Engineering Accreditation in Canada and Its Current Challenges

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Canadian Engineering Accreditation Board

Introduction to the CEAB

The Canadian Council of Professional Engineers (CCPE) is the federation of provincial and territorial authorities (constituent members) which license professional engineers. It oversees the profession across Canada. The Canadian Engineering Accreditation Board (CEAB), a standing committee of the CCPE, is responsible for the accreditation of Canadian engineering education programs.

The CEAB has two goals; engineering programs offered by Canadian universities will meet or exceed minimum educational standards acceptable for professional engineering registration in Canada, and the quality and relevance of engineering education will continuously improve. The CEAB strives to meet these goals by continuously reviewing and updating the policies and procedures for evaluating university engineering programs.

In addition to advising the CCPE on all matters related to engineering education, the CEAB works closely with Canadian universities to ensure that accredited engineering programs are able to impart to their graduates the skills and knowledge needed to become productive members of the profession. It also offers advice to universities developing new engineering programs, to help the universities ensure that those programs ultimately meet the criteria for accreditation by the CCPE. As part of this process, the CCPE produces an annual report outlining the CEAB's criteria and procedures. The report lists the Canadian undergraduate engineering programs that are currently, or have ever been, accredited by the CEAB. It also describes the work and composition of the teams of volunteers who conduct program evaluation visits to Canadian universities on the CEAB's behalf. The CEAB is assisted in its work by several sub-committees, including the Executive Committee, Policies and Procedures Committee, and Nominating Committee. The CEAB is currently composed of fifteen professional engineers drawn from the private, public and academic sectors. The members are volunteers and represent different parts of the country as well as a wide range of engineering disciplines.

An Historical Perspective on the CCPE and the CEAB

Established in 1936, the CCPE is the national organization of the 12 provincial and territorial constituent members that regulate the practice of engineering in Canada and license the country's more than 160,000 professional engineers. The CCPE serves its constituent members by

delivering national programs that ensure the highest standards of engineering education, professional qualifications and ethical conduct.

In addition to being the voice of its constituent members in national and international affairs, the CCPE establishes national policies, positions and guidelines on behalf of the engineering profession. It also promotes greater understanding of the nature, role and contribution of engineering to society, and undertakes federal government relations and national media relations on behalf of, and in consultation with, its constituent members.

The CCPE's policy-setting and governing body is the CCPE Board of Directors. The CCPE also has several operational Boards and Committees that undertake a wide range of activities and initiatives to implement the policies established by the CCPE Board of Directors including:

- Canadian Engineering Accreditation Board
- Canadian Engineering Qualifications Board
- Canadian Engineering Resources Board
- Canadian Engineering International Board

In 1965, the CCPE established the Canadian Accreditation Board (CAB), now known as the Canadian Engineering Accreditation Board, to accredit Canadian undergraduate engineering programs that meet or exceed educational standards acceptable for professional engineering registration in Canada.

The CEAB is also responsible for ascertaining the equivalency of accreditation systems in other countries and for monitoring the activities of those bodies with which mutual recognition agreements have been signed.

Accreditation and Substantial Equivalency Evaluations

An accreditation visit is undertaken at the invitation of a particular institution and with the concurrence of the constituent member having jurisdiction. A team of senior engineers is assembled under the direction of a current or recent CEAB member. A detailed questionnaire is completed by the institution and sent to the team prior to the visit. During the visit, the team examines the academic and professional quality of faculty and support staff, adequacy of laboratories, libraries, equipment and computer facilities and the quality of the students' work.

A qualitative and quantitative analysis of the curriculum content is performed to ensure that it meets the minimum criteria. Finally, the team reports its findings to the CEAB which then makes an accreditation decision. It may grant (or extend) accreditation of a program for a period of up to six years or it may deny accreditation altogether.

Preparation for an accreditation visit centres around the completion of the questionnaire. The questionnaire serves as a means for collecting data on the institution and its engineering program(s) and gives the institution an opportunity to describe its educational objectives and procedures.

The visiting team considers the information provided by the institution and that which it has gathered while on site. The team reports the pertinent information distilled so that the CEAB, in its subsequent deliberations, may make an informed accreditation decision.

In Canada, 35 educational institutions offer accredited undergraduate engineering programs leading to an engineering degree at the bachelor level. There are currently 220 accredited engineering programs, in a wide range of engineering disciplines. In addition to the well-known disciplines such as civil, electrical, mechanical and chemical engineering, aspiring engineers can enter accredited programs in bioresource, computer, environmental, materials, mining and software engineering, among others.

The CCPE, through its Canadian Engineering International Board (CEIB), strives to achieve recognition by the international community of Canadian standards of excellence in engineering education and practice. Where appropriate, the CCPE will enter into agreements with other non-Canadian organizations concerning mutual recognition of accreditation systems or professional engineering qualifications. The CEAB assists in this mission by ascertaining the equivalency and acceptability of accreditation systems in other countries relative to the Canadian system, and by evaluating, upon request, foreign engineering education programs.

These evaluations follow the CEAB's policies and procedures, but may only lead to a decision of "substantial equivalency" for such programs in foreign institutions. The term "substantial equivalency" means comparable in program content and educational experience and it implies reasonable confidence that the graduates possess the academic competencies needed to begin professional practice at the entry level. The CEAB recommends that the CCPE's constituent members treat graduates of programs evaluated as substantially equivalent as if they were graduates of CEAB-accredited programs for the period that substantial equivalence is in effect. Since CEAB accreditation is designed to provide graduates with an education satisfying the academic requirements for registration within Canada, the CEAB uses the term 'accreditation' only within Canada.

Through the CEAB's activities, the Canadian criteria and procedures for accrediting undergraduate engineering programs are now recognized around the world. As a result, several foreign engineering institutions have expressed an interest in having their engineering programs evaluated by the CEAB.

Accreditation and the CCPE's International Activities

The CCPE, through the CEAB and the CEIB, has signed mutual recognition agreements with the accreditation bodies of several other countries. Three agreements currently in force recognize that the systems of the CEAB and the other party for accreditation of programs leading to a degree in engineering are substantially equivalent and that the accredited programs of both parties satisfy the academic requirements for entry to the practice of engineering at a professional level.

The first of these agreements was signed in 1980 by the CEAB and the Engineering Accreditation Commission (EAC) of the Accreditation Board for Engineering and Technology (ABET) in the United States of America. This agreement was updated and ratified by both

parties during the course of 1996 and 1997. The agreement is valid for graduates of all programs accredited by the EAC.

The second of these agreements, entitled "Recognition of Equivalency of Engineering Education Courses/Programs Leading to the Accredited Engineering Degree", was signed by representatives of engineering organizations from six countries. Following a series of verification activities by the CEAB, this agreement was approved and ratified by the CCPE and is valid for graduates from 1989 onward. The signatory countries to this agreement were: Canada, Australia, Ireland, New Zealand, the United Kingdom and the United States of America. In 1997, this agreement (now called "The Washington Accord") was revised, mostly with respect to rules and procedures, subject to ratification by each of the signatories. The CCPE has since ratified the Agreement. Two further countries were subsequently added as signatories to this agreement: Hong Kong (valid for graduates from 1995 onwards), and South Africa (valid for graduates from 1999 onwards).

In 1999, the CCPE concluded its third Agreement with the Commission des Titres d'Ingénieur (CTI) in France which considers that the accreditation processes used by CTI and the CEAB of CCPE are substantially equivalent. The agreement enables recognition of Canadian engineers who are graduates of CEAB accredited programs as "ingénieurs diplômés" in France. Ingénieurs diplômés who are graduates of programs recognized by CTI are granted access to the Canadian engineering constituent members without having to pass technical examinations. (Professional Engineers Ontario has not implemented the agreement, so the agreement is not in force for professional engineers registered in Ontario.)

The CEAB Accreditation Criteria

The CEAB develops the criteria governing the accreditation processes and procedures. These criteria are approved by the CCPE Board of Directors on behalf of the constituent members. The criteria are both quantitative and qualitative and place emphasis on the quality of the students, academic staff, support staff and educational facilities. CEAB also uses these same criteria to conduct substantial equivalency evaluations of engineering programs outside Canada. The criteria have evolved over the years to reflect such issues as technological advances and the growth of the engineering team in the workplace. Over the past decade the CEAB increased the requirements for complementary studies (soft skills) and moved from a proportional measure of curriculum to an absolute measure. Changes under consideration at the present time include:

- refining the curriculum content requirements for Basic Science and Mathematics,
- including morale and commitment of faculty, support staff and students as a component of the qualitative evaluation, and
- including the requirement for students to be exposed to the concepts of project management.

The engineering profession expects of its members competence in engineering as well as an understanding of the impact of engineering on society. Thus, accredited engineering programs must contain not only adequate mathematics, science and engineering, but they must also contain adequate complementary studies that deal with central issues, methodologies and thought processes of the humanities and social sciences.

The criteria are intended to:

- identify those programs that develop an individual's ability to use appropriate knowledge and information to convert, utilize and manage resources optimally through effective analysis, interpretation and decision-making. This ability is essential to the design process that characterizes the practice of engineering.

- provide a broad basis for identifying acceptable engineering programs, to prevent over-specialization in curricula, to provide sufficient freedom to accommodate innovative educational development, to allow adaptation to different regional factors and to permit the expression of the institution's individual qualities and ideals.

- reflect the need for the engineer to be adaptive, creative, resourceful and responsive to changes in society, technology and career demands.

- ensure that students are made aware of the role and responsibilities of the professional engineer in society and the impact that engineering in all its forms makes on the environmental, economic, social and cultural aspirations of society.

- reflect the need for the professional engineer to function as an effective member of a team, able to communicate both within the profession and with society at large.

The criteria for curriculum content assure a foundation in mathematics and basic sciences, a broad preparation in engineering sciences and engineering design and an exposure to non-technical subjects that complement the technical aspects of the curriculum. Judgement is applied to both the qualitative and quantitative criteria requirements in each instance. Outcomes based assessment is used as a tool within the accreditation system to evaluate the program's goals. The CEAB is currently evaluating further use of outcomes based assessment. Another related idea under consideration is switching perspectives from evaluating teaching to evaluating learning.

The CEAB gives sympathetic consideration to departures from these criteria in any case in which it is convinced that well-considered innovation in engineering education is in progress. To satisfy accreditation requirements, an engineering program must include at least a minimum of each of the curriculum components specified.

The CEAB and Canadian Engineering Constituent Members

In Canada, the regulation of the engineering profession is a provincial and territorial responsibility. This responsibility has been delegated to engineering's 12 regulatory constituent members by provincial and territorial statute. The CCPE is the national organization of the constituent members, but has no regulatory authority over the profession in its own right.

In the Canadian context the purpose of accreditation is "...to identify to the constituent members of the Canadian Council of Professional Engineers (CCPE) those engineering programs that meet the criteria for accreditation". Still, in Canada, each of the twelve constituent members has entrenched in its enabling, self-governing legislation a statement of objectives that includes something along the lines of: "...to establish and maintain standards of knowledge and skill among its members ... in order that the public interest may be served and protected...".

Within this direct linkage between accreditation and protection of the public interest, there is heightened sensitivity to the responsibility to ensure that educational programs titled "_____ engineering" are indeed accreditable as such and that those programs which do not meet the accreditation criteria are excluded from recognition. It is therefore essential that the engineering profession be equally sensitized and alert to new uses of those ubiquitous terms engineer, engineered and engineering, so as to take early steps to mitigate confusion in the public mind. The accreditation process must be designed to support this activity with criteria that clearly distinguish those programs that are truly cornerstones to the formation of new engineers, yet somehow with sufficient flexibility to recognize the legitimacy of emerging, innovative new disciplines.

Future Challenges for the CEAB

Early Identification:

Some form of early identification process for these emerging innovative engineering disciplines, coupled with some level of "management" of the emerging process probably lies ahead for the profession. Identification will have to involve accreditation boards since these have direct contact with academia on a regular cycle. However, the constituent members will also need to analyze complaints received in a more probing fashion for trends and possibly consult with accreditation boards before any enforcement action is taken.

The engineering profession has survived well with its current accreditation criteria-viz. the degrees with high instructional input from non-engineers: engineering science, geological engineering, forest engineering, biomedical engineering, etc. But how long will it be before the first genetic engineering program is submitted for accreditation and what conundrums will it raise? Can it be offered following the same model? – (possibly, if we start now to look at the issues in detail). Will biology become a required Basic Science? For that matter should Computer Science material be considered Basic Science or is it Mathematics (or neither)? And is the increase in the non-technical/social content to be accomplished through replacement of the technical or by adding to the existing requirements? It seems certain that criteria cannot escape modification if we wish to maintain the current high standard, yet embrace legitimate new engineering disciplines affecting the public interest.

Experiential Learning:

Experiential learning is increasingly popular with employers - co-op terms, stage projects, professional experience terms - all enhance employment opportunities for participating students. Is this an indication that educators (in Canada at least) have been too focussed on preparation for post-graduate work or is it a reflection that in a global economy industry, large and small, can no longer tolerate extended years of internship for new engineering graduates?

Probably not enough of the pedagogical issues involved in this kind of learning is yet known - what do "we" want from it? - who is "we" (learned societies or the profession)? - does it enhance Complementary Studies learning? Most importantly, if experiential

learning should be brought into accreditation criteria, how will the accreditation boards measure the consistency of the experience and against what specific level or benchmark? Or should accreditation look to modular problem-based learning as a preferred model that in some way will serve to initiate the internship earlier than at present, while guaranteeing the consistency of the "teaching"?

Alternatively, should experiential learning be removed from academic/accreditation consideration and given over totally to the constituent members to administer as part of the internship process? While this approach might be appropriate from the strict perspective of the issues raised above, there are still pedagogical considerations that would best be addressed by academic accreditation teams. The challenge is to find the right approach, given the very strong preference for this kind of learning regularly expressed by the employment marketplace.

Specialization:

Engineering specialization is an area now under study in Canada by the CCPE. Well established in the United States (e.g. California, Washington) and recognized there as an "add-on" to the basic P.E. qualification, it is still early enough in Canada to raise questions as to how (or whether) to distinguish between a specialty and a new discipline. An added consideration is the licensing of eminently but often narrower qualified engineers from off-shore for short term assignments and for immigration. Do these situations involve accreditation issues, or are they adequately addressed ad-hoc by the constituent members through their Boards of Examiners?

New disciplines commonly emerge as options that have matured under the more traditional disciplines, - e.g. electrical engineering to computer engineering to software engineering - or as new extensions of a science, e.g. forest engineering, biomedical engineering. Specializations seem to have emerged driven by perceived market demand or in response to a need for advanced capability perceived by some level of government, perhaps due to a local condition rather than a national one. What are the issues arising from the accreditation of a building engineering degree on the one hand and a "building engineer" specialization required to perform certain certifications under public legislation in a single jurisdiction, on the other? Is the public interest best served if Boards of Examiners have to be involved in all other jurisdictions to assess transferees holding the specialization designation? How does the accreditation board respond to the first structural engineering program submitted for accreditation, given that there has never been a stand-alone structural engineering program in Canada and it would be far narrower than the norm?

While a policy on specialization has not yet been finalized by CCPE, it appears that there may be justification for systems to be put in place that will recognize advanced training and knowledge. Such systems could be provided by external agencies, as is currently happening for a number of certifications such as the PMP (???), or be provided as an additional designation from the provincial and territorial licensing bodies.

Non-Academic Instruction:

As part of their engineering design content Canadian universities make strong use of projects solicited from and put forward by private sector, often involving the submitting firms in both advisory and evaluation roles. This seems to acknowledge the need for "real life" projects as a break from the strictly academic, theoretical framework and the involvement of non-academic engineers to provide the "applications" perspective. It also often provides students with valuable experience in presenting their cases outside the classroom environment.

Such experience often provides the only exposure to such things as codes and their requirements, assessments of loadings for which there are no handbooks and the realities of limited budgets and project phasing, that students get. Given the earlier mentioned link between accreditation and the constituent members, the question arises as to whether the accreditation criteria should be amended to embed this practice. While Canadian criteria already stipulate that engineering science and engineering design content be taught by "P.Eng's" (licensed engineers), the focus intended has been on the academic faculty. Should some portion of an accredited program be reserved for presentation by non-academic members of the profession or does this encroach on the universities' freedoms or further still, is it moving some of the internship phase inappropriately back into the academic formation?

Conclusion

While the foregoing considerations are all raised in the Canadian context, each in its own way also has implications in the global sense, particularly as engineers are increasingly mobile. The challenge for the CEAB will continue to be to facilitate innovation within universities, while remaining fully mindful of the "public interest" expectations.

References

1. Canadian Council of Professional Engineers, *Canadian Engineering Accreditation Board 2001 Accreditation Criteria and Procedures*, Ottawa, 2001.

2. Paterson, W.G., Ruth, D.W., and Wolfe, D., *Accreditation Issues Workshop*, Ottawa, 2001.

3. Paterson, W.G., *Some Thoughts on Accreditation, Canadian-style*, Ottawa, 2001.

Biography

SAMANTHA DE BON received a degree in Biochemistry and a Masters in Business Administration from the University of Ottawa. Ms. De Bon began her career with the Canadian Blood Agency before joining the Canadian Council of Professional Engineers. Throughout her career she has worked closely with various volunteer boards and committees, including her current work with the Canadian Engineering Accreditation Board.

DEBORAH WOLFE is the Director, Education, Outreach and Research at the Canadian Council of Professional Engineers. She received a degree in Civil Engineering from the University of Western Ontario and served in the

Canadian Armed Forces as a construction engineer. Ms. Wolfe serves on a number of committees including the Canadian Engineering Memorial Foundation, and she is the current Chair of the Association of Accrediting Agencies of Canada.

JEAN-YVES CHAGNON received three degrees in Geological Engineering; one from l'École Polytechnique de Montréal and the others from McGill University. After graduation, he began his career in the public sector, and later joined on as a faculty member at l'Université Laval. Mr. Chagnon is the current Vice-Chair, and incoming Chair, of the Canadian Engineering Accreditation Board.

BILL PATERSON received two degrees in Civil Engineering at the University of New Brunswick. After graduation, he joined the university's faculty and subsequently left to work in the private and public sectors. He later rejoined the University as its director of research and development services. Active in professional association committees and governance, Mr. Paterson is the current Chair of the Canadian Engineering Accreditation Board.