Graduate attributes and accreditation

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For some years, the development of civil engineering programs in Canada has increasingly relied on an assessment of desirable attributes of graduates of those programs, so as to affirm that graduates possess the attributes expected of them and so as to continually improve the programs.

Consistent with this, some years ago the Canadian Engineering Accreditation Board (CEAB) – now known as the Engineers Canada Accreditation Board – introduced two new criteria relating to graduate attributes and to continual improvement (GA/CI), in addition to other criteria already in place. Initially, conformance with these two new criteria was not used as a basis for making accreditation decisions. However, since June 2015 accreditation decisions have relied in part on these GA/CI criteria.

This paper outlines these two criteria; summarizes the purpose and process of accreditation; and describes broadly accepted approaches for developing and assessing graduate attributes and making consequential program improvements. It also summarizes CEAB's approach to assessing conformance to these criteria and clarifies the relationship of these criteria to input-based criteria. The reliance of programs on graduate attributes assessment is evolving appropriately and effectively. Further progress is anticipated so as to assure that institutional efforts in this regard are manageable and are sustainable.

CEAB criteria

As mentioned, there are two new CEAB criteria that relate to graduate attributes and continual improvement. The first of these reads: "The institution must demonstrate that the graduates of a program possess the attributes under the following headings. The attributes will be interpreted in the context of candidates at the time of graduation. It is recognized that graduates will continue to build on the foundations that their engineering education has provided." It then goes on to identify and describe twelve attributes (CEAB, 2014). They have the following headings:

- A knowledge base for engineering
- Problem analysis
- Investigation
- Design
- Use of engineering tools
- Individual and team work
- Communication skills
- Professionalism


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- Impact of engineering on society and the environment
- Ethics and equity
- Economics and project management
- Lifelong learning.

Specific descriptions are provided for each of these. For example, two of them are described as follows:

"A Knowledge Base for Engineering: Demonstrated competence in university level mathematics, natural sciences, engineering fundamentals, and specialized engineering knowledge appropriate to the program."

"Professionalism: An understanding of the roles and responsibilities of the professional engineer in society, especially the primary role of protection of the public and the public interest."

The companion criterion relating to continual improvement reads: "Engineering programs are expected to continually improve. There must be processes in place that demonstrate that program outcomes are being assessed in the context of the graduate attributes, and that the results are applied to the further development of the program."

Accreditation purpose and process

For context, it is appropriate to summarize the purpose and process of engineering accreditation in Canada.

Purpose. Regulatory authorities in each Canadian province and territory regulate the practice of engineering in Canada and license members of the engineering profession. The underlying basis for accreditation is that these authorities recognize graduates of accredited programs as meeting the academic requirements for licensure. They

[1] *Although Dr. Isaacson is a member of the CEAB, the views expressed in this paper are his and do not reflect the position of the CEAB.*

are all constituent members of Engineers Canada. In turn, Engineers Canada has established the CEAB as one of its standing committees, and has vested in the CEAB the authority to make accreditation decisions.

Washington Accord. There is an important international aspect to Canada's accreditation system. The Washington Accord (IEA, 2014) is an international agreement between relevant organizations of signatory countries, including Canada, such that they all recognize the substantial equivalence of programs accredited in each of these countries. That is, all signatory countries recognize graduates of accredited programs in any of them as having met the academic requirements for licensure. While these countries conform to common education standards in different ways, they all now include graduate attribute considerations amongst their criteria.

Accreditation process. The CEAB has established a well-developed process to assess engineering programs and make accreditation decisions. This entails the following components: an initial request is made by an institution; the institution submits documentation relating to its conformance to the CEAB criteria; a site visit to the institution is undertaken on behalf of the CEAB; a Visiting Team Report that includes ratings (acceptable, marginal, unacceptable) with respect to all criteria as well as other commentary is prepared; and a written response and update by the dean is provided. The CEAB then considers the Visiting Team Report along with the dean's response to make accreditation decisions. Accreditation may be granted for up to six years, although a range of accreditation decisions are possible.

GA/CI elements

Approaches to developing and assessing graduate attributes rely on a sampling of assessment results, or a "spot-check" approach. This is distinct from a "minimum path" or "individual student" approach that is applied to input-based assessments relevant to other CEAB criteria. It is also recognized that the extent of student learning and the extent of assessments made may differ widely across the 12 attributes, and also that the assessment of the individual attributes and associated program improvements may occur over a multi-year cycle.

A common approach for institutions to develop and assess graduate attributes and make consequential improvements, consistent with CEAB's approach to assessing conformance to the criteria, is to recognize that these occur through a series of elements. Eight elements as relating to the two criteria have been formulated as follows:

- Organization and engagement
- Curriculum maps
- Indicators
- Assessment tools
- Assessment results
- Improvement process
- Stakeholder engagement
- Improvement actions.

The first five relate to the Graduate Attributes criterion and the last three relate to the Continual Improvement criterion. Comments on each of these elements follow.

Organization and engagement. This relates to the need for all faculty members to be aware of, and engaged in, outcomes-based assessment and the resulting continual improvement that occurs; and to the need for suitable committee and reporting structures to assure the sustainable measurement of graduate attributes.

Curriculum maps. A curriculum map shows the relationship between learning activities (usually courses) for each of the attributes and the semesters in which these take place. The map may provide additional information such as an identification of those courses in which course-specific assessments are made, and it may make suitable distinctions (or distinct maps may be used) for options in a program and/or for more than one primary cohort.

Indicators. Indicators are descriptors of what students must achieve in order to be considered competent in the corresponding attribute. Typically, each of the 12 attributes has a few indicators.

Assessment tools. Assessment tools are measurements made to develop data on student learning. These may be course-specific measurements addressing one or more indicators within an attribute, or surveys or other tools that may span multiple indicators or attributes. As well, there may be other forms of assessment, such as those arising from third-party reviews. Ideally, assessment tools need to be suitably distributed over the program duration in order to track progress towards the achievement of a particular attribute. In the selection of assessment tools, consideration may be given to the validity and reliability of the results to be obtained, the applicability of the results to continual improvement, and the sustainability of the data collection effort over the long term.

Assessment results. It is recognized that assessment results for all 12 attributes may be gathered over a multi-year cycle. Most often, course-specific assessment results are provided in the form of achievement levels (typically: fails to meet expectations, minimally meets expectations, adequately meets expectations, and exceeds expectations).

Improvement process. There is a need to establish a clear continual improvement process with a suitable committee structure, an articulation of the roles and responsibilities of the participants, and a well-defined annual or multi-year timetable.

Stakeholder engagement. It is anticipated that the continual improvement process will involve the close engagement of a broad range of stakeholders in specified ways, including those within the program, those within the institution but outside the program, and those outside the institution.

Improvement actions. Generally, the continual improvement process is expected to result in specific curriculum or other program improvements, improvements in the achievement of graduate attributes, and/or improvements in the assessment process itself.

For a program that incorporates the eight elements in the manner

outlined above, its graduate attributes development and assessment should be effective in assuring that its graduates achieve the attributes and in assuring continual program improvements. In turn, CEAB's approach to assessing conformance to the relevant GA/CI criteria is expected to rely on a reporting of these eight elements reflecting the considerations that are indicated.

Relationship to input-based criteria

There is sometimes confusion regarding the relationship between graduate attributes and input-based criteria, especially those that quantify the curriculum. Curriculum input criteria and outcomes-based criteria are complementary, addressing different aspects of a program so that the reliance on one does not preclude the need for the other. Indeed, Washington Accord countries have all retained curriculum-input measures, albeit with different measurement systems. Thus, graduate attributes assessment activities in themselves cannot replace measures of curriculum quantity, and cannot universally assure minimum levels of curriculum – this is one reason why curriculum input assessments need to continue.

The CEAB has adopted the Accreditation Unit (AU) as the basis for quantifying the curriculum. (An AU is taken to correspond approximately to the extent of learning associated with one lecture hour.) Although the formal definition of the AU could be simplified in order to reduce institutional effort, the AU or equivalent cannot be dispensed with as such, since the need for a clear measure of curriculum quantity will continue – whether this entails a modified AU definition or some other unit of measurement such as hours or academic credit or semesters suitably defined.

Summary and conclusions

Civil engineering programs in Canada are relying increasingly on graduate attributes with respect to assessing their graduates and assuring continual improvement of their programs. Approaches to developing and assessing graduate attributes and making consequential program improvements, along with CEAB's approach to assessing conformance to the related criteria, are summarized. The relationship of such assessments to curriculum input measures is also clarified. The reliance of programs on graduate attribute assessment is evolving appropriately and effectively. Further progress is anticipated so as to assure that institutional efforts in this regard are manageable and are sustainable. ■

References

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Is there value to student competitions?

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Over the last decade there has been a conscious effort by most engineering schools across Canada to change the ways our engineering students learn. This effort has been primarily in response to an improved understanding of how our students learn, as well as changing student demographics. A shift is underway from traditional passive learning to active learning. Examples include blending learning, flipping classrooms, problem-based learning, various types of experiential learning, and entrepreneurship encouragement. Integrated within these activities has been an increase in student competitions. Student competitions span an enormous spectrum, from those that are intra-curricular (e.g. grades assigned for participation and performance in a popsicle stick bridge building competition) to extra-curricular (e.g. National Student Steel Bridge Competition).

The goals of student competitions create a need for students to engage in self-learning of concepts and skills within and beyond the scope of their courses, allowing them to solidify or expand their knowledge of these subjects (Carroll, 2013 and Sirinterlikci, 2011). Research suggests knowledge gained from problem-based learning activities, including student competitions, is retained longer (Gallagher, 1997). This said, some guidance structure may be necessary to allow students to achieve a full understanding of the topics (Carroll, 2013 and Yost, 2008). On the instructional side, major barriers to implementing active learning are intimidation and skeptical perceptions of non-traditional teaching methods (Carroll, 2013). While the results of the projects and actual competition may be mixed, learning outcomes tend to be strongly met and consistent among students (Carroll, 2013 and Sirinterlikci, 2011). In our experience, the competition event provides a sense of anticipation and excitement, and acknowledges the efforts put in by each team, allowing them to feel valued for their work.