THE FACULTY OF ENGINEERING ATTRIBUTE ASSESSMENT PROCESS AT THE UNIVERSITY OF MANITOBA: SUGGESTIONS FOR CLOSING THE LOOP

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***Abstract** - This paper describes the findings from a three-year longitudinal study at the University of Manitoba designed to explore how the Canadian Engineering Accreditation Board (CEAB) graduate attributes are manifested and measured in the Faculty of Engineering's curriculum. Instructors from the Departments of Biosystems, Civil, Mechanical, and Electrical and Computer Engineering were asked to consider the presence of four of the 12 CEAB attributes and their subsequent indicators in one engineering course taught in one academic year. Each year, four different attributes were targeted, chosen to reflect both the traditional/technical and the professional/workplace competencies. Data were collected using a self-administered checklist, which evolved over the three years of the study in an effort to more clearly define student attribute competency levels, and to develop a common language and understanding in regards to the graduate attributes and the process of outcomes-based assessment. This final phase of the study enables us to understand how all 12 of the CEAB graduate attributes are manifest and measured across our engineering curricula, to discuss our findings within the context of outcomes-based assessment and accreditation protocols, and to strategize ways to close the loop.*

Keywords: CEAB graduate attribute assessment; accreditation; instructor checklist

1. INTRODUCTION

According to Suskie (2008), "Assessments should yield value that justifies the time and expense we put into them… They should not take so much time that they detract from other essential activities such as teaching" [1]. Understanding what comprises best practices for assessment enables faculty to optimize its value. Poignantly, the overriding best practice for assessment is simple: It should be good. There are five characteristics of 'good' assessment that have emerged from the literature in recent years: (1) good assessments are used; (2) good assessments are economical, particularly in terms of time; (3) good assessments provide reasonably accurate and truthful results (reliable and valid); (4) good assessments are valued; and (5) good assessments result from, and target, specific and important goals [1].

Increasing the value of assessments is especially important in engineering education, as assessment is linked to accountability and accreditation. It is also essential because in countless ways, assessment is distasteful to many educators. In fact, for some, assessment may be considered the dark horse of education. Testimonial to this is the fact that the term was avoided for a number of years:

> Assessment permeates every aspect of our lives, and is a natural and automatic activity (Rowntree, 1987, p. 4). In the educational context, the terrors evoked by the term 'assessment' have distorted its necessity, centrality and its potentially neutral position. Indeed 'assessment' is considered so negative that the term 'evaluation' was preferred for many years. [2]

The idea of asking faculty to perform additional assessments, on top of their own individual course assessments, as part of the process for program improvement and accreditation, increases assessment distaste. However, program assessment is required and essential for improving program quality and thereby, student learning. Consequently, it is most beneficial to make assessment as painless as possible: it must be clearly understood, purposed, transparent, efficient and effective, which will help develop trust and create faculty buy-in [3][4][5]. It is through the efficiency and effectiveness of the assessment process that an appropriate middle ground can be found to generate the desired outcome, i.e., improvement of teaching and learning for a reasonable and sustainable degree of effort. When this happens, stakeholders will be satisfied, and a culture of assessment will be embedded in the program [1].

2. BACKGROUND

In Fall 2011, inspired by the new accreditation requirements for CEAB, which mandated a continuous curriculum improvement cycle informed by the outcomes-based assessment data of the graduate attributes [5], the Faculty of Engineering at the University of Manitoba began a three-year longitudinal faculty attribute assessment study. The objectives of the study were to determine how the 12 CEAB graduate attributes were manifest and measured in the four engineering departments within the faculty: Biosystems, Civil, Electrical and Computer (ECE), and Mechanical, and to explore the extent to which the assessed attributes resulted in course content proficiency [6]. Additionally, informed by the analysis of the data after the first year of the study, we began to investigate what instructors determine as the level that represents student competency for each attribute/indicator [7].

Each year, a different group of instructors were asked to complete a self-administered checklist that was designed to determine which attribute indicators instructors assessed or demonstrated in their courses, and which indicators they did not. Assessed indicators were defined as linked to instructor's assessment tools, such as quizzes, assignments, projects, labs or exams. In the second part of the checklist, instructors were asked to map each assessed indicator to one of their assessment tools, and specify how they communicated the assessment results to students, i.e., numerical marks, letter grades, rubrics or comments. Demonstrated indicators were ones that instructors felt were covered within the course content, but that were not formally assessed. Indicators that instructors neither assessed nor demonstrated were also categorized.

For every year of the study, the Heads for each department gave a list of potential instructor participants to the researchers. Generally, each instructor was only asked to participate in the study once (although there were exceptions where a few instructors were unintentionally asked to participate twice). Participating instructors completed the checklist for one course during either the Fall or Winter semester. Thereby, data were collected twice each academic year. For each year of the study, four different attributes were targeted, so that by the end of the three years, all 12 attributes were investigated within the faculty. The initial division of the attributes was determined by choosing two technical skills and two professional skills [6][7]. Tables 1 and 2 show how the attributes were divided, and which courses were investigated.

At the end of each year, we analyzed the data and disseminated our findings to the participating instructors, Department Heads, and the Faculty's curriculum management committee (CMC). We have also presented our findings at three annual CEEA conferences [6][7][8], and published the findings from the second year of the study in the *International Journal of Engineering Education* [9]. The intent has been to give each department data that can be used in their cycle of continual program improvement.

This paper is the last installment of this study. All three years of the research data have been collected and analyzed. As there is a large amount of data, only a portion can be reported in this forum. Therefore, for this paper, we will present the data from Part A of the checklist, specifically the results for which indicators are assessed, demonstrated or not demonstrated. The findings will be contextualized for each engineering department individually, so that they may be used to inform the departments' individual assessment processes.

3. METHODS

For each year of the faculty attribute assessment study, four of the 12 CEAB graduate attributes and their associated foci and indicators as conceived by the CMC were built into the checklist administered during the 2011-12, 2012-13 and 2013-14 academic years. A selection of instructors who had ideally not participated in the study before and who were chosen by their program department heads were asked to report the extent to which the indicators for each attribute were built into their course and its associated mark distribution in Part A of the checklist (*Full, Part, None*). If the indicator was marked as *Full*, then instructors were asked to record the *assessment tools, assessment communication* and the *expected competency level* and *target percentage* for the indicator [8]. In Part B of the checklist, instructors were asked to record course assessment results.

Over the progression of the study, there were changes made to the checklist, including amendments to (i) the language, to more accurately reflect the language of outcomes-based assessment; (ii) the reporting categories, where a *Target Percentage* category was added to encourage instructors to set a goal for the minimum number of students in class whom they felt should perform at the level of expected competency, which was proposed to add another layer to the process of outcomes-based assessment; (iii) the structure and content, to make the checklist more user-friendly to support instructor participation; and (iv) the process by which the checklist was introduced to instructors. As confusion and the rate of data return were found to be issues in the previous iterations of the study, a workshop was instituted in an attempt to circumvent these [8].

The checklist was offered to instructors via email, and in the last year of the study, via a workshop in October of each year. Part A of the checklist was self-administered by instructors at the beginning and through the middle of the semester, and Part B was completed once course assessments were finalized (December to mid-January).

Table 1: Faculty attribute assessment study: Biosystems (BIOE) and Civil (CIVL) engineering courses assessed over 3 years.

YEAR	ATTRIBUTES	BIOE (11)	CIVL(10)
2011-2012	3. Investigation 4. Design 8. Professionalism 12. Lifelong Learning	BIOE 3580 – Design Trilogy II BIOE 4580 – Design Trilogy III	CIVL 3760 –Structural Analysis CIVL 4030 –Structural Design 3
2012-2013	2. Problem Analysis 5. Use of Eng. Tools 7. Communication Skills 10. Ethics and Equity	BIOE 2580 – Design Trilogy I BIOE 3320 – Eng. Properties of Biological Material BIOE 3590 – Mechanics of Materials in Biosystems BIOE 4520 – Crop Preservation	CIVL 3730 – Geotechnical Materials & Analysis CIVL 3760 –Structural Analysis CIVL 1440 – Intro to Statics
2013-2014	1. A Knowledge Base for Engineering 6. Individual & Team Work 9. Impact of Engineering on Society & the Environment 11. Economics & Project Management	BIOE 2590 – Biology for Engineers BIOE 4240 – Graduation Project BIOE 3320 – Eng. Properties of Biological Materials BIOE 4240 – Graduation Project AGRI 2200 – Principles of Plant & Animal Physiology	CIVL 2840 – Geomatics CIVL 3750 – Hydrology CIVL 4380 – Elements of Law for Civil Engineers CIVL 4050 – Engineering Economics CIVL 4470 - Watershed Processes

Table 2: Faculty attribute assessment study: Electrical & Computer (ECE) and Mechanical (MECH) engineering courses assessed over 3 years.

YEAR	ATTRIBUTES	ECE (9)	MECH (11)
2011-2012	3. Investigation 4. Design 8. Professionalism 12. Lifelong Learning	ECE 3720 – Introductory Power & Machines ECE 4310 – Electrical Energy Systems 2	MECH 3980 – Mech Eng'g Lab MECH 4182 – Aerospace Structures: Analysis & Design
2012-2013	2. Problem Analysis 5. Use of Eng. Tools 7. Communication Skills 10. Ethics and Equity	ECE 3740 – Systems Engineering Principles ECE 3600 – Physical Electronics ECE 4260 – Communication Systems	ENG 1460 – Intro. to Thermal Sciences MECH 4510 – Fundamentals of Finite Element Analysis MECH 3550 – Robotics & Computer Numerical Control MECH 2272 – Engineering Materials MECH 4412 – Heating, Ventilation & Air Conditioning
2013-2014	1. A Knowledge Base for Engineering 6. Individual & Team Work 9. Impact of Engineering on Society & the Environment 11. Economics & Project Management	ECE 3670 – Electronics 3E ECE 2240 –Numerical Methods for Engineers *ENG 1450 – Intro. to Electrical & Computer Engineering **ECE 4600 – Group Design Project	MECH 2202 – Thermodynamics MECH 4452 – Aircraft Performance, Dynamics & Design MECH 2272 – Engineering Materials MECH 3170 – Project Management

*Completed checklist for Individual & Teamwork. **Completed checklist for Impact of Eng. and Eco. & Project Management.

4. FINDINGS

There were 41 courses for which instructors completed or partially completed a faculty attribute assessment checklist: 11, 10, 9 and 11 courses each from the departments of Biosystems, Civil, ECE and Mechanical engineering (Tables 1 and 2). Partial completions of the checklist were found in two usages. In one department, two instructors focused on realizing the checklist for one and two of the four attributes respectively, a decision that supported their department's assessment protocol. Data from these two checklists are still used in the study, for although they may not give a complete picture of all four targeted attributes in those particular courses, the data that are reported are still valuable. Those courses can be explored further by the department, dependent on their assessment goals. The second type of incomplete checklist was found when the assessment results portion of the checklist (Part B) was left unfinished. Those missing data do not affect the findings for this paper, as only data from Part A of the checklist will be presented.

For Part A of the checklist, instructors were asked to consider the four targeted attributes and their associated indicators, and report on whether those indicators were built into the associated mark distribution in the course (*Full*), if the indicator was demonstrated but there was no formal process built into the mark distribution (*Part*), or if the content of the course did not demonstrate the indicator (*None*). The following four sections report the results by individual engineering departments.

4.1 Attribute/Indicator Checklist Results: Biosystems

Table 3 and Figure 1 show the assessment results for the attributes/indicators in 11 courses in the Biosystems Engineering program, as collected over the three years that the study was implemented.

Table 3: Number and percentage of attribute indicators assessed for 11 courses in Biosystems Eng., 2011-2014.

BIOSYSTEMS (11)			
	Full	*Part*	*None*
1. Knowledge Base for Engineering - 7 indicators	6 85.7%	1 14.3%	0 0%
2. Problem Analysis - 13 indicators	10 76.9%	3 23.1%	0 0%
3. Investigation - 28 indicators	8 28.6%	13 46.4%	7 25%
4. Design - 31 indicators	22 71%	8 25.8%	1 3.2%
5. Use of Engineering Tools - 10 indicators	4 40%	2 20%	4 40%
6. Individual & Teamwork - 16 indicators	1 6.3%	5 31.3%	10 62.5%
7. Communication Skills - 18 indicators	8 44.4%	6 33.3%	4 22.2%
8. Professionalism - 13 indicators	4 30.8%	9 69.2%	0 0%
9. Impact of Engineering on Society & the Environment - 8 indicators	0 0%	3 37.5%	5 62.5%
10. Ethics & Equity 9 indicators	3 33.3%	1 11.1%	5 55.5%
11. Economics & Project Management - 18 indicators	6 33.3%	8 44.4%	4 22.2%
12. Lifelong Learning - 27 indicators	7 25.9%	10 37%	10 37%

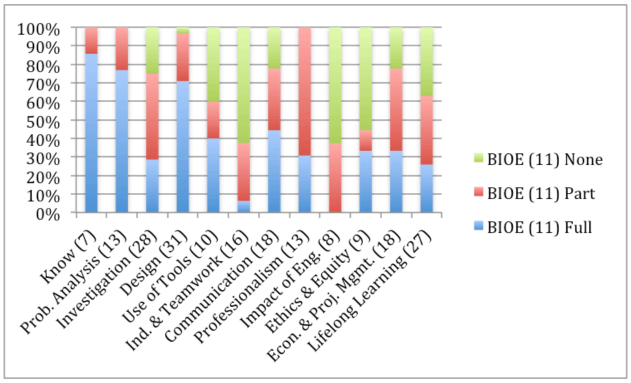

Fig. 1. Percentage of CEAB Graduate Attribute indicators assessed (Full), demonstrated (Part) and undemonstrated (None) in 11 courses in the Biosystems Engineering program, 2011-14.

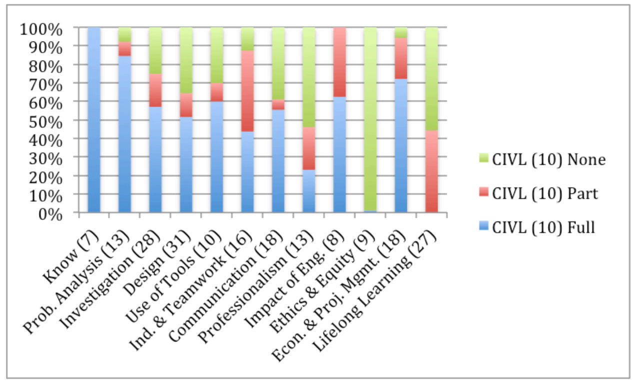

Fig. 2. Percentage of CEAB Graduate Attribute indicators assessed (Full), demonstrated (Part) and undemonstrated (None) in 10 courses in the Civil Engineering program, 2011-14.

4.2 Attribute/Indicator Checklist Results: Civil

Table 4 and Figure 2 show the assessment results for the attributes/indicators in 10 courses in the Civil Engineering program, as collected over the three years that the study was implemented.

Table 4: Number and percentage of attribute indicators assessed for 10 courses in Civil Eng., 2011-2014.

CIVIL (10)			
	Full	*Part*	*None*
1. Knowledge Base for Engineering - 7 indicators	7 100%	0 0%	0 0%
2. Problem Analysis - 13 indicators	11 84.6%	1 7.7%	1 7.7%
3. Investigation - 28 indicators	16 57.1%	5 17.9%	7 25%
4. Design - 31 indicators	16 51.6%	4 12.9%	11 35.5%
5. Use of Engineering Tools - 10 indicators	6 60%	1 10%	3 30%
6. Individual & Teamwork - 16 indicators	7 43.8%	7 43.8%	2 12.5%
7. Communication Skills - 18 indicators	10 55.6%	1 5.6%	7 38.9%
8. Professionalism - 13 indicators	3 23.1%	3 23.1%	7 53.8%
9. Impact of Engineering on Society & the Environment - 8 indicators	5 62.5%	3 37.5%	0 0%
10. Ethics & Equity 9 indicators	1 1.1%	0 0%	8 88.9%
11. Economics & Project Management - 18 indicators	13 72.2%	4 22.2%	1 5.6%
12. Lifelong Learning - 27 indicators	0 0%	12 44.4%	15 55.6%

4.3 Attribute/Indicator Checklist Results: ECE

Table 5 and Figure 3 show the assessment results for the attributes/indicators in 9 courses in the Electrical and Computer Engineering program, as collected over the three years that the study was implemented.

Table 5: Number and percentage of attribute indicators assessed for 9 courses in Electrical & Computer Eng., 2011-2014.

ELECTRICAL & COMPUTER (9)			
	Full	*Part*	*None*
1. Knowledge Base for Engineering - 7 indicators	4 57.1%	3 42.9%	0 0%
2. Problem Analysis - 13 indicators	12 92.3%	1 7.7%	0 0%
3. Investigation - 28 indicators	17 60.7%	10 35.7%	1 3.6%
4. Design - 31 indicators	15 48.4%	9 29%	7 22.6%
5. Use of Engineering Tools - 10 indicators	6 60%	1 10%	3 30%
6. Individual & Teamwork - 16 indicators	6 37.5%	6 37.5%	4 25%
7. Communication Skills - 18 indicators	0 0%	6 33.3%	12 66.7%
8. Professionalism - 13 indicators	1 7.7%	10 77%	2 15.4%
9. Impact of Engineering on Society & the Environment - 8 indicators	2 25%	3 37.5%	3 37.5%
10. Ethics & Equity 9 indicators	0 0%	2 22.2%	7 77.8%
11. Economics & Project Management - 18 indicators	12 66.7%	5 27.8%	1 5.6%
12. Lifelong Learning - 27 indicators	1 3.7%	14 51.9%	12 44.4%

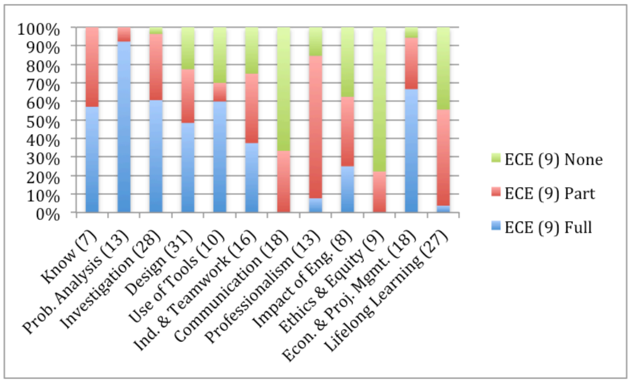

Fig. 3. Percentage of CEAB Graduate Attribute indicators assessed (Full), demonstrated (Part) and undemonstrated (None) in 9 courses in the Electrical & Computer Engineering program, 2011-14.

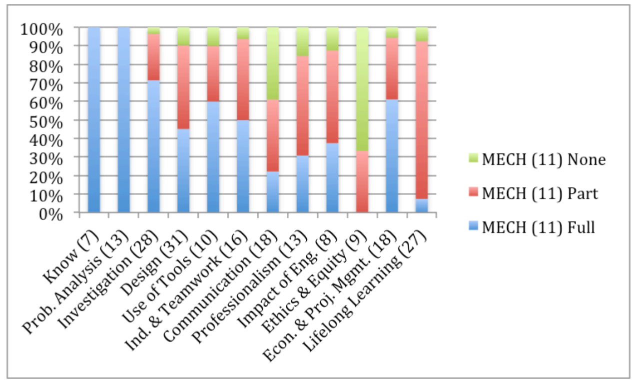

Fig. 4. Percentage of CEAB Graduate Attribute indicators assessed (Full), demonstrated (Part) and undemonstrated (None) in 11 courses in the Mechanical Engineering program, 2011-14.

4.4 Attribute/Indicator Checklist Results: Mechanical

Table 6 and Figure 4 show the assessment results for the attributes/indicators in 11 courses in the Mechanical Engineering program, as collected over the three years that the study was implemented.

Table 6: Number and percentage of attribute indicators assessed for 11 courses in Mechanical Eng., 2011-2014.

MECHANICAL (11)			
	Full	*Part*	*None*
1. Knowledge Base for Engineering - 7 indicators	7 100%	0 0%	0 0%
2. Problem Analysis - 13 indicators	13 100%	0 0%	0 0%
3. Investigation - 28 indicators	20 71.4%	7 25.0%	1 3.6%
4. Design - 31 indicators	14 45.2%	14 45.2%	3 9.7%
5. Use of Engineering Tools - 10 indicators	6 60%	3 30%	1 10%
6. Individual & Teamwork - 16 indicators	8 50%	7 43.8%	1 6.3%
7. Communication Skills - 18 indicators	4 22.2%	7 38.9%	7 38.9%
8. Professionalism - 13 indicators	4 30.8%	7 53.8%	2 15.4%
9. Impact of Engineering on Society & the Environment - 8 indicators	3 37.5%	4 50%	1 12.5%
10. Ethics & Equity 9 indicators	0 0%	3 33.3%	6 66.7%
11. Economics & Project Management - 18 indicators	11 61.1%	6 33.3%	1 5.6%
12. Lifelong Learning - 27 indicators	2 7.4%	23 85.2%	2 7.4%

5. DISCUSSION

It is important to realize that these data could be easily misinterpreted. Although on average 10 courses were assessed for each department, each instructor was expected to consider the manifestation and measurement of only 4 attributes per course. Therefore, the data really represent the treatment of the graduate attributes for an average of 3 courses per department. Considering the data in this light, the faculty can be pleased that on majority, only one attribute per department was not assessed in the courses that were considered for the study.

That being said, it is beneficial to ask what else these findings demonstrate. For the Biosystems engineering program, 50% or more of the indicators of three attributes were assessed in the selected courses: A Knowledge Base for Engineering, Problem Analysis, and Design. The indicators for the attribute, Impact of Engineering on Society and the Environment were not assessed in any of the Biosystems courses that were considered for the study, and a minimal number of indicators were assessed for Individual and Teamwork (below 10%). More than 50% of the indicators for these attributes were not demonstrated: Individual and Teamwork, Impact of Engineering on Society and the Environment, and Ethics and Equity.

The findings for the Civil engineering program show that 50% or more of the indicators for the attributes, A Knowledge Base for Engineering, Problem Analysis, Investigation, Design, Use of Engineering Tools, Communication Skills, Impact of Engineering on Society and the Environment, and Economics and Project Management were assessed in the selection of courses. No indicators were assessed for the attribute, Lifelong Learning, and less than 10% of the indicators were assessed for the attribute, Ethics and Equity. More than 50% of the indicators for these attributes were not demonstrated: Professionalism, Ethics and Equity, and Lifelong Learning.

Analysis of the findings for the Department of Electrical and Computer engineering confirmed that 50% or more of the indicators for these attributes were assessed: A Knowledge Base for Engineering, Problem Analysis, Investigation, Use of Engineering Tools, and Economics and Project Management. For two attributes, Communication Skills, and Ethics and Equity, no indicators were assessed. Professionalism and Lifelong Learning indicators were minimally assessed (less than 10%), and more than 50% of the indicators for both Communication Skills, and Ethics and Equity were not demonstrated.

The Mechanical engineering program courses that were scrutinized for the study exhibited six attributes whose indicators were assessed 50% or more: A Knowledge Base for Engineering; Problem Analysis; Investigation; Use of Engineering Tools; Individual and Teamwork; and Economics and Project Management. The indicators for the attribute Ethics and Equity were not assessed; and the indicators for Lifelong Learning were minimally assessed (less than 10%). More than fifty percent of the indicators for Ethics and Equity were not demonstrated.

A holistic analysis of the data for all four departments reveals that overall, 50% or more of the indicators for the attributes, A Knowledge Base for Engineering and Problem Analysis were assessed. These attributes represent two of the five traditional skills of engineering [10][6]. Attributes whose indicators were not assessed at all included Communication Skills, Impact of Engineering on Society and the Environment, Ethics and Equity, and Lifelong Learning, all considered the professional skills of engineering [10][6]. Similarly, it was again the professional skills whose indicators were minimally assessed: Individual and Teamwork; Professionalism; Ethics and Equity; and Lifelong Learning. Finally, there was one attribute in all four departments where 50% or more of its indicators were not demonstrated, and that was the professional skill, Ethics and Equity. These findings reflect the engineering education research, which shows that not only is there less evidence of assessment of the professional skills, instructors find them more difficult to assess [8].

6. NEXT STEPS

This faculty attribute assessment study was a longitudinal study with the aim to explore how the 12 CEAB graduate attributes are manifest and measured in some of the engineering courses in the four engineering departments in the Faculty of Engineering at the University of Manitoba: Biosystems, Civil, Electrical and Computer, and Mechanical engineering. The findings from this study have given us some insight into where and how the graduate attributes are taught and assessed, and where they are less demonstrated in our engineering programs, and generally confirm that in these data, the traditional skills are more commonly assessed than the professional skills. This trend would be worth investigating further. As shown, it is heartening that in an average of three courses, the majority of the graduate attributes are assessed or demonstrated. However, increasing the demonstration and assessment of the professional skills in our programs would be an advisable endeavor, especially as embodying the professional skills are deemed critical to the success of today's engineer [16][17][18][19].

At this point, we have a set of assessment data that departments can use for their individual assessment protocols. The data offer some valuable information, and it is suggested that departments triangulate them with other sources of available data. Alternate data include those from the student exit surveys [11][12][13], student forums [14], Industry Forums [15], and the course curriculum graduate attribute maps that were produced for the purposes of accreditation. For example, at the same time this study was being executed, an explanatory case study was being conducted to examine fourth year engineering student perceptions of the CEAB graduate attributes in the Mechanical Engineering program [13]. Findings from the study indicate that students would like the program to emphasize several professional attributes more, including Ethics and Equity and Professionalism. Students recommended holding mandatory seminars throughout the semester where Industry leaders would speak about authentic ethical and professional issues engineers face today. Additionally, it was recommended that students in the program be required to write a paragraph on environmental impact in every design report to address more comprehensively the attribute, Impact of Engineering on Society and the Environment. Thereby, once the data from this faculty attribute assessment study are triangulated with other assessment data, trends can be highlighted, and plans can be made within each department for next steps contingent on the results.

Concluding our previous paper for CEEA 2014 [8], which highlighted the findings in the data collected in Fall 2013, we wrote that the checklist in its present form would be retired due to the re-development of the indicators for each of the graduate attributes, all of which transpired with the creation of a set of graduate attribute rubrics [20]. However, it might be worthwhile to consider resurrecting Part A of the checklist and have instructors of the remaining courses in each department assess one set of four targeted graduate attributes. This would give an even more comprehensive picture of how the graduate attributes are manifest and measured in our engineering programs. Alternatively, every indicator does not necessarily need to be targeted for an attribute to be considered assessed. Further exploration of these data could determine the majority of indicators that academics are choosing, and an investigation could be conducted into how many indicators are considered 'enough' to assess students' graduate attribute outcomes.

In the end, we have enough data from this study, and from other sources of assessments, for individual departments to look at 'closing the loop.' In other words, it is time to consider using the results for the purposes of program improvement, a vital step in the CEAB accreditation mandate [5]. This is not easy. As stated by Kaupp and Frank:

> Since 2012, the engineering education community has become comfortable with many aspects of the outcomes-based mandate, yet the continuous curriculum or program improvement side of the mandate is an area of much concern and question… Simply collecting the data of student performance and improving a single course on its own may be straightforward, but making meaning of the data and then effectively implementing a change across a program is far more complex. [5]

There is no singular way to go about closing the loop of program assessment [5]; ultimately, this will be a decision for faculty from each of our engineering departments to make. However, we are hopeful that these data, gathered with the cooperation of many of our faculty, will help point out the direction those decisions could take.

6. CONCLUSION

New work is continually being undertaken in the Faculty of Engineering at the University of Manitoba to explore outcomes-based assessment in our four engineering programs. Nevertheless, the findings from this longitudinal study have laid the groundwork for closing one loop of our program assessment efforts. Through three years of investigation, we have been provided with an overview of how the 12 graduate attributes are manifest and measured in the courses in our four engineering departments. There are clearly trends that support the research on the proclivity for assessing the traditional versus the professional skills in engineering education that should inform our program improvements.

Reflecting on this study has revealed its value, and the vision we have gained regarding our engineering programs and the 12 CEAB graduate attributes. By closing this assessment loop, we will experience improvements in our engineering curriculum that will fully demonstrate our commitment to an outcomes-based engineering education assessment protocol.

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