AU Task Force report to Engineers Canada

Report prepared for the February 2018 Engineers Canada Board meeting

Working on reviewing the current definition of the Accreditation Unit (AU) to identify and define a process to evolve AUs to cope with the changes in engineering education

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1. Introduction

1.1. Shared vision of the future of accreditation

"What do we need to do, together, to ensure that accreditation is done in a manner that brings greatest benefit to the profession?"

This was the question posed to over 100 participants at the 2016 Engineers Canada Forum on Accreditation[1].

At the same meeting the president of Engineers Canada also expressed his opinion that the status quo is not acceptable.

Seeking a shared vision of the future of accreditation has led to several initiatives to improve how Engineers Canada delivers its world class engineering accreditation system. This report focuses on one such initiative where the collaboration of stakeholders is contributing to innovation in engineering education.

1.2. The AU Task Force

In February 2017, the AU Task Force was established by the Executive Committee of the Accreditation Board with a mandate to:

- consider the definition of an AU in its present form (criteria 3.4.1.1) and to identify the advantages, disadvantages and ramifications of any definition change on existing criteria; and
- to envisage how curriculum content requirements could be linked to student outcomes/graduate attributes whatever system of AU counts is used.

This Task Force initially consisted of Graham Reader, Michael Isaacson, Matthew Oliver, Dan Candido, and Tom Tiedje. In July 2017, the Task Force membership was broadened to the current membership of seven individuals from regions across Canada. Members are:

- Bob Dony Task Force leader
- Luigi Benedicenti CEAB member
- Dan Candido CEAB member
- Ray Gosine CEAB member
- Andy Hrymak NCDEAS member
- Matthew Oliver Regulator/Admissions official representative
- Tom Tiedje NCDEAS member

The Task Force also received much support and encouragement from:

- Ishwar Puri Chair of NCDEAS
- Wayne MacQuarrie Chair of CEAB
- Russ Kinghorn President, Engineers Canada
- Stephanie Price Acting CEO, Engineers Canada
- Graham Reader CEAB member

[1] The 2016 Forum on Accreditation, Toronto ON, August 17 and 18, 2016
https://engineerscanada.ca/sites/default/files/consultants_report.pdf

The Task Force initially worked via email and teleconference. Face-to-face working meetings were held on July 18 and October 26, 2017.During these meetings, a workplan was developed based on the Task Force deliverables. This report represents the deliverables set by the Task Force.

The Task Force recognizes that many stakeholders will be affected by any changes to the AU definition, and wishes to consult with as many of those stakeholders as possible before making a final recommendation to the Board. This report is the basis for that consultation. It contains recommendations as a starting point for input from others.

1.3. General principles

The work of the Task Force was guided by several principles:

1. The accreditation system should not unduly limit the use of innovative or best-practice instructional approaches.
2. Students, regulators, and HEIs are all stakeholders in accreditation and see value in it.
3. The goal of accreditation is to ensure a graduate has met the minimum academic knowledge and competence (i.e. “minimum path”) required to be licensed as an engineer. No further technical examinations are required, therefore, for graduates of accredited programs.

1.4. The Accreditation Unit

The Accreditation Unit (AU) was established in the 1990’s, after the National Committee of Deans of Engineering and Applied Science (NCDEAS) officially requested changes in the CEAB annual report, specifically that “in all cases the requirements are to be met in terms of the absolute amount of instruction, not the proportion of a particular curriculum.[2]”

The definition of an AU is found at criterion 3.4.1.1. It currently reads as follows:

> *“Accreditation units (AU) are defined on an hourly basis for an activity which is granted academic credit and for which the associated number of hours corresponds to the actual contact time between the student and the faculty members, or designated alternates, responsible for delivering the program:*
>
> - *one hour of lecture (corresponding to 50 minutes of activity) = 1 AU*
> - *one hour of laboratory or scheduled tutorial = 0.5 AU*
>
> *This definition is applicable to most lectures and periods of laboratory or tutorial work. Classes of other than the nominal 50-minute duration are treated proportionally. In assessing the time assigned to determine the AU of various components of the curriculum, the actual instruction time exclusive of final examinations should be used.[3]”*

More recently, there have been increasing discussion about this measurement methodology as it has shortcomings in terms of newer education delivery approaches.

[2] An Armchair View of Engineering Accreditation in Canada J. D. Aplevich, FEC, P.Eng.

[3] 2017 CEAB Accreditation Criteria and Procedure, p. 18 https://engineerscanada.ca/sites/default/files/accreditation-criteria-procedures-2017.pdf

2. Definitions

Accreditation Unit (AU): "Accreditation units (AU) are defined on an hourly basis for an activity which is granted academic credit and for which the associated number of hours corresponds to the actual contact time between the student and the faculty members, or designated alternates, responsible for delivering the program:

- one hour of lecture (corresponding to 50 minutes of activity) = 1 AU
- one hour of laboratory or scheduled tutorial = 0.5 AU

This definition is applicable to most lectures and periods of laboratory or tutorial work. Classes of other than the nominal 50-minute duration are treated proportionally. In assessing the time assigned to determine the AU of various components of the curriculum, the actual instruction time exclusive of final examinations should be used.[4]"

Accredited engineering program: An accredited engineering program consists of studies in engineering leading to a bachelor's degree that fulfills the academic requirement for licensure with Canada's engineering regulators.

Blended classes: Mix of traditional and online course delivery.

Board of Directors: The Board of Directors of Engineers Canada.

CEAB, AB: The Canadian Engineering Accreditation Board, or simply the Accreditation Board. Though referred to as a 'Board' the CEAB is technically a committee of the Board of Directors of Engineers Canada.

Flipped classroom: An instructional method where the course material is available outside of the classroom (typically on-line) and the classroom time is spent engaging with this material where the instructor acts as a mentor or coach.

Higher education institution, HEI: A post-secondary institution, which would refer to an institution offering educational programming after high school.

K factor: One method for determining an equivalent measure in AU is a calculation on a proportionality basis. This method relies on the use of a unit of academic credit defined by the institution to measure curriculum content. Specifically, a factor, K, is defined as the sum of AU for all common and compulsory courses for which the computation was carried out on an hourly basis, divided by the sum of all units defined by the institution for the same courses.

Then, for each course not accounted for on an hourly basis, the number of AU is obtained by multiplying the units defined by the institution for that course by K.[5]

$$K = \frac{\Sigma \text{ AU for all common and compulsory courses for which the computation was carried out on an hourly basis}}{\Sigma \text{ units defined by the institution for the same courses}}$$

[4] 2017 CEAB Accreditation Criteria and Procedure, p. 18
https://engineerscanada.ca/sites/default/files/accreditation-criteria-procedures-2017.pdf

[5] 2017 CEAB Accreditation Criteria and Procedure, p. 19
https://engineerscanada.ca/sites/default/files/accreditation-criteria-procedures-2017.pdf

Mandate: The functional scope of the committee/task force approved by the CEAB.

Online courses: Courses where the interaction by the student is through the internet. Typically, this involves online course delivery methods such as web-based reading, multimedia presentations, and video lectures as examples. Interaction with the instructor could be through email, online chat rooms, etc. The course is structured so that a student does not have to be physically present at the institution.

Regulators: The provincial and territorial associations established under law to regulate the practice of professional engineering within their respective jurisdictions, and who are the members of Engineers Canada, as defined in the Articles of Continuance.

Task Force: For the purposes of this report, a task force is a subcommittee operating for a defined period with a specific task. Task forces may include members who are not members of the committee or Board that created the Task Force.

Work Plan: Briefly describes specific tasks to be undertaken during the year by a committee/task force and the deliverables expected upon completion of the tasks. Work plans are to be developed each year and are to be submitted to the CEAB for approval.

3. Task Force Deliverables

3.1. Recommendations on curriculum measurement following analysis of the data

The current definition of an AU (provided in the introduction, above) focuses on contact time for which academic credit is granted. Other approaches are permitted:

> *"3.4.1.2 For an activity for which contact hours do not properly describe the extent of the work involved, such as significant design or research projects, curriculum delivered through the use of problem based learning, or similar work officially recognized by the institution as a degree requirement, an equivalent measure in accreditation units, consistent with the above definition, should be used by the institution.[6]"*
>
> *3.4.1.3 One method for determining an equivalent measure in AU is a calculation on a proportionality basis. This method relies on the use of a unit of academic credit defined by the institution to measure curriculum content. Specifically, a factor, K, is defined as the sum of AU for all common and compulsory courses for which the computation was carried out on an hourly basis, divided by the sum of all units defined by the institution for the same courses.*
>
> *Then, for each course not accounted for on an hourly basis, the number of AU is obtained by multiplying the units defined by the institution for that course by K.[7]*

$$K = \frac{\Sigma \text{ AU for all common and compulsory courses for which the computation was carried out on an hourly basis}}{\Sigma \text{ units defined by the institution for the same courses}}$$

> *3.4.1.4 The Accreditation Board can give consideration to departures from this approach and these methodologies in any case in which it receives convincing documentation that well-considered innovation in engineering education is in progress.[8]*

Recommendation 1

It is the recommendation of the Task Force that the CEAB consider adding additional flexibility to measuring curriculum. This could be achieved by developing an interpretive statement for criterion 3.4.1.4 on the "Learning Unit":

Learning Unit: Equivalent to *N* hr learning time, as established by focused learning time for all learning activities through (a) student surveys as part of course evaluations and (b) instructor expectations to be stated in course outlines. In the case of conventional learning activities, learning time measurements are used for formative feedback only, AU's assigned as in the past.

[6] 2017 CEAB Accreditation Criteria and Procedure, p. 18 https://engineerscanada.ca/sites/default/files/accreditation-criteria-procedures-2017.pdf

[7] 2017 CEAB Accreditation Criteria and Procedure, p. 19 https://engineerscanada.ca/sites/default/files/accreditation-criteria-procedures-2017.pdf

[8] 2017 CEAB Accreditation Criteria and Procedure, p. 19 https://engineerscanada.ca/sites/default/files/accreditation-criteria-procedures-2017.pdf

Rationale

This recommendation proposes student learning time as an alternative proxy measure of curriculum content, in addition to the existing contact hour-based AU measure. It allows a course with a delivery method that cannot easily be measured in terms of contact time or whose contact time does not adequately reflect the degree of curriculum content to have its curriculum content quantified in an equivalent manner to the existing AU measure. The rationale is that if students are working a certain number of hours for one course assigned an AU count as determined by criterion 3.4.1.1, another course with an equivalent student workload should have the equivalent curriculum content measure. The examples in Appendix 2 give some sample calculations to show the equivalence of student learning time to the AU measure for existing programs. For simplicity, a standard equivalency of the number of hours of student learning time per Learning Unit could be determined as per Recommendation 2 below. However, it is recognized that this will require a significant national consultation to determine an appropriate equivalency factor (as per Recommendation 3 below).

Recommendation 2

It is the recommendation of the Task Force that a preliminary measure of a **Learning Unit** be equivalent to 2.5 hours of learning time.

Rationale

The analysis for the examples in Appendix 2 show that for those instances the equivalent learning time for students per the program's total AU count comes to approximately 2.5 hours of learning time per AU. Since this equivalency is based on very preliminary analysis, further work will be required before any equivalency is finally agreed upon.

Recommendation 3

It is the recommendation of the Task Force that the CEAB enter a national consultation on the Task Force's recommendations 1 and 2.

3.2. Data gathered by the Task Force via survey to National Council of Deans of Engineering and Applied Science

In order to perform a "gap analysis" the Task Force, in collaboration with the National Council of Deans of Engineering and Applied Science (NCDEAS) developed a survey requesting feedback from higher education institutions regarding possible or contemplated future changes in relation to engineering education delivery. The survey was sent on October 26, 2017 via the NCDEAS secretariat to all members. 21 responses were received. *Appendix 1* to this report is the full analysis of responses received. The high-level summary indicates that respondents saw challenges with applying the current definition of an AU to flipped classrooms. Blended classes and online courses were also frequently mentioned. Nearly all mentions of blended classes, and approximately half of the mentions of flipped classes, indicated that they are currently in use.

This information provided context for Task Force members to develop a curriculum measurement approach that would allow for increased flexibility for programs. Accredited engineering education programs are proud to achieve accredited status. New programs work very hard to receive accreditation. Some programs report a perception of risk of loss of accreditation and/or additional work in showing conformance with curriculum content criteria when adopting teaching delivery methods that are different from the traditional classroom/lecture model. There is a recognition that the AU is a "proxy" for student learning and can be very “professor centric”, meaning based on classical lecture delivery. The Task Force sought to develop a measurement that is more “student centric”, or based on student learning effort.

3.3. Initiative to provide historical analysis of overall AUs in programs

The Task Force gathered and analyzed preliminary data regarding the average number of AU’s of accredited programs to investigate whether there has been an increase in AU counts for programs (AU “creep”) over the years and to determine if the Canadian programs’ “face time” compares with that of programs internationally. Data was obtained from pre-visit questionnaires (self assessments).

Preliminary analysis indicates that there may be an overall AU increase in the range of 1% per year over the last 20 years. The reasons for this can vary. One reason suggested for the increasing number of AU’s is the increase in the minimum number of required AU’s from 1800 to 1950 in 2008. Also, there may be concern that a visiting team could reallocate AU’s between categories and bring programs under the minima and therefore some may feel it is prudent to have a 10% reserve of extra AU’s in each category. Further, some institutions may wish to design a program deliberately with a curriculum that significantly exceeds the CEAB minimum.

There was discussion about developing messaging that the “optimum” number of AU for the programs is 1950. Perhaps consider messaging that excessively high AU count may be a barrier to effective learning by the students. However, it was recognized that the 1950 AU count is indeed a minimum and institutions are free to offer programs that can exceed this minimum by various degrees.

Feedback from the group indicated that going forward they would like to see comparisons in the data and more summaries. It was suggested that there is a widespread belief that AU creep is an issue, when the data seem to indicate that there is no significant AU creep. It may be helpful to have a communication piece (“one pager”) that provides the data about historical ranges of AUs in accredited programs. This could help the discussion focus on continual improvement.

3.4. Curriculum measurement approaches reviewed by the Task Force

The Task Force reviewed and discussed various global systems which are in use and considered whether they could be adopted ‘as is’ or after modification in the CEAB accreditation requirements. The systems which were examined include:

- ABET
- British Credit Accumulation and Transfer System (CATS)
- European Credit Transfer and Accumulation System (ECTS)
- Engineering New Zealand

3.5. Reporting on the initiative of linking AUs with graduate attributes

The Task Force has recognized the benefits of linking Accreditation Units and Graduate Attributes. The link between curriculum content requirements enshrined in the AU system and student outcomes expressed by the Graduate Attributes is beneficial because it shows that the curriculum provides adequate student exposure to the Graduate Attributes, whereas the assessment process provides information on the depth and breadth of such exposure. Furthermore, the establishment of such link essentially eliminates the requirements for detailed indicator and attribute assessment analysis for the visiting team, greatly reducing the size of the Accreditation Questionnaire and the amount of work required to prepare it; and it reduces the visiting team workload because it does not require to check every single indicator measurement, but rather just the process by which the data are collected, assessed, and used to generate program decisions. Thus, a visiting team would transition to a process assessment approach for the Graduate Attributes part of the Criteria and could effectively adopt a standard audit methodology for this task, based on process descriptions, process outcomes, and random transaction samples.

Task Force members discussed four proposed linking methods and an example of how they could be applied, determined the most promising linking method, and outlined the next steps for the initiative.

Recommendation 4

The Task Force recommends that this initiative be continued with the creation and presentation of concrete examples based on currently accredited program data to demonstrate the benefits accrued by applying the linking method.

Should a method to link curriculum to outcomes be adopted, the implementation timelines will consider any redefinition of AU.

Rationale

Linking accreditation units to graduate attributes will likely result in a sizeable workload reduction, a deeper level of understanding of the program for visiting teams, a standardized process-based evaluation method, and additional clarity on evidence-based continual improvement.

3.6. Report on communications initiatives

The Task Force engaged a variety of stakeholders throughout 2017 by providing a number of updates in several delivery formats. The table below provides the dates these updates were provided and to whom.

Audience	Date	Topic/Title	Format
Engineers Canada Newsletter	August 10, 2017	Accreditation Units Task Force meets in Toronto	e-Newsletter
Engineers Canada Newsletter	October 19, 2017	Accreditation renewal activities gaining momentum	e-Newsletter
Engineers Canada Newsletter	November 2, 2017	2017 Deans hold fall meeting in Niagara Falls	e-Newsletter
Accreditation Improvement Program Update	September 2017	Clarifying the AU Task Force, AIP, and the day-to-day of accreditation	e-Newsletter
NCDEAS	April 28, 2017	Accreditation Board update to NCDEAS	Presentation
NCDEAS	October, 2017	Accreditation Board update to NCDEAS	Presentation
GACIP	December 7, 2017	Accreditation Board Update 4th Graduate Attribute and Curriculum Improvement Process Summit	Presentation
Update to the AB	September 9, 2017	AU Task Group Activities Update	Presentation
Update to the Engineers Canada Board	September 27, 2017	AU Task Group Activities Update	Presentation
Update to the CEO group	September 25, 2017	AU Task Group Activities Update	Presentation

3.7. Proposed consultation process

It is the recommendation of the Task Force that a stakeholder consultation process be executed.

Stakeholders to be consulted:

- Engineers Canada Canadian Engineering Accreditation Board (CEAB) members
- National Council of Deans of Engineering
- Engineering regulators
- Engineering students

Consultation process and milestones:

Tactic	Timeframe (TBC)
Formal email invitation to comment on Task Force recommendations	
Consultation open	**March 1, 2018**
Consultation kick-off webinar	First week of March
Conduct a pilot study with (volunteer) programs by applying the learning unit based on the recommendations of the Task Force report	March 2-April 30
Presentation at DLC meeting	April 25, 2018 TBD
Presentation at NCDEAS meeting	April 26 2018
Presentation to Engineering regulators' councils (TBD)	March 2-April 30, 2018
Presentation to regulators' boards of examiners/Academic review committees (TBD)	March 2-April 30, 2018
Presentation to national Admissions Officials Group (NAOG) (TBD)	March 2-April 30, 2018
Presentation to CEQB	April 2018
Consultation closed	**April 30, 2018**
Consolidation of comments received	June 1-29, 2018
Publish summary of comments to all consulted stakeholders	July 2018
Approval by CEAB (consider special meeting)	August 2018
Approval by Engineers Canada Board	September 2018
Notification of approval	October 2018

4. Appendices

4.1. Appendix: 1 Report on AU Task Group Survey of NCDEAS

Question 1:
Institutions were asked what non-traditional teaching methods were currently in use, or being contemplated, in their faculty of engineering. While 21 different methods[9] were clearly identified *(Table 1)*, some methods were mentioned with more frequency. The most common mention was of flipped classrooms, with blended classes and online courses being less common, but also frequently mentioned. Interestingly, nearly all mentions of blended classes, and approximately half of the mentions of flipped classes, indicated that they are currently in use. While online classes have some adopters, not nearly as many as flipped and blended classes. It's important to note that some respondents did not use the survey form as intended. Therefore, it is recommended that the forms be reviewed to understand the full breadth of comments from the institutions.

Table 1: Counts of educational methods being contemplated, currently in use and the number of total mentions (total mentions = contemplated changes + currently in use + those mentioned, but not specified if contemplated or in use).

Educational Method	Contemplated Changes	Currently in Use	Total Mentions
1 : Badge powered learning	1	0	1
2 : Blended classes	0	6	7
3 : Broader electives or major and minor offerings	0	1	2
4 : Case study	0	1	1
5 : Community Service learning experiences	0	0	2
6 : Co-operative education	0	1	2
7 : Design courses	0	4	4
8 : Exchange programs	0	0	2
9 : Experiential learning	0	2	4
10 : Extracurricular	2	1	2
11 : Flipped learning	0	7	11
12 : Hands on Learning	0	1	1
13 : Hybrid Class	1	0	1
14 : Independent research	0	1	1
15 : Just-in-time teaching	0	0	2
16 : Lab based course	0	1	1
17 : Online course	3	2	6
18 : Online lab	1	2	1
19 : Problem Based Learning	0	4	2
20 : Project Based Learning	1	3	4
21 : Seminar based learning	1	0	1

[9] Note from JR: I don't know enough, and didn't have enough time to determine if any of these are redundant with one another. If you believe that two methods are actually the same, or similar enough, you can simply add the numbers in the associated cells to understand how often that group was mentioned.

Question 2:
While the responses to the question, "What are the challenges, if any, in adequately capturing these methodologies with the AU system?" were diverse, trends emerged.

Most predominantly, institutions identified the need to improve teaching methodologies (i.e. shift away from traditional lecture-style teaching), to methods that centered on student learning, achievement and diverse skill acquisition. These methods included those outlined in Table 1. However, it was stated that the current AU system encouraged the adoption of traditional, less effective lecture-style instruction. Many of the alternative teaching styles required much more student work outside of the classroom, which was believed to not be accurately counted by course credits or the accreditation system. In addition, they required less lecture style instruction and more lab or tutorial style instruction, which is believed to be counted as 50% time, thereby requiring students to spend more actual time to equate to 'AU time'. It was argued by many that, in fact, the traditional lecture style is less effective and should be considered the same as other instructional methods.

It was also noted repeatedly that the current system does not allow for consideration of student learning outside of course content, whether through extra-curriculars, co-curriculars, international exchanges, co-ops and internships, or other informal learning opportunities. It is believed that these experiences provide essential skills and competencies required of graduates, but that they are not appropriately accounted for. Particularly in light of the heavy investment at federal and provincial levels in work-integrated-learning (co-ops, internships, etc.), this may become a greater issue in the near future.

These two points draw attention to the need for criteria that measure the true impact of different components of students' education, whether direct (alternative classroom styles that could be counted the same as lecture style) or indirect (extra-curricular, co-op, or international experience).

Many other important points were made that are likely important to consider, but were only mentioned a few times. This included the challenges of counting transfer students' credits (also noted to be of recent significant provincial investment), academic literature supporting arguments, concerns over students' mental health and the relative 'tied-hands' of Faculties of Engineering, as well as confusion over how criteria can be combined. It is encouraged that the AU Task Force reads all responses to question 2 to understand the breadth of concerns raised that this synopsis could not provide.

The Survey

***(Survey)* Background: Why this survey?**

The NCDEAS is collaborating with CEAB, Engineers Canada, and regulators to improve the system of Engineering Accreditation in Canada with the overall goal of enhancing the quality of Engineering education. Engineers Canada has established an AU Task Group with broad stakeholder representation to look specifically at the role of input measures (AU's) in accreditation and how this system might be improved. As part of this project the AU Task Group is asking for feedback from higher education institutions and would like your response to the two questions below.

The AU Task Group would be very grateful if you could provide your feedback by **November 8, 2017 to John Kizas, at: john.kizas@engineerscanada.ca and lynn.villeneuve@engineerscanada.ca**

1. What non-traditional educational methods are (a) currently in use or (b) contemplated in your programs (up to 4 examples each are suggested, if any?) 2. What are the challenges, if any, in adequately capturing these methodologies with the AU system?
(preferred but optional) What is your title/position: From which institution:

(survey)* Question 2 responses *(raw data)

(Q)What are the challenges, if any, in adequately capturing these methodologies with the AU system?

(R)

- PBL: AU counts determined by k factor that is based on traditional course hours but the allocated AU count may be low compared to the rigor of and time required to complete the assigned task
- JITT: no significant challenges identified
- Flipped Learning: AU calculations specify that lecture time is twice as "valuable" as tutorial or lab time; reviewers who are unfamiliar with the principles and advantages of flipped learning may question (and halve) the AU count for such learning environments
- Co-op: all AUs are assigned to a generic AU count while the work performed in the majority of co-op work terms are engineering science and/or engineering design in nature

(Q) What are the challenges, if any, in adequately capturing these methodologies with the AU system?

(R) The challenge with the above non-traditional educational methods and the AU system is that the extensive amount of preparation and reflection work that students do outside the classroom is not captured with the AU system.

(Q)What are the challenges, if any, in adequately capturing these methodologies with the AU system?

(R)

- Flipped classroom: AUs can be computed using the K-Factor, though we are perhaps less familiar with the practice of using K-factors. There are perhaps problems in counting the material as “lecture” instead of “tutorial” – the work done before coming to class is intended to replace the “lecture”, the actual activity in class probably looks like “tutorial”.
- Blended classroom: this is perhaps more challenging because some of the classroom activities can be counted using the basic AU counting principles and others require quantification using the K-Factor. It isn’t clear if AUs can be computed using these different criteria, and combined, for a single course.

(Q)What are the challenges, if any, in adequately capturing these methodologies with the AU system?

(R) It is understood that in principle K-factors should allow all these to be correlated with AU’s for traditional lecture based courses, however there is great reluctance at the program level to risk doing this with more than a few courses, since the calculation/assignment of the K-factor is open to interpretation. Stories abound of visiting teams challenging the K-factor AU assignments, risking shortfalls in some AUs.

The AU system tracks contact hours, but has difficulty dealing with independent work or experiential learning.

(Q)What are the challenges, if any, in adequately capturing these methodologies with the AU system?

(R) There are two challenges associated with capturing these methodologies within the current AU system.

i. The AU system assumes that each higher education institution has its own defined and consistent approach to counting academic course credits. At the senate level our institution does not posses or impose such definitions. As such our Engineering School, in anticipation of these additional educational methods being implemented, is working to define a framework around counting and representing the various forms of contact time, within the academic credit weight system. This is a critical exercise given that the use of the k-factor requires the use of the academic credit system. If the academic credit system is not calibrated it could falsely represent the k-factor.

ii. The AU systems implicitly assumes that the contact time via tutorial and labs is half as valuable as the contact during lecture. A shift toward equal weighting of lectures, labs and tutorials would allow us to represent the high value we place on project based and flipped classroom learning.

(Q)What are the challenges, if any, in adequately capturing these methodologies with the AU system?

(R)

a) Evaluating AU equivalencies when students go on exchange is an enormous task, especially since most students go on exchange to universities with which “No Formal Structure or Agreement” exists (as per Appendix 1 of the Accreditation Criteria and Procedures). At present, any student who goes on exchange is especially limited in the courses they can take to minimize the impact on their studies (all the while respecting the “Engineering science and engineering design curriculum content” regulations specified in Appendix 1). Upon their return, each student is subjected to an individual (AU) curriculum analysis, for their studies taken abroad and any deficits in AUs, even minor, must be accounted for by additional coursework. This both delays the “time-to-graduation” of students, and completely ignores all the indirect benefits they reap from going on exchange, learning in another country/culture, etc. Lastly, the administrative burden placed on HEIs by this task, along with that of evaluating AUs of transfer students, and students taking courses at other HEIs, occupies one half of one full-time employee’s workload, which could be better used for other purposes that directly improve student education.

b) As time progresses, instructors in our faculty are increasingly investigating alternate learning methodologies. These include approaches such as flipped classrooms (in which the delivery of instructional material occurs outside of the classroom, and “class-time” is used for other activities, such as problem-solving, which traditionally occurred outside of class), online education, etc. Neither of these approaches can be sensibly captured by the traditional definition of AUs. More generally, the notion of “contact time” to quantify curriculum content is not substantiated. A measure of course workload (perhaps related to credits), which would include instructor-student contact time, personal study time, other out-of-class activities that are scheduled outside of lecture and tutorial/lab hours, etc. may be a more accurate measure of curriculum content.

c) Our students are involved in many different types of co-curricular learning activities, which i) occur outside of class, ii) result in substantial learning, and iii) do not lend themselves to being counted in the current AU-based analysis of curricula. Such activities can have a notable impact on students’ education. Moreover, the majority of our undergraduate students undertake at least one 4-month internship, which is not accounted for in traditional AU accounting methods.

(Q)What are the challenges, if any, in adequately capturing these methodologies with the AU system?

(R) Since most of our courses are “traditional” courses, we have no issues with the current AU system. It is a system that allows us to relatively easily quantify course content for all of our courses as part of preparing for an accreditation visit, and is a system that allows us to demonstrate that our programs meet the input criteria for accreditation. For a military college, AUs also provide a quantifiable measurement that prevents encroachment on student time during the day for non-academic activities that might otherwise be imposed upon students – everyone understands that Engineering programs are different and accredited, and that our students need some minimum number of hours in the classroom.

Reference 1 - 10.78% Coverage

What are the challenges, if any, in adequately capturing these methodologies with the AU system?
The definition of the hours in AUs is too restrictive to account for these means of achieving learning outcomes and delivering content. The k-factor is insufficiently well defined and does not properly account

for the true nature of the contact hours and learning.

Reference 1 - 23.39% Coverage

What are the challenges, if any, in adequately capturing these methodologies with the AU system?

Discounting of lab activities by 50% relative to lecture time does not fit well with the emphases of our program, though I understand that this practice may be more suitable for programs that place more emphasis on theory. The relevance of AUs may come into question if and when we introduce competency tracking within our program. More generally, AUs are a blunt tool focused largely on the size of the program, when what you want is to assess the overall competency of graduates and relevance of what they have learned. This is certainly not easy to accomplish, but movement in that direction could be helpful.

(Q)What are the challenges, if any, in adequately capturing these methodologies with the AU system?

(R) K factor adequately describes AU for the courses in question. We have had no challenges in using AU's in the traditional approach or the k factor values for our new programs. When one translates the h – AU values for our design courses, the capstone course, the h-AU value is approximately 90, which makes sense for the in class and out of class effort.

(Q)What are the challenges, if any, in adequately capturing these methodologies with the AU system?

(R) To not being entirely confident that we respect CEAB criteria is always very stressful for professors. Instead of innovating, they tend to repeat the old way of teaching. The current system doesn't support pedagogical innovation and multidisciplinary experiences. Doing innovation in engineering teaching is hard enough; why had a stress on this challenging process?

Reference 1 - 26.38% Coverage

(Q)What are the challenges, if any, in adequately capturing these methodologies with the AU system?

(R) All of these involve substantial learning outside of the classroom and in most cases reduced face-to-face lecture hours, making AU attribution more difficult. While K-factor calculations may be possible for these, it would be preferred to have a more straightforward approach based, for example, on course credits towards the degree.

What are the challenges, if any, in adequately capturing these methodologies with the AU system?

- Accurately providing representative AU numbers
- Capturing the out-of-class hours associated with the learning

(Q)What are the challenges, if any, in adequately capturing these methodologies with the AU system?
(R)

1. The AU system is restrictive. It does not take into account the value of the learning process as a whole. Learning is not only a process by which a teacher transmits his knowledge in a classroom, in a laboratory or tutorial work.

2. In some cases, students find that actual workload exceeds academic credits granted for a course.
3. What is the logic in attributing 1 AU for one hour of lecture and only .5 AU for one hour of laboratory or tutorial work? Students learn as much or more than in a classroom setting. At the present time, it could be proposed the opposite.
4. Recognizing Specific AU based only on professional engineering licensure does not take into account excellence in teaching.
5. The AU system is an artificial metric insofar as student presence in lecture classrooms is optional.

Reference 1 - 94.95% Coverage

Response:

To be honest, to us the assignment of AUs continues to have two major problems. One is that by virtue of how a calendar year falls, placement of statutory holidays, and other minor issues, the CEAB measurement of our programs via AUs changes. In reality, these subtle and unavoidable changes do not, in our opinion, have an effect on program quality or total content with the exception that they force us to add additional contact time or content to guard against ‘shorter years’. These sorts of issues should not be a factor in deciding the correct balance of content and contact time for our students. The second major problem is that we struggle to respond to issues of mental health concerns for our students in terms of the intensity of the program, again due to the sheer volume of content and contact time. We support our students as best we can in other ways, but this is one area where our hands are tied. Student stress and anxiety is of national concern and some additional latitude over how to structure our content with less emphasis on contact hours (and without having to invoke other measurement systems in their place) would allow a more holistic construction of our programs, to student benefit.

Beyond these general concepts, I have tried to identify a few areas where we feel that the focus on AU numbers and categories are problematic. We recognize they are not exactly answers to your direct questions, but hopefully useful nonetheless.

Topic 1:

This is more of a provincial practice than a non-traditional educational method, but BC has a well developed transfer college network, and a philosophy of student mobility that encourages institutions to grant credit for prior studies when transferring from one institution to another. We have a variety of colleges that provide a 1st year engineering program and pathways that let students move to institutions that grant engineering degrees. Enforcing AU counts and particularly specific AU counts on junior level work is onerous on a number of counts. It forces institutions such as UBC to add additional content in upper years to protect against AU shortfalls (or enter into micromanagement of college instructors); it adds additional strain on students; it creates uncertainty for colleges that struggle to grow their programs due to limited instructors with P.Eng. status. In a modern educational system that focusses on learning outcomes, prior credit should be easier to grant and should not be subject to AU counts if intermediate and senior level work is satisfactory. The actual content and learning outcomes should be of far greater importance than the counting of contact time. We are working in BC to define a ‘first year engineering program’ in terms of core topics included and learning outcomes. If we had the latitude to, say, package and share our first year engineering science and engineering design content with smaller college programs at full AU value, this would be of great benefit to us in achieving our province-wide goals.

Topic 2:

The concern with the AU system should not be limited to the inability to capture non-traditional techniques. The differential counting of contact time based on activity type as a measure of learning must also be questioned. Attendance is not frequently taken in university classes, and significant student learning takes place outside of the classrooms and labs. Indeed, there is no reason to believe that labs and tutorials are half as valuable as lectures, and instructors set assignments for students because doing is truly the way that students learn the intricacies of any given topic (independent time currently has no direct value in the AU system). Modern teaching techniques incorporate online components, in class activities, and integration of traditional lecture content with student led in class examples. To this end, a distinction should not be made between different types of learning activities, and instructors should be trusted to identify the best combination of teaching and learning styles for their topic and their students, emphasizing the mastery level of students over the amount of time spent achieving that level.

Topic 3:

The preoccupation with having sufficient AUs in each of the pre-defined categories has overshadowed more valuable discussions about the content that is being included in programs. The analysis of whether enough natural science is taught in a program is becoming more important than an analysis of what specific topics are being covered, for example. The external review of programs by visiting teams would be far more valuable if there could be greater emphasis on the breadth and depth of different areas of study for each program in question.

Topic 4:

For many students, the current workload in engineering is too high and some students would prefer to be able to spend some time on other developmental aspects of their education. But, there are some for whom the pace may be too slow (perhaps in one area, perhaps in multiple areas). If a student could demonstrate mastery of a subject at a rate faster than we plan, why should we be the rate limiting step, and why should we measure contact time? If a decision was made to allow two streams that had the same content but delivered at different speeds, should the ‘faster’ students have to take the same number of credits? Or, should those students be forced to do twice as much content to satisfy the same AU counts? Neither seem right. Challenge exams or accelerated courses should be a possibility without affecting the minimum path, similar to the exams available to those who apply to a provincial licensing body after having trained with a non-traditional background.

Reference 1 - 15.99% Coverage

What are the challenges, if any, in adequately capturing these methodologies with the AU system?

- program content that is not expressed in either traditional contact hours (classroom/lab/tutorial) or academic credit hours does not fit within the current system.

When considering the specific activities you listed above, please indicate which part of the accreditation criteria should the Task Force review further? What are some issues you have identified?

Reduction of Total AUs and in particular the number of specified AUs to allow more participation in “Engineering Plus” activities.

Remove the restrictions on reporting of AUs that limit the minimum % of a course that may be counted. This is an essential action if we are to benefit fully from integrated learning.

Remove the AU distinction between lectures, tutorials and labs, this is particularly important in relation to flipped classrooms, because the content is typically delivered on line and developed in “studios” and “workshops”. Whilst the current requirements do not contain explicit barriers to these activities, it is not unusual for visit teams to argue that the studios and workshops are essentially tutorials. Although at one level this position is accurate, it is not consistent with the CEAB claim to support new teaching and learning methods. It would be more convenient to remove the distinction which erroneously emphasises lectures over other learning vehicles.

4.2. Appendix 2: Proposal for a Revised System for Measuring Educational Inputs

Submitted by AU Task Force member Tom Tiedje

January 14, 2017

1. Background

Engineers Canada, the CEAB and Canadian Engineering Faculties are agreed that the system of engineering accreditation should not serve as a barrier to incorporation of new learning methodologies that enable improvements in engineering education. In particular Canadian Engineering Faculties and the CEAB wish to find ways to adapt and improve the AU system for measuring educational inputs to better connect input measures to graduate attributes, and to find appropriate content measures for new learning methodologies that don't involve traditional lecture-lab-tutorial based instruction.

There are also concerns that not enough attention is being paid to student workload. In many/most Canadian engineering schools only a minority of students graduate in the recommended time. Anecdotal feedback from students suggests that many students are unable to complete all the required elements of their academic programs in the available time, leading to skipped classes, student burnout and copied assignments.

Over the last 30 years or so there has been a shift in education away from teacher-centred learning to student-centred learning. Student-centred learning emphasizes the critical role of the learner in education, and enables independent problem solving and lifelong learning. In traditional teacher-centred learning the instructor has the active role and students are passive receptors. See Wikipedia for a more detailed discussion.

There is a widespread belief that Canadian university students benefit from international experiences, yet on an annual basis only 3% of Canadian university students have an international experience, an even lower fraction than in the US. Students face many barriers to international experiences. Restrictions on transferability of international AU's imposed by accreditation may not be the biggest obstacle, but improving transferability of international credits would certainly help reduce barriers.

In order to make academic credits transferable across the EU, for countries with different academic requirements and traditions, the EU introduced the European Credit Transfer System, in which academic credit is based on student learning time. The CEAB faces a similar challenge. CEAB needs to assess academic credits assigned to a growing number of different learning activities offered by different institutions with different academic traditions. We argue that the European solution is transferable to the similar problem faced by the CEAB.

2. Executive Summary

- This document is a proposal to change the way AU's are measured, from instructional time to student learning time. This change is aligned with the general trend in education towards student-centred learning, and away from traditional teacher-centred learning.
- Learning time can be measured in three ways: from student surveys incorporated into course evaluations, from the expectations of course instructors, and from interviews with students. In combination, these approaches provide a robust measure of learning time.
- 2.5 hr learning time is recommended as the new AU definition, 3.0 hr of learning time is another viable option.
- Four optional approaches to implementing the learning time methodology are proposed.

- By shifting the basis of input measurement from classroom time to learning time, engineering schools will be able to incorporate new learning methodologies in an equitable and transparent way without using the K-factor or university credits.
- By introducing learning time as a metric, we focus appropriate attention on the single most important resource in engineering education, namely the students' time.
- Learning time measures will facilitate academic exchanges with European countries which now measure university credits in ECTS units which is a measure of learning time.
- The total number of hours per week that the typical student spends on their studies is an important parameter in any system based on learning time. In this document we use 50 hr/week as the learning time for a typical student. 60 hr/week is another viable option.

3. Description of Learning Time and Connection with AU's

Learning time is defined as the aggregate of all the time that a typical student spends on activities required to achieve learning outcomes in a particular course including: attending lectures, labs, tutorials; working on assignments; reading the textbook; attending webinars; discussing course materials with peers, TA's and instructors; making and preparing presentations and reports; working on projects; writing and studying for midterms and quizzes; and meeting with design teams. Learning time in this document is defined as focused learning time. Learning also occurs in unfocused ways, for example when standing in the shower, walking to school etc. but this type of learning time is not counted in this definition of learning time. Registering for courses and buying textbooks are also not included. Writing and preparing for final exams are not included in the current definition of AU's but could be included in a new definition of AU's based on learning time.

The recommended learning time per week is 50 hr (this number needs further discussion). To bring learning time into alignment with the existing definition of AU's, one AU is defined as 2.5 hr of learning time. To see how this works we compute the number of AU's for the second year ECE program at McMaster University, which has the relatively standard format of five 3 hour lecture courses per week, 8 hr of labs per week and 4.5 hours of tutorials. According to the current accounting system this workload is (15+ (8+4.5)/2) = 21.25 AU's, or 2125 AU's for a full 100 week program if all terms have the same number of AU's.

We assume that students spend 1.5 hr in study outside the classroom for each hour inside the classroom and that for each 3 hour lab students spend one hour outside the lab writing up their reports. In this case the total learning time in one week of the McMaster ECE program is: (15 + 1.5x15 + 4.5 + (8+8/3)) = 52.7 hr. This counting methodology means that three lab hours are worth 1.6 lecture hours and that one tutorial hour is worth 0.4 lecture hours, approximately the same as the current weighting of 1, 0.5 and 0.5 for Lect, Lab, Tut.

If the HEI and the CEAB accept this way of translating AU's into learning time then the HEI could continue using the existing way of counting AU's with no changes. There would be no need to even measure learning time in this case.

If an HEI chooses instead to develop an engineering program with non-traditional elements then it would need to measure student learning time to determine the AU's for the non-traditional parts of the program.

In the new system, with suitable documentation of learning time, HEI's could also develop heavier or lighter courses that require more or less than 1.5 hr/class of work outside the classroom and adjust the number of classroom hours accordingly.

4. Measurement of Learning Time

Three ways to measure learning time are illustrated below with examples: 1. student surveys as part of student course evaluations, 2. the expectations of the course instructor and 3. one-on-one student interviews.

Student surveys

The graphs at the end of this document show UVic student responses to the question: *The approximate number of hours per week I spent studying for this course outside of class time.* Students are given 6 choices as indicated on the horizontal axis in the figures. The aggregate response for all Electrical and Computer Engineering and Mechanical Engineering Courses at UVic in the spring term in 2016 are shown in the first graph. The average number of hours spent studying per 3 hr/wk course, for all courses, is 4.6 hr/week. [Note: A typical response rate to the online course evaluation is 50% of the students registered in the course.]

Expectations of the instructor

The next two graphs show the number of hours students spend studying in two individual courses, a first year computer science course and a second year thermodynamics course. The instructors were asked to estimate how many hours per week students in their classes spent working on the course outside of class time, without knowing what the students actually said on the course evaluation. In the case of the computer science course the instructor said he expected the students to spend 1 hr reading the textbook, 1 hour working on a blog and 3-5 hr working on the assignments for a total of 5-7 hr per week. The students reported working an average of 4.6 hr/week in this course (see graph below). In the thermodynamics course the instructor said that he expected his students to spend 1-2 hr a week reading the textbook and reviewing their notes and 3-4 hr per week working on the assignments for a total estimated study time of 5 hr per week. The students reported working an average of 5.8 hr/wk on this course (see graph below).

Reviewing a number of course evaluations, I found that the students reported average study times in the 3.5-5 hr/week range for most courses with a few outliers as low as 2 hr/week and as high as 10 hr/week.

The learning time measure of 2.5 hr/AU is intended to be the time required by a typical student to achieve the learning outcomes of the course. Some students will take longer and some students will take less time. For example one might expect strong students to be able to get achieve the learning outcomes more quickly. On the other hand a strong student might be more diligent and may take more time to do a better job.

Student interview

The third method for estimating learning time is to speak directly with individual students or groups of students. Copied below is a report from a McMaster grad, an outstanding student with all A's in his courses, who was asked about the amount of time he spent doing his engineering degree. This person reported a 59 hr work week. There is no indication that the amount of work required to graduate has declined since this person graduated. Here is what he said in his own words:

"I counted how many hours a week I spent in a lecture or a lab. In second year, this was 35 hrs. By the time I went home, had dinner and started studying, I had 2 to 3 hr on a week day. I studied on the weekend too (7 hrs each day). So, the total number of hours I had for homework was 24 hrs. During exams, I worked harder. I can imagine increasing 24 to 35 hrs, but it is not sustainable.

Real life is something like this:

Labs—If the lab requires a write up, I usually spent 3 to 5 hours working on the calculations and preparing the lab report.

Tutorials—No direct preparation time was associated with it.

Lectures—When I was not overwhelmed, I did take the time to read the relevant parts of the book and try to go over my notes to stay on top of everything. When I had the time, I spent 30 to 45 minutes reading for every lecture I had. When things got crazy, I only read the book when I had to (for an assignment for example). Many of our students, today, don't read the book probably because there is no time in the first place.

Assignments—Not sure under what category these fall. Most courses have between 4 and 6 assignments. If they don't have this many assignments, they probably have a project which is as much work as 4 to 6 assignments :) At 6 courses per term, this works to ~2.5 assignments per week. Each assignment took me 2 to 4 hrs to complete. Again, we often wonder why the students copy the assignments. It is because they don't have time to do them.

Midterms: Say 10 per term @ 5 hrs of studying each?

Sum: 4 hrs/lab x 12 lab = 48 hr + 0.5hr/lecture * 15lectures/week*13 weeks = 98 hrs + 2.5 assign/week *13weeks* 3 hrs=98 hrs + 50 midterms =293 hrs per term

Which gives 22.5 hrs per week, which is in agreement with my rough calculations of 24 hrs per week. Now 24 hr/week is hard work. Anyone, who has anything else going on in their lives, won't be able to put in this much work. So here is hypothesis to consider, all our students are smart (they all have >90%) the reason we have a grade distribution after 1st year is because we have a distribution of how much time our students have to study (some work, some commute, some have family responsibilities) …."

Given the consistency among the various measures, I claim that the measurement of learning time can be made relatively robust. The statement on "Monitoring of credit allocation" in the ECTS Users Guide 2015, copied at the end of this document, explains how the EU manages this issue and shows that the Europeans do not have a problem with assigning transferable credits that are based on learning time.

5. Comparison with ECTS

The AU and ECTS have different purposes but they can be brought together in a natural way. The role of AUs is to measure breadth and depth within the curriculum components of Math, NS, ED, ES, CS.

3.4 The curriculum content and quality criteria are designed to assure a foundation in mathematics and natural sciences, a broad preparation in engineering sciences and engineering design, and an exposure to non-technical subjects that supplement the technical aspects of the curriculum.

The purpose of ECTS is as follows:

ECTS is a learner-centred system for credit accumulation and transfer, based on the principle of transparency of the learning, teaching and assessment processes. Its objective is to facilitate the planning, delivery and evaluation of study programmes and student mobility by recognizing learning achievements and qualifications and periods of learning.

Our opportunity to change the way curriculum content is measured is already in the Accreditation Criteria and Procedures document:

3.4.1.4 The Accreditation Board can give consideration to departures from this approach and these methodologies in any case in which it receives convincing documentation that well-considered innovation in engineering education is in progress.

One ECTS (European Credit Transfer System) in Europe is 25-30 hr of learning time, depending on the country. Therefore the 5000 hr of learning time proposed here (50 hr/week, 100 weeks) is 167-200 ECTS. The 5000 hr in Canada does not include final exams, which is included as part of the ECTS in Europe. If we did include exams and assume three weeks at 50 hr/week studying-for and taking final exams at the end of each term as in Europe, (see below) this adds 1200 additional learning hours for a total of 6200 hr or 207-248 ECTS in total for the degree or 52-62 ECTS per year. Normally a European academic year is 60 ECTS so Canadian academic years contain slightly less or similar learning time as European degrees. We can conclude, unsurprisingly, that a Canadian four year degree is more than a three year degree in Europe but less than a five year degree.

The message below from a Swiss professor further illustrates the difference between the Canadian system and the European system. The credits he refers to are ECTS credits:

“Each semester is worth 30 credits, with 6 semesters in the bachelor curriculum, which makes a total requirement of 180 credits (the example at hand has 186). Note that our professional degree is not the bachelor degree, but rather the master degree, which requires another two years, hence a total of 5 years and 300 credits.

We expect the average student to invest up to 30 h per credit, hence 900 h per semester; our semester has 14 weeks of classes and 3 weeks of exam (+preparation), hence a total of 17 weeks. This results in an average workload of 900/17= 53 h/week. A respectable workload!”

6. Learning Hours per Week and per AU

The number of hours in a typical student work week can be debated: 37.5 hr/week is full time in many jobs. What we are looking for is the recommended time that a typical engineering student needs to spend engaged in learning in order to succeed in the program. Many students will spend considerably more time. In addition, the workload is normally not uniform through the term, early in the term the workload will be less.

In this document we have assumed the weekly learning time to be 50 hr/week. With eight 12.5 week terms this means the total learning time for a degree is 5000 hours. The required 1950 AU’s in a CEAB degree means 5000 hr/1950 AU = 2.56 hr/AU, rounded down to 2.5 hr/AU to keep it simple.

If a 60 hr week is preferred the learning time per AU and learning time for the degree would be 3 hr and 6000 hr respectively. Both 50 and 60 hr work weeks fit within the range of acceptable learning times in the European Credit Transfer System.

At least one dean recommends that 45 hr is the right number of learning hours per week. Further discussion on this point is needed.

7. International Credit Transfer

Credit for international study abroad is generally impractical because of the need to show that ES/ED instructors are qualified to practice engineering in the foreign jurisdiction. This restriction is ironic given that graduates of the same foreign universities are likely approved for licensure in Canada with no such requirement (as advised by QB).

An option for resolving this would be to replace the current regulation with two requirements: (a) that the foreign university be on the list of universities that the QB considers as providing acceptable academic qualifications for Canadian licensing of foreign trained engineers and (b) that the home Canadian university approve the foreign course for credit. If the foreign university is in Europe, the number of AU’s allocated is obtained by converting the ECTS assigned to the learning activity as explained above.

8. Options for Implementation

If a decision were made to implement the learning time approach one of the options below could be selected or the options could be adopted sequentially for a progressive transition to a Canadian version of the European ECTS system.

Options

1. Apply the learning time approach to non-standard learning activities and leave everything else the same. That is, assign 1 AU for every 2.5 hr of focused learning time that is required by the non-standard learning activities (e.g. project courses). Learning time to be assessed by the course instructor. Continue to use the existing AU assignment method for other learning activities (lectures, labs, tutorials). Rationale: many university senates already take learning time into consideration in assignment of course credit. Note: We don't want to have two different methods for measuring AU's, therefore this option should only be available for a limited time to facilitate the transition to learning time.

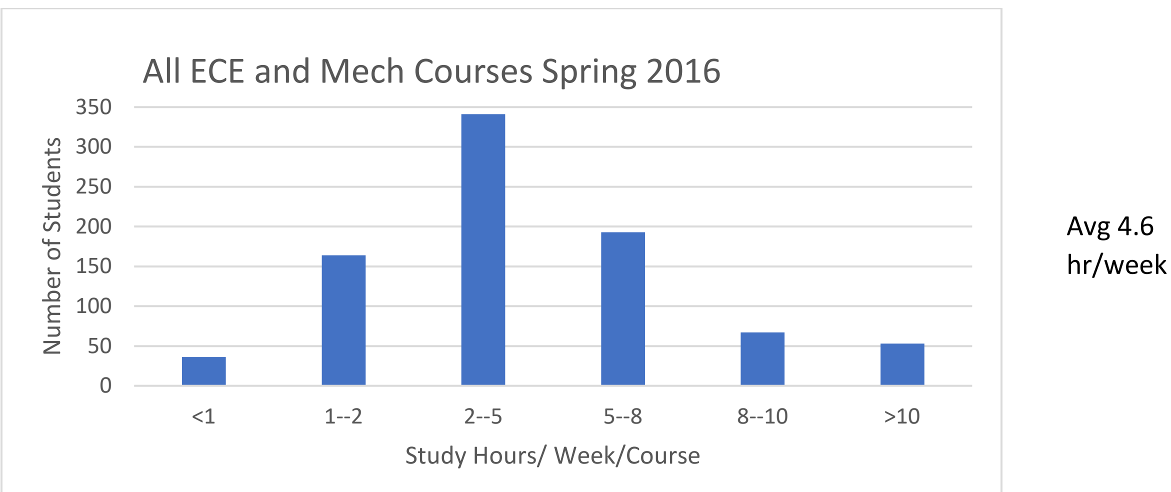
2. Same as in Option 1, but measure focused learning time for all learning activities through (a) student surveys as part of course evaluations and (b) instructor expectations to be stated in course outlines. In the case of conventional learning activities, learning time measurements are used for formative feedback only, AU's assigned as in the past. The measured learning time to be used by the CEAB as an indicator of achievement of learning outcomes in courses. Rationale: Awareness of expectations with respect to learning time by both students and instructors supports good pedagogy.

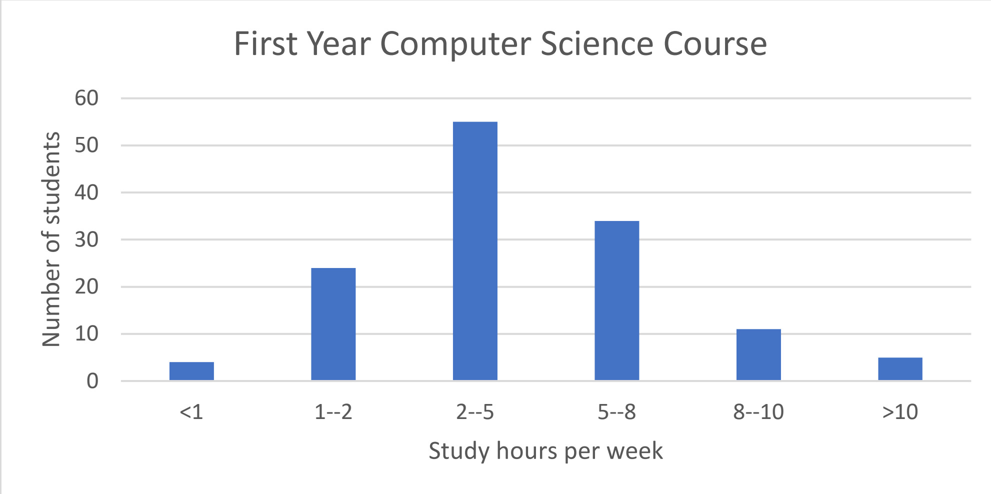
3. Same as in Option 2 except HEI's have the option of adjusting AU counts for all learning activities to take into account actual learning times as supported by learning time measurements. An accredited engineering degree to consist of 5000 hr of learning time as in the previous options. Rationale: This option provides flexibility in terms of the number of courses and how subject matter is packaged. Once this option is implemented AU's are no longer needed and can be replaced with learning time.

4. As in Option 3 except include learning time associated with preparing for and writing final examinations as is done in Europe and adjust learning time requirements for degree upward, accordingly.

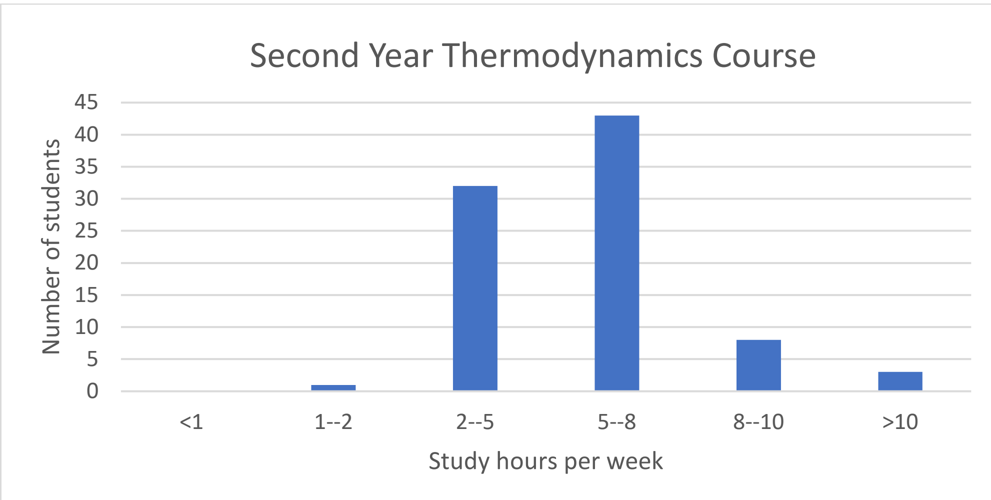
Measurement of Learning Time from Student Course Evaluations

The data below comes from answers to the question, "*The approximate number of hours per week I spent studying for this course outside of class time"*, on the University of Victoria student course evaluations.





Avg 4.6 hr/week



Avg 5.8 hr/week

Discussion of Learning Time in ECTS Users Guide 2015

The discussion below shows that in the European system the measurement of learning time is relatively straightforward.

http://europass.cedefop.europa.eu/sites/default/files/ects-users-guide_en.pdf

p. 28

3.6 Monitoring of credit allocation

The programme is monitored to establish whether the credit allocation, the defined learning outcomes and the estimated workload are achievable, realistic and adequate. Monitoring can be managed in different ways through questionnaires, focus groups, or interviews, or by monitoring the results achieved. Whatever method is used, feedback from students, staff and where appropriate, stakeholders should constitute an essential element for checking and revising credit allocation. Data on completion times and the assessment results of programmes and their components should also be used.

It is important to inform students and staff about the purpose of the monitoring exercise, and how it will be carried out, to ensure accurate answers and a high response rate. If the information gathered reveals a discrepancy between the workload foreseen and the time actually taken by the majority of students to achieve the defined learning outcomes, it will be necessary to revise the workload, credits, learning outcomes or learning and teaching activities and methods. This could also involve redesigning the study programme and its educational components. The revision should be done as soon as possible without creating problems for those who are currently taking the programme and should be communicated to those who had participated in the monitoring exercise, in order to foster an ongoing, cooperative feedback culture in the institution.

4.3. Appendix 3: The AU-Task Force Background research

The Accreditation Unit –Revise or Replace?

An interim paper drafted by Graham Reader with input from Tom Tjedje, Michael Isaacson, Dan Candido, and Matthew Oliver and insight provided by Dwight Aplevich.

Preamble:

In March 2017 a Task Force was struck by the Policies and Procedures Committee (P&P) of the Canadian Engineering Board (CEAB) to 'Reassess the value of continuing mandatory use of the AU system". The stated aims of the Task Force were:

1. To consider the definition of an AU in its present form (criteria 3.4.1.1) and to identify, the advantages, disadvantages and ramifications of any definition change on existing criteria.

2. To envisage how curriculum content requirements could be linked to student outcomes/graduate attributes whatever system of AU counts is used.

Preliminary reports were presented to the Dean's Liaison Committee (DLC) and P&P in April 2017 together with a brief summary to NCDEAS. A short presentation was provided for use at the June 2017 meeting of the CEAB.

This report was drafted by some members of the AU Task Force. However, Task Force composition changed in June 2017. This report was never formalized. It remains as background information.

Preliminary Draft Report

The Accreditation Unit (AU) is the quantitative measurement tool used by Engineers Canada to determine the curriculum content of undergraduate Engineering programs. The tool was introduced in the 1990s and is still used today. It is the core of a measurement system beloved by many, perhaps almost all, Provincial regulators and increasing disliked by a growing number of members of the National Council of Deans of Engineering and Applied Science (NCDEAS). The dislike appears to have gained momentum since the almost simultaneous introduction of the mandatory criteria requirements for programs to have to demonstrate that the graduates of a program possess defined attributes – Graduate Attributes – and that the program must demonstrate that all graduates have had a minimum of 1950 university level AUs of instruction. The possession of the graduate attributes is a qualitative output measurement of the program whereas the AUs are an input measurement of the instruction all students must receive – and define the regulator valued 'minimum path'. The Graduate Attributes (GA) – usually called Learning Outcomes or Learning Objectives in other global engineering jurisdictions – are a relatively new way of measuring program quality In Canada. They have been in use for many years in other countries and are the key element of what educators and Government agencies refer to as a quality assurance framework. Universities and Colleges (HEIs - Higher Education Institutions) were informed well in advance about the introduction of GAs into the Canadian Accreditation system and the increased requirement for program totals AUs and that compliance with these two criteria was to become required for all programs seeking accreditation in 2015 in the case of GAs and 2014 in the case of the AU increases.

As soon as the new criteria were announced through the Engineers Canada's / Canadian Engineering Accreditation Board's (EC/CEAB) annual Accreditation criteria and procedures reports some HEIs began to determine what would be involved in meeting the new requirements. In terms of GAs their introduction would require a steep learning curve for HEIs and all the academics involved in curriculum design and delivery. Many, in fact almost all, academic faculty would have graduated from programs which had not used learning outcomes as part of their performance assessments and they would likely not be familiar with even the terminology associated with learning outcomes and graduate attributes. Every course would require learning outcomes and these learning outcomes and how they were to be assessed would have to be 'mapped' to demonstrate how they would contribute to the acquisition of the desired GAs.

Approved by the EC Board, the CEAB recommended that the International Engineering Alliance's (IEA) Washington Accord GA 'exemplars' be used in their entirety as the desired outcomes of Canadian Accredited programs. To say that this approach has caused some confusion, concerns and academic push-back would not be an understatement, nevertheless a vast amount work has been undertaken especially by HEIs, with Queen's University in Kingston playing a leadership role, and current and former members of the CEAB to implement the GA system and this undertaking continues. However, it has to said that some regulators are not wholly convinced by the efficacy of the GA output measures and some appear to remain 'agnostic' about the use of GAs as a way of determining whether graduates meet the educational requirements for licensure. But what has this to do with Accreditation Units?

There is no doubt that the introduction of Graduate Attributes has increased the workload on HEIs and the CEAB accreditation reviewers. For the HEIs this increased workload is not just in the preparation of the documentation required for accreditation visits but in the continued development of GAs for the whole curriculum. The optimistic intention of the CEAB as the measurement of outputs became the global norm was to balance the workload – in terms of documentation – by offsetting the increases associated with the GAs by decreases in the documentation related to inputs – of which AUs are a key element. This was a naïve expectation and maybe a reflection of the lack of awareness of how the move to 'output' measurements had been implemented in global jurisdictions. The core of the problem could be that input measurements are simply AUs and that output measurements are just GAs. The perception appears to be that countries which have fully embraced output measurements no longer require input measurements, but this is not the case. All jurisdictions require input measurements and not merely measurements regarding curriculum content. However, a widely held view was that the accreditation workload could be reduced by no longer requiring curriculum content measurement. Indeed the EC board passed a motion in February 2016 to 'Reassess the value of continuing with the mandatory use of the AU system' albeit offering no insight into what this might entail.

Interestingly over three years earlier, in August 2012, a CEAB Task Force had already submitted a comprehensive report titled 'Balancing Inputs and Outputs: Moving to Criteria with Graduate Attributes' and authored by three senior Deans, two of whom had been Chairs of CEAB, in which changes to the AU system had been considered and compared to the quantitative curriculum measurement systems used in some other Washington Accord countries. The Task Force proposed keeping an amended AU system but which still required specifications for (a) a minimum program length and (b) the usual curriculum components expected in every program. Two possible 'amended' methodologies were recommended which could be adopted to reduce the reliance on the then existing fully-fledged AU type curriculum analysis and at the same time recognize the advent of the criteria associated with mandatory learning outcomes assessment. The proposals were not endorsed by the CEAB and the CEAB's Policies and Procedures Committee proposed an alternative scheme based on the use of "Standard Credits" (SC's) using an HEI defined reference course. This scheme was presented to NCDEAS in April 2013 but was not formally discussed at the CEAB 2013 summer meeting. However, at this meeting the decision was made to establish another Task Force on 'Criteria Changes'.

The proposals from these activities suggested that with graduate attribute assessments coming on stream that they could be a case for not transitioning to 1950 AUs from the original 1800 AUs and suggestions were made to retain the 1800 AUs minimum or if Standard credits were to be used the 1950 AUs minimum could be reduced to perhaps 1875 AUs. None of these proposals went forward because of a lack of consensus among CEAB members. With the arrival of the compulsory GA criteria in 2015 NCDEAS suggested that maybe the minimum AUs could be reduced to 1545 during a transition period. Although a few minor adjustments were made to the AU system during the 2012-2016 period there were no changes recommended to EC regarding the 1950 AUs requirement or the AUs associated with the individual curriculum components (mathematics, natural science, engineering science, engineering design, complementary studies) although another category 'other' was added to the CEAB's interpretive statement to account for studies that could not be covered by the usual five components. The 'other' category was only to be used after the minimum AU criteria for the five main components had been complied with and was to represent studies that ‘complement’ the technical content of the curriculum. Exactly how ‘other’ was different to complementary studies was not made clear.

So despite the best efforts of members of CEAB and NCDEAS because of a general lack of consensus between the involved parties little progress was made in addressing the ‘AU issue’. The tensions generated between what could be described as those regulating and those being regulated became increasingly apparent and eventually NCDEAS frustration led to direct overtures to the EC for a resolution of the AU and other accreditation issues. There then followed a series of meetings involving members of EC, CEAB, NCDEAS and sometimes provincial regulators all aimed at finding a way forward. One of the outcomes of these meeting was the EC establishment in Sept 2015 of an ‘Engineering Instruction and Accreditation Consultation’ group with a mandate ‘to make recommendations to the Board regarding improvements to the accreditation system’. A consultation document was produced and made publicly available and formed the basis of a survey of all stakeholders and interested parties. Eventually a 2 day ‘Forum on Accreditation’ was held in August 2016. All the documents associated with the consultations, the survey and the Forum are available on the Engineers Canada website. A wide variety of opinions were expressed in these documents and at the meetings on the ‘way-forward’ but it could be said that the exchange of opinions and recommendations was useful to all concerned and while not providing a clear roadmap to the development of an improved accreditation system – or at least one more relevant to the 21st century - did enable some myths and misinterpretations to be addressed and some of the current issues to be more fully appreciated by all concerned.

A number of working groups evolved from the consultations and the Forum, some official others more ad-hoc but nevertheless important. In all cases the groups involved all the key stakeholders enabling a broader spectrum of input and insight to be obtained. One the official groups formed by the CEAB Policies and Procedures committee was the ‘AU Task Force’ tasked to (a) To consider the definition of an AU in its present form (EC criteria 3.4.1.1) and to identify, the advantages, disadvantages and ramifications of any definition change on existing criteria and to envisage how curriculum content requirements could be linked to student outcomes/graduate attributes whatever system of AU counts is used. This task force formed in March 2017 comprised 3 members of the CEAB, a representative from NCDEAS and a regulator. Updates on the work of the group were presented to the EC, NCDEAS and the CEAB. The CEAB secretariat provided significant support in producing significant statistical data and undertook an up-to-date survey of how other Washington Accord signatories address curriculum contentment and component categorisation. In addition, members of the group reviewed in detail the approaches used in other countries in determining the academic requirements, specifications and delivery of their national engineering educational curricula. The EC consultation group documents were also reviewed along with the CEAB commissioned reports since 2012.

Apart from the primary aims of the Task Force it was also paramount that the context of the study regarding the HEIs (NCDEAS) also be addressed, namely that (a) ‘the current accreditation process entails onerous workloads for HEIs and accreditation teams, (b) the current AU system ‘overly constraints educational innovations’, (c) the current AU system “over-emphasizes the importance of in-classroom instruction’, (d) curriculum content measurements do not assess the success of student learning and do not represent student or program ‘quality’, (e) the AU system and the concomitant criteria are a major obstacle to International exchanges and impede the ability of students wishing to study overseas count the studies as part of their accredited program, (f) the scheduled workloads are overwhelming students resulting in decreasing attendance and reported increases in stress and anxiety. A core factor is considered to be the AU requirement since HEIs have been increasing the AU program totals above the 1950 minimum so as not to be disadvantaged in an accreditation review and the possible loss of accredited status, and (g) the immense efforts that HEIs are having to make to develop and implement GA/CI requirements as specified in the Accreditation documents in addition to the input measurements is generating an unsustainable system.

Of particular note is that the comment that curriculum content measurements do not assess the success of student learning. This is true but AUs, as with all quantitative curriculum measurements, were never intended to measure individual student learning success. This observation may have its origins in the growing global trend to use learning outcomes and the subsequently associated graduate attributes as measures of student learning success and it appears that a number of Deans are keen to at least consider using such credit hour structure systems such as the British Credit Accumulation and Transfer System (CATS) and its European counterpart the European Credit Transfer and Accumulation System (ECTS). These systems use learning outcomes as the main, if not only, measure of student learning success. However, both systems also use credit unit systems to define program length and curriculum content. So, it is not clear how the use of these systems and their accompanying credit unit definitions would address workload issues, indeed their use could lead to an increase in workload at least in the early years of adoption. But exactly what is a CATS or ETCS credit unit/hour?

There are four main differences between the AU system – which defines AU units in terms of hours of instruction – and the CATS and ETCS systems. In the first instance is that in the latter systems not only are hours of instruction measured but also the 'notional' hours spent by students in private study are defined. In the CATs system 1 credit unit is defined as being equivalent to a combined 10 hours of learning activities such as lectures, laboratories, tutorials, seminars etc., and private study. Although the literature suggests that for each hour of contact time there should be 4 hours of private study, i.e., 20% contact time, each HEI and individual program defines its own proportions. Thus, at the Imperial College of London, the Civil Engineering degree has 47% of contact time whereas other equivalent Civil Engineering programs may have only 29% contact with the average being about 32%. A four-year degree requires a minimum program length of 480 credits or 4800 hours of learning activity. Thus, the Imperial College Civil Engineering degree would has 2256 hours on contact whereas the average for other Civil Engineering programs is 1536 hours.

However, the second major difference between the UK and EU credit systems compared to AUs is that all 'formal' learning activities are considered to be of equal value. i.e., 1 lecture hour = 1 laboratory hour = 1 tutorial hour and so on. In the CEAB system laboratory and tutorial hours are considered to be only half-the-value of lecture hours. This makes it difficult to directly compare AUs with CATS (or ECTS) credit units but in terms of contact hours over the last two CEAB accreditation cycles the average contact time was 1985 hours, which is actually less than the Imperial College example but more than the average UK accredited Civil Engineering degree. Clearly then in some instances the Deans are quite right to be concerned about workload but in other instances Canadian students have a lower workload than other global students – so where does that leave us? It is worth noting that the Civil Engineering program at Imperial College has been ranked in the world's top 5 degrees for a number of years – so what does that imply?

The third difference is that the CATS/ECTS approach make full use of learning outcomes assessment and the number of credits awarded have to be demonstrated to be sufficient for the students to achieve the desired outcomes. Assessment is by formal examinations and coursework – a conventional approach – but each UK institution has to state how the assessment is proportioned and there is a published and public national database of these proportions. For the Imperial College example learning outcomes assessment is 53% by written examination and 47% by coursework other programs may have a higher percentage of written examinations. These type of proportions would not be unusual in most Canadian HEIs. So once again the CATS system is not that dissimilar to our system, except that the number of AUs for a particular curriculum are not directly linked to CEAB Graduate Attributes. How could they be since the component AUs the requirements have hardly changed in the last 40 years. For example, the complimentary studies requirement is a minimum of 225 AUs – prior to 1995 half-a-year of study but then half-a-year was determined to be 225 AUs. To date it has not been shown how any of the CEAB's curriculum component minimums are linked to the mandated outcomes and requiring a 'curriculum map' only indicates when assessments take place.

The fourth difference is that CATS/ECTS system does not use the level of 'time' precision to define individual curriculum components as is present in the AU system. UK and European accreditation agencies may well when reviewing a program observe that – in their opinion – there is insufficient mathematics or another key Engineering learning area in a program to justify the learning outcomes claimed. In the AU system 5 individual curriculum component minimums are precisely defined along with a sixth category, 'other' - as previously mentioned – and 2 curriculum category combinations. Thus, EC accredited programs must satisfy 7 curriculum component categories. Is this precision necessary? In addition, although AUs are defined in the criteria statements the number of courses a program has to have is not. However, the precise content of a course is defined in the 'Interpretive Statements' annexes of the Accreditation procedures report. HEIs cannot claim in their criteria compliance that a course has more than three of the defined curriculum components and each individual component must represent 25% or 8 AUs of the total course content. There is a get-out-of-jail clause in the statement that indicates if a the program has a course, or presumably courses, that deviate from the individual component requirements then is up to them, "to justify the unique aspects" of the course or courses. So where does that leave the mandatory 'significant design experience' which literally has to involve all that has gone before, i.e., all 5 curriculum components but can only claim 3? In 2012 the then Chair of NCDEAS brought the educational disadvantages of the 3-content system to the attention of DLC/P&P in an extended letter but these concerns, it appears, did lead to any changes except to amend the interpretative statement to include the 'unique aspects' approach and four years later a change was made to include the '8 AUs' suggestion.

The explanation for this level of curriculum content detail is that it makes individual curriculum component, "readily and easily identifiable". So presumably if a course has four curriculum components of 25% only three can be counted as the fourth is not readily identifiable or a component with say 7 AUs – 1 hour less than 8 AUs - in a program of approximately 2,000 hours (a half of one percent) is inadmissible. While some may think this complex and microscopic analyses of individual curriculum component and course content demonstrates the academic rigour of the AU system – or at least its reporting - other educators would consider that is an over-rigid system more indicative of review convenience than academic quality. However, some educational research has shown that there is a link between hours of instruction and student performance with those receiving more instruction in a particular subject outperforming those receiving less. So, the amount of specific instruction received by a student does appear to be a factor in their level of 'success'.

Even if HEIs move to a learning outcomes – student workload systems such as the CATS/ETCS system – and the indications coming from the Educational Quality Assurance agencies of Provincial Governments, especially Ontario, are that this is current direction, would Engineering regulators accept that graduates from such a system meet the academic requirements for eventual licensure as a professional engineer? Would regulators ignore Government instructions? One of the major stumbling blocks seems to be the inclusion of student workloads in program criteria definitions. Whereas the European countries, including the UK, trust the HEIs to determine the appropriate student workloads associated with the formal instruction aspects, albeit with some stops and checks in the system, would Canadian regulators exhibit the same level of trust? Ironically over 80% of Canadian Engineering programs make use of the CEAB K-Factor approach in which student workload is used to quantitatively measure, "an activity for which contact hours do not properly describe the extent of the work involved", Although limited in its use, disliked by many institutions and open to tensions caused by those program visitors prone to challenging the HEI's calculations nevertheless the acceptance of the need to measure student workload in addition to contact hours has long been in the case. Could then the K-Factor or equivalent be applied more generally to the curriculum content of accredited Canadian engineering schools?

Overall it does seem that the CATS/ECTS total student workload systems (teacher contact plus private study) could be used in Canadian programs using a modified AU system developed through collaboration between NCDEAS, Provincial Regulators and EC through the CEAB. Most certainly such a system could well address some, if not all, of the concerns expressed by NCDEAS. One of the major issues in such an approach however will be to decide if all contact learning activities are to be treated the same as in the CATS/ECTS systems. This suggestion has been made before in various reports, by working groups and in the EC consultations of the past couple of years. The responses to what could be termed the 1-1-1 system (lectures-laboratories-tutorials) was generally negative from all types of stakeholders. Some felt that such a system would be too complicated and generate excessive workload for all concerned, even though it would not increase student workload and would precisely reflect the HEI's official calendar statements. Others felt that it could only work if the total program AUs were increased which would not sit well with HEIs whilst some felt that it would be used to reduce the time spent by academic staff in delivering lectures. Statistical analyses undertaken by the CEAB secretariat found that the breakdown in recently reviewed Engineering programs between lectures and laboratory/tutorial periods in terms of contact hours was ⅔ to ⅓. So, on average the average contact time necessary for 1950 AUs to be delivered to students is over 2,600 hours or over 26 hours per week. On the other hand, if the 1-1-1 system were to be used then students would receive 1950 AUs in just under 20 hours per week. During the EC consultation phase some regulators found such a reduction in contact time unacceptable. Other stakeholders felt that lectures and laboratories could be treated equally as long as the laboratory times were 'actual' rather than calendar statements but that tutorials if counted at all should be of reduced value since they were delivered in the main by teaching assistants or graduate students and therefore of inferior quality. So, if equal value learning activities are to become acceptable then the road ahead will be long and winding.

The other type of quantitative curriculum measurement system is that used by the United States' Accreditation Board for Engineering and Technology (ABET) and its Engineering Accreditation Commission (EAC) which employs the semester credit hour as the unit of measurement. This system is used not only in the USA but by programs in colleges and universities in over 30 other countries, especially the rich Gulf states, and the number of ABET accredited programs outside the US has been growing following ABET's 2007 decision to dispense with the 'substantial equivalency' approach for international programs which is still favoured by Engineers Canada. The origins of the semester credit hour measurement system can be directly traced back to the early 20th century 'Carnegie Unit' which defines that 1 hour of teaching each week over a 14-week semester is equivalent to 1 semester credit hour and that 120 credit hours are required for graduation. This system, with some very slight modifications, has been in place for well over a hundred years and remains the primary method for quantitative curriculum measurement in the US. Many US Engineering schools now have 15-week semesters and also include laboratory work in credit hour determinations but in a less generous way than the CEAB's AU system in that 1 hour of such work each week for 15 weeks is defined as ⅓ of a credit hour.

To date ABET have required a 4-year program and have stipulated curriculum content in terms of years – much like CEAB used to do up to the early 1990s. However, ABET also defined what a 'year' was in terms of semester credit hour units or the equivalent for those using 'quarter' terms. A year was defined as a minimum of 32 semester credit hours giving a total program length of 128 units but did allow some flexibility so there are a few programs which have the more traditional 120 credit units whilst the majority have programs of 128 or more credit units. For a program with 128 credit units this would equate to approximately the equivalent of 1920 AUs whereas a 120-credit unit program would be 1800 AUs, so certainly in the range of past and current CEAB criteria. In 1996, the ABET adopted a new set of standards, called Engineering Criteria 2000 (EC2000), which "shifted the basis for accreditation from inputs, such as what is taught, to outputs — what is learned", i.e., student learning outcomes. The EC 2000 requirements specified 11 learning outcomes and expected programs to assess and demonstrate their students' achievement in each of these. A recommendation to reduce these 11 outcomes to 7 has been approved by the ABET Executive committee and will be the subject of a full council vote in summer 2017.

In terms of individual curriculum components ABET specifies minimum requirements for combinations of components rather than precise minimums for each individual subject area. So, in place of the CEABs requirements of 420 AUs for mathematics and natural science with each contributing at least 195 AUs, ABET requires 1 year of mathematics and basic (natural) science. Under the newly proposed criteria the 1-year requirement will be changed to a minimum of 30 semester hours which is approximately equivalent to 450 AUs. The amount of Engineering Science and Engineering Design is also specified in a similar manner as a combination but with no individual component requirement. As with the CEAB criteria a significant design experience is required and the curriculum must include a general education component which complements the technical components of the curriculum. A comparison of the CEAB and ABET curriculum categorization is given in the following table.

CEAB	ABET (Current)	ABET (Proposed)
AU category: Minimum AU's required Mathematics 195 Natural sciences 195 Mathematics and natural sciences 420 Engineering science 225 Engineering design 225 Engineering science and Engineering design 900 Complementary Studies 225 Additional 405 The engineering curriculum must culminate in a significant design experience ….	One year of a combination of college level mathematics and basic sciences (some with experimental experience) appropriate to the discipline… One and one-half years of engineering topics, consisting of engineering sciences and engineering design A general education component that complements the technical content of the curriculum …… Students must be prepared for engineering practice through a curriculum culminating in a major design experience ….	A minimum of 30 semester credit hours (or equivalent) of a combination of college-level mathematics and basic sciences with experimental experience appropriate to the program. A minimum of 45 semester credit hours (or equivalent) of engineering topics appropriate to the program, consisting of engineering sciences and engineering design A broad education component that complements the technical content of the curriculum A culminating major engineering design experience.
Total minimum AUs = 1,950	Total minimum credits = 128	Total minimum credits = 128

So, the two systems appear to be identical in terms of curriculum component content except the ABET measurement system is coarser or grainer than the CEAB system but perhaps, as always when comparing systems and concluding they are equivalent, the devil is in the details. The ABET Engineering Science and Engineering Design requirement of 45 credit hours is equivalent to 675 AUs but the significant design experience is apparently a separate component whereas the CEAB's requirement for the component combination is 900 AUs but the significant design experience is included in this combination.

Therefore, as with the use of the Imperial College example for a CATS system program, a number of the exact curriculums used in ranked US Engineering Schools was reviewed including the Georgia Institute of Technology (Georgia Tech) and the Virginia Polytechnic Institute and State University (Virginia Tech).

In the Georgia Tech mechanical program there are 129 credit hours, with hours of professorial instruction over the 8-semester program being 1785 hours in lectures and 450 hours in laboratories, tutorials are not included in the credit hour calculations. In the CEAB system these hours of instruction would equate to 2010 AUs but with more emphasis being placed on lectures than laboratory work. For the Virginia Tech 132 credit Electrical Engineering program the contact hours are 1,875 in lectures and 390 in laboratories equating to 2070 AUs. However, as CEAB engineering schools over the last twenty years have invariably had more AUs than these two example and recently accredited schools have averaged 2119 AUs – although the minimum requirement is 1950 AUs up from 1800 AUs since 2014 – the actual rather than defined differences in credit hours and AUs are not profound. However, because of the greater emphasis placed on laboratory and tutorial work in Canadian schools the actual scheduled contact hours are far higher than in US Schools.

To achieve 1950s AUs using the two-third to one third breakdown mentioned earlier requires 2,632 hours on contact rather than the 2,225 hours at Georgia Tech and the 2325 hours at Virginia Tech. As Canadian Engineering Schools are averaging 2119 AUs then the scheduled contact hours increases to 2,860. Thus, in the US schools reviewed a student is programmed to spend 18-19 hours per week in a classroom/laboratory environment whilst the Canadian student – taking account of the shorter semester lengths – has 26 (1950 AUs) to 29 (2119 AUs hours in the same environment. In the UK examples, where the semesters are almost identical to the Canadian system, teacher contact can be as high as 23.5 hours per week but the average is around 16 hours per week. So, in comparison to their US and UK counterparts the average Canadian student is spending up 13 hours more per week in the classroom-laboratory environment. Even with the former 1800 AUs requirement the weekly contact hours would still be over 24.

In addition to the hours of instruction required by ABET the semester credit hours system stipulates that the average student will spend a further 2 hours in preparatory or self-study for each hour of class time. US University websites emphasize this additional study requirement on their websites as part of the overall student workload. So, although ABET expect that this additional study time will take place they do not directly measure it. Canadian HEI's have no such stated requirement for additional study probably believing that it a blinding glimpse of the obvious that out-of-class study will be necessary. Having said that it is noteworthy that in CEAB's current interpretive statements a program using problem-based learning teaching methodology, where in essence individual courses are melded into a single unit of learning activities, the expectation is that students will spend 40-60 hours a week on their studies. Implying that a significant amount of self-study is required. However, if the melded courses were split into their component parts then no self-study expectations are stated.

While other examples could be chosen and the calculations reworked the NCDEAS and some student group claims that Canadian students are comparatively overloaded seems clear. The CEAB analyses and international comparisons indicate that the main arithmetic reason for the significant differences in contact hours is the emphasis Canadian HEI place on laboratory-tutorial work, which is between 2 and 4 times higher than in US and UK programs. However, for the ABET and CEAB criteria dealing with 'laboratory experience' has almost identical wording.

Neither ABET or CEAB specify exactly how much laboratory work must be undertaken so the reasons why Canadian programs have considerably more such learning activities must be because of the associated curriculum designers and planners. Maybe the clearly obvious more hands-on approach to Engineering Education is considered to be an inherent Canadian quality differentiating us from the rest of the world? Maybe it is a reflection that our system's objective is to produce specialist technical engineers and not engineer-managers who graduate from the great French Engineering schools accredited by the Commission des Titres d'Ingénieur (CTI)? Whatever the reasons and rationale for the hands-on emphasis it may be useful to have a clear understanding of exactly what type of graduate we are trying to produce and why apparently so few graduates from our programs, comparatively speaking, seek professional licensure.

Whatever system of quantitative curriculum content measurement is used, AU, Credit hour, CATS and ECTS credit units one of the common purposes of such measurements is mobility and transferability. An engineering degree from an Accredited Canadian HEI in one province is accepted in all other provinces as meeting the academic requirements for licensure and therefore removes the potential for impeding mobility. The UK CATS is aimed at students being able to transfer to and study at different universities without peril and the European ECTS system at the name implies is to enable students to study in its many different countries and accumulate sufficient credits to graduate. Of course quantitative similarities and content alone are not sufficient in this modern 21st century era to guarantee transferability and hence the use of learning outcomes and graduate attributes as the comparator between programs and countries and the determination of substantially equivalent program quality.

The many issues concerned with learning outcomes and graduate attributes, their specification and how to assess them are important matters requiring further discussion but not in this report. It is clear from the foregoing discussion that all countries involving in Engineering Education accreditation have some form of quantitative curriculum measurement system. The proposal that such quantitative measurements should be dispensed with in the Canadian (CEAB) system and wholly replaced with measurements of outcomes alone is then somewhat unsound, unless we wish to be quite different in our approach from all other global systems. Some would probably argue that this would make us unique and they would be right in the same sense as insisting that our planet if flat! That the quantitative measurement system we use should continue to be based on the AU system is a different question.

Globally then there are two different systems used to quantitatively measure curriculum content. The one used in the United States and Canada is based on scheduled contact hours. The second system is based on 'notional' student workload hours which includes both scheduled contact hours and the time an average student have to spend in private study. This is the system used in the vast majority of European countries, the UK, Ireland and New Zealand. Unfortunately, the term 'notional' can be used literally to describe a suggestion, an idea or theory and its differing global linguistic uses can cause significant interpretational problems with curriculum measurement when viewed from afar, i.e., Canada and the US. However, it appears that 'notional' is really an attempt to express what is considered be to the time that needs to be spent in scheduled and private study by an average student. But what is an average student and who decides how much time they need to spend? As we have seen with the UK examples, the private study time allocations vary from Institution to Institution and program to program. In the ETCS system each country defines its own 'standard' of notional learning activity as it applies to the course or teaching module. So, in Italy 1 ECTS credit is considered to be equivalent to 25 hours of notional learning activity whereas in Germany 1 credit is considered to be 30 hours of such activity. Adopting such a system in Canada (CEAB and HEIs), although some student 'private' study can be accounted for in accordance with the present criteria, would be a colossal but not unsurmountable challenge to all involved in the accreditation of Engineering programs. Moreover, adopting such a system would not resolve the issues surrounding the application of learning outcomes and graduate attribute and their assessment.

So, are we stuck with the present AU system? In the US the same type of criticisms as NCDEAS have levied against AUs have been made by their HEIs against the semester credit unit, so have we anything to learn from our southern neighbours? ABET's specification of curriculum content is not less descriptive than CEAB's but the specified minimums are grainer and are only applied to the programs as a whole and two component combinations leaving HEIs great flexibility when designing over 40% of the curriculum. CEAB on the other hand with the specified total program minimum leave only 20% of the

curriculum to the discretion which is slightly better than the 15% in place prior to 2014. The rationale being that the somewhat restrictive CEAB approach ensures that a minimum standard is maintained across all Canadian Engineering programs and whether studies at the top ranked Universities or lesser ranked universities the programs are basically the same at least in terms of curriculum content. This provides provincial regulators with a strong comfort zone in accepting CEAB accredited degrees as meeting the academic requirements for licensure. However, the State licensing boards in the USA while all accepting the ABET degrees, also require that all applicants take the Fundamental of Engineering exam (F.E) in addition to their ABET accredited degree. This requirement also applies to holders of CEAB accredited degrees who apply for licenses in the US.

Probably because of Globalization or at least Internationalization, there is evidence to indicate that there is a growing worldwide trend for undergraduate students wishing to study in another country for part of their degree. A Dean of one of our major Canadian universities has suggested that over 50% of the present undergraduates, about 2,000 students, are seeking overseas study opportunities either as an individual or as part of a formal student exchange program. It is claimed that the AU system presents severe obstacles to overseas studies as the courses studied may be not been allowed as part of the minimum path requirements of CEAB either at the individual component level or for the complete program.

However, the accreditation criteria do allow such studies and the accreditation procedures report contains a wealth of information on how these studies can be counted within the overall program. Maybe the problem is one of interpretation by some visiting teams although it is the full CEAB board who make the final recommendation to THE EC Board albeit the visiting teams are consider to the 'peers'. It could be that part of the problem is the 'conversion' factor between ECTS, CATS and Semester Credit hours and AUs. There is an accepted factor between ECTS and CATs credits namely that 1 ECTS = 2 CATS. However, there is no universally accepted factor for converting ECTS/CATS credits to semester credit hours and AUs and vice versa. Although some US HEI's publish what factors they will use this does not appear to be the case with Canadian HEIs. However, as there are a number of exchange programs between Canadian and global institutions then obviously some conversion factors must have been determined if only on a case by case basis. Regulators also encounter these 'factor' problems when receiving applications from individuals holding non-CEAB degrees. It is a reasonable question to ask how many CATs, ECTSs are equal to an AU?

The Washington Accord is claimed to be the benchmark for accepting degrees from other signatory countries as meeting the educational/academic requirements for licensing or the equivalent in all signatory countries. The basis for the acceptance being the Washington Accord 'exemplars' for Graduate Attributes and an equivalence regarding the Accreditation systems used by the individual signatories. In practice this intent has not resulted in the hoped-for blanket 'acceptance'. Some jurisdictions in Canada do not accept without question (further review) degrees from many of the signatory countries and in the USA, State licensing boards require that degrees from non-ABET countries be assessed by the US's National Council of Examiners for Engineering and Surveying (NCEES) although some accept CEAB degrees at face value for certain disciplines. However, some State Board have recently announced that they will no longer accept degrees from other Washington Accord countries and there have been instances where ABET have declined 'accrediting' degrees from Engineering Council UK accredited schools. Engineers Canada and the CEAB may wish to revisit how the equivalence of Washington Accord of signatory degrees is determined and implemented.

(The above was work-to-date, May 2017)

Some Preliminary and Observations

1. Globally and in the majority of Canadian Provinces the tertiary education providers are moving to a learning outcomes mode of delivery of degree programs. While learning outcomes (LO) and student workload measurements are not synonymous the two systems are invariably related. In the US the expectation is that there will be at least 2 hours of student preparation- self -study for every hour of instruction. In Canada the use of the so-called K-Factor enables some elements of the engineering program to be assessed with respect to student workload especially for design projects and PBL. In other global programs the self-study allocation of student hours is explicit and mandated. It would therefore be advantageous for the CEAB and EC to start to work more closely with NCDEAS on developing a system extending the application of the K-factor approach with a view to eventual adoption of the UK CATS or European ECTS type methodology.

2. The limited allowed categorization of course reporting it artificial and is detrimental to program innovation and is causing undue stress on Canadian Engineering programs, especially those designing the curriculum and those receiving the curriculum. The convenience of 'readability' is not a principle that should override educational excellence and should be abandoned.

3. There appears to be an over-emphasis on scheduled laboratory work which is not found elsewhere. Unless there is substantive evidence to show that this emphasis produces the world's best engineering graduates and that all other engineering graduates are inferior to those from Canada this situation needs to be reviewed by institutions represented by NCDEAS and Engineers Canada.

4. The move to 1950 AUs is a recent requirement and in comparison, with the previous criterion represents a 3 to 4 course increase in requirements in what is already a crowded curriculum. Whilst the 1800 AUs criteria was modified some time ago to enable HEIs to be more innovative – although the original criterion was also supposed to achieve such innovations – it would make sense following the introduction of Graduate Attributes to reduce this numerical criterion to a more justifiable number such as 1800-1875 AUs which has been proposed by various P&P Task Forces.

5. The fine grain specifications of the 5 individual curriculum components not present is any other global accreditation system needs to be reviewed and compared with these other systems. A good starting point could be the ABET approach so that the specifications become:
    a. Math and Natural Science = 420 AUs
    b. Engineering Science and Engineering Design = 675 AUs
    c. A significant design experience
    d. A general education – or complimentary elements
    e. A Program requirement of a t least 1850-1875 AUs.

6. The AU count for scheduled lectures and laboratories should be assessed as equal although tutorials should normally be counted as 0.5 as is the current practice.

7. The EC approach to Graduate attributes needs to reassessed with a view to:
    a. Stated program educational objectives being linked to course learning outcomes and the methods of assessment of the learning outcomes.
    b. The proscribed time spent in scheduled activities (and perhaps student workloads eventually) should be directly correlated with achievement of the learning outcomes.
    c. It must be clear that all graduating students achieve the learning outcomes.