

The Academy fulfills this mission by:

- promoting increased awareness of the role of engineering in society,
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- advising on engineering education, research, development and innovation,
- promoting industrial competitiveness while preserving the environment in Canada and abroad,
- speaking out on issues relevant to engineering in Canada and abroad,
- developing and maintaining effective relations with other professional engineering organizations, academies and learned societies in Canada, and abroad.

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EXECUTIVE SUMMARY

This report continues the Academy's examination of areas where the Canadian engineering profession could evolve over the next decade, to enhance its stature and its service to the public. It explores some of the issues of assuring the public that professional engineers in Canada continue to acquire, retain and enhance the competences that are required, in adequately fulfilling the evolving roles that they are called on to address in current society.

The report has been produced primarily to assist in discussion and to stimulate action by professional engineers in Canada – and particularly by the councils and committees of their provincial and territorial Associations of Professional Engineers/Ordre des ingénieurs (Associations), and their coordinating agency, the Canadian Council of Professional Engineers (CCPE). A secondary objective is providing the public with the views of the Academy on this important matter.

The Academy recommends:

- 1 That CCPE undertake a comprehensive review of its accreditation criteria in response to the broadening recommendations of the Education report of the Academy, the changing requirements of several engineering disciplines, and the evolving needs of the profession.
- 2 That Associations review their criteria for entry into the engineering profession, and consider adopting enhanced requirements for Engineers in Training, to include continuing education, evidence of independent learning, mentorship, and more stringent supervision of experience.
- 3 That the Associations, coordinated through CCPE, negotiate common requirements for admission to the engineering profession in Canada.
- 4 That the Associations, coordinated through CCPE, negotiate acceptable national standards for acquisition and reporting of evidence of continuing competence for all Canadian professional engineers.
- 5 That employers be encouraged to provide their professional engineering employees with adequate opportunity and resources, to maintain and enhance their professional competence.

ASSURING COMPETENCE IN THE CANADIAN ENGINEERING PROFESSION

INTRODUCTION

The Canadian Academy of Engineering has issued a number of reports relating to desired developments within the Canadian engineering profession. The wealth creation role was explored in *Wealth through Technological Entrepreneurship (1)*. Recommendations on the educational preparation of engineers were made in its report *Evolution of Engineering Education in Canada (2)*. Best practices for maintenance of continued competence were presented in *Lifelong Learning for Professional Engineers (3)*. (The Academy's most recent report in this area was *Protecting the Public and the Environment – A Responsibility of Canadian Professional Engineers (4)*).

This present report continues the examination of areas where the engineering profession could evolve over the next decade to enhance its stature and its service to the public. It explores some of the issues of assuring the public that professional engineers in Canada continue to acquire, retain and enhance the competences that are required in adequately fulfilling the evolving roles that they are called on to address in current society.

The report has been produced primarily to assist in discussions and to stimulate action by engineers in Canada – and particularly by the councils and committees of their provincial and territorial Associations of Professional Engineers/Ordre des ingénieurs du Québec (Associations) and their coordinating agency, the Canadian Council of Professional Engineers (CCPE). A secondary objective is providing the public with the views of the Academy on this important matter.

Through the Engineering Acts of the provincial and territorial legislatures, the Associations are responsible for establishing and administering appropriate standards for entry to the engineering profession, for continuity of registration, for discipline and for enforcement. The assurance of competence for a professional engineer currently requires, first, an adequate fundamental grounding provided by the formal education phase. Next, it requires a period of internship, usually four years, to acquire a basis of practical engineering experience. Finally, it requires the maintenance of continued competence throughout the professional career.

In many respects this report by the Academy supports the principles and current practices of the profession as presented in various CCPE Guidelines. It is also recognized that many of the issues raised are currently under consideration by CCPE and its constituents, see *Meeting the Challenge of Continuing Relevance for the Engineering Profession (5)*.

In brief, the Academy recommends that the professional engineering Associations, coordinated through CCPE, proceed to:

- review the criteria for accreditation of undergraduate engineering programs, to better reflect trends in the evolution of current engineering education
- review the requirements for entry to the profession, giving greater emphasis and structure in Engineering Internship Programs, preferably with common national standards
- review the requirements for maintenance of competence, giving particular attention to common national standards and mobility.

ACCREDITATION

A first requirement for registration as a professional engineer is graduation from a Canadian university in an accredited engineering program or the presentation of equivalent recognized educational qualifications. The Associations, through their cooperation in CCPE, established in 1965 an excellent system of accreditation for programs in undergraduate engineering education in Canada. Criteria are set by the Associations cooperatively through CCPE and administered by its Canadian Engineering Accreditation Board (CEAB). Graduation from an accredited engineering program has been accepted by all the provincial and territorial Associations as fulfilling the academic requirements for licensing.

A major effect of this system has been the establishment of a high minimum standard of quality and content for all engineering graduates throughout the country. Since the inauguration of CEAB, essentially every degree program in engineering in Canada has sought accreditation and achieved it, sometimes following changes required by CEAB. In practice, unaccredited programs do not survive.

The current CEAB criteria specify the minimum content for each program in mathematics, basic sciences, engineering sciences and engineering design, and also in complementary studies, a category which must include engineering economics, the impact of technology on society, issues in the humanities and social sciences, and oral and written communications.

Generally, employers in Canada have expressed satisfaction with the technical capabilities of current engineering graduates. However, they are much less content with the skills in certain non-technical areas such as communication ability, economics, leadership, teamwork and management. Selection of engineering students with potential in these areas, and broadening their undergraduate education, are seen by these employers as highly desirable and possibly necessary steps in producing the scope, sensitivity and judgment that

they now deemed to be needed. At the same time, the formal undergraduate education phase must continue to provide a sound foundation for the ever-widening range of technical specialties that the graduate will encounter.

The proposals in the Academy report on the *Evolution of Engineering Education in Canada (2)* included broadening the student's undergraduate experience through increased emphasis on these non-technical areas. Also, that report called for better integration of these areas into design-oriented curricula, and increased emphasis on learning to learn.

Program Length: If these revised objectives are to be achieved, there must of necessity be some reduction in the technical content of the current "4-year" curriculum or an increase in the length of time spent in formal education. The Academy considers that the current time in formal residential education can continue to be adequate provided that students acquire the skills of independent learning which will prepare them for a world of rapidly evolving technology. Postponement of some specialized technical content until after graduation is deemed to be an acceptable tradeoff to achieve the range of skills needed in a modern graduating student.

Flexibility: With the expansion in the range of engineering application and the introduction of the newer information and biology-related engineering disciplines, a review of technical content requirements for accreditation seems necessary. Greater flexibility may be needed in the specification of what basic technical content is necessary for each discipline. Also, emphasis can be somewhat shifted from the specification and measurement of input content to the measurement of design achievements and acquired attributes such as skills in problem solving, organization of projects, work groups and tasks, communications, interpersonal relations and leadership, together with sensitivity to public welfare concerns.

Teaching as Engineering Practice: The increased emphasis on design and application in engineering curricula adds to the argument that the teaching of these engineering subjects be considered as a practice of engineering, requiring the teachers of engineering subjects to be licensed professional engineers

Recommendation 1: That CCPE undertake a comprehensive review of its accreditation criteria in response to the broadening recommendations of the Education report of the Academy, the changing requirements of several engineering disciplines, and the evolving needs of the profession.

The Academy would be pleased to participate in this review if deemed appropriate.

ADMISSION TO THE PROFESSION

Engineering education is currently faced with a variety of trends: the expanded range of engineering disciplines, the proposed broadening of the curricula, the desire of students for greater diversity and choice, and the accommodation of joint or dual degree programs that are planned at several Canadian universities linking engineering to arts, humanities, business, medicine or education. In view of these trends, the Associations, coordinated through CCPE, should consider whether the academic requirements for entry to the engineering profession can continue to be fulfilled adequately by the undergraduate engineering program, or should further postgraduate education be required?

The engineering profession is somewhat unusual in requiring only a bachelor's degree as the academic component for registration. Several other professions such as library science, social work, business administration and health administration typically require a master's degree, frequently of a two-year duration, following a bachelor's degree. Some may argue for a system of defined post-graduate specialties within the engineering profession similar to the range of specialties provided in the medical profession. However, the range of specialties and activities in engineering is so broad, and is broadening at such a rate, that this approach is deemed to be impractical. While a number of engineering graduates will acquire Master's and Doctorate degrees, such formal degrees are not considered necessary as a preparation for licensing.

Currently, the Associations require evidence of acceptable experience and the passing of formal examinations in ethics and professional practice prior to registration. With the broadened nature of undergraduate engineering education, the extended range of engineering activity and disciplines, the increased complexity of public welfare issues and the proposed increase in acceptance of responsibility by engineers (4), these requirements need to be reviewed and strengthened.

A comprehensive technical entry examination is held for engineers in the United States, and is normal for professions such as medicine, chartered accountancy and law. Technical entry examinations are feasible when the areas of required specialist knowledge are well defined. However, engineering with its many diverse disciplines and its wide variety of employers does not lend itself well to such restrictive requirements. To compensate for a probable reduction in the technical content of undergraduate education and to ensure adequacy of preparation for professional practice, consideration should be given to requiring evidence of adequate and relevant continued learning during the four-year experience period prior to registration. This follows directly from the proposed undergraduate emphasis on learning to learn. In addition to augmenting competence, it would promote the establishment of a firm habit of lifelong learning which must characterize the profession.

Formal courses could be made available on a variety of technical specialties, possibly in cooperation with universities, colleges, technical societies and corporations. The quality assessment offered by the Engineering Institute of Canada through its Continuing Education Unit (CEU) program might be used. Courses in non-technical skills and ethics could also be made available. For the convenience of the participants, many of these courses could be provided through distance education sources. There should also be acceptance by the Associations of evidence of an effective program of independent learning.

It is the view of the Academy that a much increased emphasis on the **Engineering Internship Training** program following graduation is needed. This program can provide knowledge and experience in the specialty area of employment. More importantly, it can instill attitudes and working habits which are applicable in the range of sequential roles that a modern professional engineer can be expected to play. Most if not all engineering graduates should be registered in such a program immediately on graduation.

A central focus of the Engineering Internship Training program is the planning and monitoring of engineering experience. This requires effective linkage of interns to appropriate professional engineers. Members of the profession have a responsibility to these engineering interns and should give high priority to their role as mentors and advisors. They should be encouraged by both the Associations and their employers to contribute to this process.

In the past, the graduation and Iron Ring ceremonies have been seen as the high points in culminating the education of an engineer in Canada. Consideration should now be given to providing at least equal prominence and publicity to the occasion of entry to the profession.

The CCPE Report *Meeting the Challenge of Continuing Relevance for the Engineering Profession (5)* states that “The profession should establish, as part of the experience requirement, a postgraduate internship program that will be a highly regarded post-graduation stage in the training and development of a professional engineer.” The Academy applauds this recommendation, and through this report adds its support in ongoing discussions with the Associations.

Recommendation 2: That Associations review their criteria for entry into the engineering profession, and consider adopting enhanced requirements for Engineers in Training, to include continuing education, evidence of independent learning, mentorship, and more stringent supervision of experience.

Engineering graduates are highly mobile and generally cannot predict where they will be employed throughout and after the internship period. The establishment

of nationally accepted requirements and registration processes for interns would be highly desirable. There is evidence that lack of such a national approach is a deterrent to early internship registration. The Academy supports the ongoing development through CCPE of a National Admissions Guideline incorporating the concepts developed in this report, and its adoption by the Associations.

Recommendation 3: That the Associations, coordinated through CCPE, negotiate common requirements for admission to the engineering profession in Canada.

CONTINUED COMPETENCE

A continuing reputation for competence is central to retaining and enhancing the confidence of clients, employers and the public. Every professional engineer must establish and maintain throughout their active career a reasonable level of competence in the specific areas of work for which she or he is responsible. Ideally, adequate implementation of this basic principle of personal responsibility should be sufficient to satisfy both clients and the public. However, governments and the public have become increasingly concerned that members of all licensed professions provide evidence periodically of measures taken by each licensee to maintain competence.

With the great diversity of roles filled by professional engineers, it is neither practicable nor feasible to depend primarily on the periodic completion of formal courses, or on the passing of examinations, to provide assurance of continued competence. Rather, the public must rely to a large extent on the ethics and integrity of individual engineers, to satisfy themselves and their peers that they have acquired and maintained the competence needed for the tasks they are called on to perform.

A program for the creation of specialist categories in engineering was tried in Ontario in the 1980's with limited success and was eventually abandoned. While there may be a future role for such a program, it is not considered to be the appropriate means of providing competence assurance throughout the engineering profession. There are too many specialties, they are multiplying too rapidly, and each is constantly evolving. It is however appropriate for clients and governments to require evidence of adequate current knowledge and experience for work in particular areas, such as building design, where Ontario and British Columbia require engineers working in this area to demonstrate a sufficient knowledge of the Building Code. Associations may well cooperate in providing access to accredited courses and examinations to meet such specialized needs.

To provide reassurance to the public and as a regular reminder of each individual's commitment to assured competence, it is reasonable for the

Associations to require periodic reports from each professional engineer on steps taken to renew competence.

Convenient channels for the public to report alleged incompetence by a professional engineer should be maintained by the Associations. Such reports should be investigated thoroughly and quickly by appropriate councils of the profession. Where found to be valid, the penalties should be publicized and should be sufficient to maintain public confidence.

Recommendation 4: That the Associations, coordinated through CCPE, negotiate acceptable national standards for acquisition and reporting of evidence of continuing competence for all Canadian professional engineers.

Employers of engineers should recognize that maintenance of the competence of their professional engineering employees is not only essential, but is also as sound an investment as the maintenance of capital equipment and operating systems. Employment arrangements and contracts should provide for appropriate allocation of time and resources for this purpose.

Recommendation 5: That employers be encouraged to provide their professional engineering employees with adequate opportunity and resources, to maintain and enhance their professional competence.

CONCLUSION

Engineering as a profession in Canada is a world leader in its regulation, its self-governance and the competence of its members. The proposals and recommendations of this report are directed at enhancing still further the stature, relevance, public service, and perception of the profession to meet current and future challenges. Specifically, the report recommends review and revision of the criteria for accreditation, the requirements for entry to the profession and the assurance of continuing life-long competence.

REFERENCES

1. *Wealth through Technological Entrepreneurship*, Canadian Academy of Engineering, March 1998
2. *Evolution of Engineering Education in Canada*, Canadian Academy of Engineering, December 1999
3. *Lifelong Learning for Professional Engineers*, Canadian Academy of Engineering, October 1997
4. *Protecting the Public and the Environment – A Responsibility of Canadian Professional Engineers*, Canadian Academy of Engineering, April 2002
5. *Meeting the Challenge of Continuing Relevance for the Engineering Profession*, Canadian Council of Professional Engineers, May 2001