October 14, 2014

Final Assessment Report on
Review of Engineering Undergraduate Programs
(Chemical, Civil, Computer, Electrical, Environmental, Geological, Management, Mechanical, Mechatronics, Nanotechnology, Software, Systems Design)

Table of Contents

Introduction

Twelve undergraduate Engineering programs were scheduled to undergo an accreditation review by the Canadian Engineering Accreditation Board (CEAB) in 2013[1]. The Engineering programs being reviewed (start dates in parentheses) are: Chemical (1957), Civil (1957), Computer (1984), Electrical (1957), Environmental (1995), Geological (1982), Management (2007), Mechanical (1957), Mechatronics (2003), Nanotechnology (2005), Software (2001) and Systems Design (1969). The Architecture program was reviewed in 2011 for professional accreditation and was excluded from this exercise. A new undergraduate program in Biomedical Engineering was recently approved (Fall, 2013) and will enroll its first students in Fall, 2014.

These above programs are the responsibility of 6 departments in the Faculty of Engineering: Chemical Engineering; Civil and Environmental Engineering; Electrical and Computer Engineering; Management Sciences, Mechanical and Mechatronics Engineering; and Systems Design Engineering. Several programs are supported by more than one department within the Faculty and others are supported by both Engineering as well as other Faculties. Geological Engineering is supported jointly by the Department of Civil and Environmental Engineering and the Faculty of Science (Department of Earth and Environmental Sciences); Software Engineering is supported jointly by the Department of Electrical and Computer Engineering and the Faculty of Mathematics (mainly David R. Cheriton School of Computer Science); and Nanotechnology Engineering is supported jointly by the Department of Chemical Engineering and the Department of Electrical and Computer Engineering as well as the Department of Chemistry in the Faculty of Science.

Review process

The program self studies were completed in November 2013. Program self studies were prepared by associate chairs, program directors or their designates. Wayne Parker (Associate Dean Co-operative Education and Professional Affairs) coordinated the CEAB process for the Faculty. The site visit occurred from November 24-26, 2013. The CEAB visiting team met with administrators, faculty, staff and graduate and undergraduate students from the various programs being reviewed.

The CEAB permitted a UW "observer" (David McKinnon, Faculty of Mathematics) to monitor the process, thus enabling the University of Waterloo to effectively leverage the accreditation team

[1] The purpose of accreditation by the CEAB is "to identify to the constituent associations of Engineers Canada those engineering programs whose graduates are academically qualified to begin the process to be licensed as professional engineers in Canada. The process of accreditation emphasizes the quality of the students, the academic and support staff, the curriculum and the educational facilities."

expertise, logistics and assessment report toward meeting our own institutional requirements for cyclical program reviews.

The "Report of the Visiting Team on the Accreditation visit" was received Feb 24 2014 The report from the internal UW observer was received February 13, 2014. The Engineering Faculty "Response to the Report of the Visiting Team on the Accreditation Visit" was submitted to the CEAB on March 24, 2014. The final decision of the CEAB was received on June 26, 2014.

This Final Assessment Report compliments the documents prepared for the CEAB process as it includes aspects of the Engineering programs not included in the CEAB reporting, but that are required as part of the regular cyclical review of academic programs, as articulated in UW's Institutional Quality Assurance Framework. The scope of the material to be included in this addendum was agreed upon by Geoff McBoyle (then Associate Vice-President, Academic), Wayne Loucks (Associate Dean of Engineering, Undergraduate Studies) and Wayne Parker (Associate Dean Co-operative Education and Professional Affairs). This report was written by Mario Coniglio (Associate Vice-President, Academic), assisted by Wayne Loucks and Wayne Parker. Institutional Analysis and Planning (IAP) provided much of the data used in this report. Separate reports on course evaluations and co-operative education in Engineering are available upon request.

This document also includes information derived from Engineering's strategic plan and its progress report:

- *Vision 2015 – Building on Excellence – Waterloo Engineering Strategic Plan 2011–2015 (May 2012)*
- *Vision 2015 – Building on Excellence – Waterloo Engineering Strategic Plan Progress Report 2012/2013 (November 2013)*

All references referring to "Vision 2015" indicate the 2013 progress report.

Academic programs offered and program objectives

The Faculty of Engineering mission statement as articulated in its 2012 strategic plan document is the following:

> *Waterloo Engineering offers professional education of the highest quality across a comprehensive set of engineering and architecture disciplines. We engage in internationally recognized research and design. We build knowledge and intellectual rigor through scholarship, graduate, and undergraduate teaching. Our outward-looking*

philosophy sets us apart: it is reflected in our commitment to co-operative education, in our extensive regional, national, and international partnerships, and in our research to meet the challenges of today and to shape the future. (source: Vision 2015 Strategic Plan, May 2012)

All 12 programs under review, except for Software Engineering, grant an Honours BASc (Co-operative Program) in their respective disciplines. Software Engineering offers an Honours BSE. All 12 programs offer one or more options. Minors are not offered in Engineering.

The objectives of the 12 programs are as follows:

- **Chemical Engineering**: to produce graduates capable of designing, analyzing, and controlling processes and systems involving the physical, chemical, or biochemical transformation of matter in the areas of energy, environment, materials, and manufacturing, with attention to economics and sustainability.

- **Civil Engineering**: to allow students to develop the necessary technical and professional skills in structures and mechanics, and in the areas of geotechnical, water resources, transportation, environmental and other areas in order for them to function effectively as Civil Engineers.

- **Computer Engineering**: to provide students with a solid theoretical foundation for the practice of Computer Engineering, expertise in analysis and design techniques in all the major areas within this broad discipline (including but not limited to aspects of hardware, software, and embedded systems, as well as related topics in electrical and software engineering), and practical experience in the application of these methods.

- **Electrical Engineering**: to provide students with a solid theoretical foundation for the practice of Electrical Engineering, expertise in analysis and design techniques in all the major areas within this broad discipline (including but not limited to circuits, devices, power and energy systems, radio-frequency systems, antennas and propagation, control systems, as well as related topics in computer and software engineering), and practical experience in the application of these methods.

- **Environmental Engineering** provides the setting that allows its students to develop the necessary technical and professional skills and knowledge to function effectively as Environmental Engineers.

- **Geological Engineering:** to provide a diverse and sufficiently focused curriculum structure that will permit students to experience the wide spectrum of technical skills associated with Geological Engineering with specific emphasis on geomechanics and hydrogeology.

- **Management Engineering:** to provide its students with skills in operations research, behaviour science, and information technology through core courses and technical electives that reflect important advances in their applications to the design and operation of management and industrial processes.

- **Mechanical Engineering:** to offer a world class program in Mechanical Engineering education that balances theory and practice by means of an innovative and extensive co-op program.

- **Mechatronics Engineering**: integrates the design principles and practices in Mechanical, Electrical, Computer and Systems Design Engineering, and is designed to integrate the various disciplines throughout the program and provide students with a firm grasp of the fundamentals.

- **Nanotechnology Engineering**: to prepare its students for entry either into industrial and government work places or into graduate programs in nanotechnology engineering, nanoscience, or nanomedicine.

- **Software Engineering**: to produce graduates capable of applying a systematic and disciplined approach to the creation, operation and maintenance of software systems by combining Computer Science software expertise with Engineering philosophies, principles and practices.

- **Systems Design Engineering:** to provide an innovative curriculum that produces graduates with broad background and capability in engineering fundamentals, along with study in human factors, environmental, and societal impacts necessary for designing solutions for multi-disciplined problems associated with today's complex systems.

Assessment of Engineering undergraduate programs – provincially and nationally

Metrics for the standing of each Engineering program are not available. However, a qualitative idea of the standing of most of the Engineering departments can be obtained through Vision 2015 exercise whereby external assessors commented subjectively on the programs' standings in Canada. The selected comments below relate only to the undergraduate program.

- **Civil and Environmental Engineering:** *"The department certainly hasn't declined in its standing since the Vision 2010 external assessor report (top 5 in Canada and arguably the best in undergraduate studies), and might have increased slightly."*

- **Chemical Engineering:** *"Waterloo's Chemical Engineering Department is one of the better departments in Canada…. Waterloo certainly offers the best co-operative chemical engineering undergraduate program in Canada, and its overall undergraduate program is second to none."*

- **Electrical and Computer Engineering:** *"In Canada at the undergraduate level, Waterloo is in a field all by itself due to the recognizable brand it has, which is built on the co-op program"*

- **Mechanical and Mechatronics Engineering:** *"Waterloo's Mechanical and Mechatronics Engineering department is among the top mechanical engineering departments in Canada…. Hard to "rank", as it is quite unique: its undergraduate program is excellent, with a great deal of hands-on experience (offered in labs and co-op work terms) with which others can't really compare."*

- **Management Sciences:** *"The question is difficult to answer for such a new undergraduate program. The Waterloo Management Sciences graduate program has an excellent reputation: it is well-established and recognized as a top-ranked program among Canadian and American schools."*

- **Systems Design Engineering:** *"The department's undergraduate program is quite unique in Canada and one of the top programs in North America."*

International rankings

Rankings of the Engineering and Technology field

According to the four best-known international university rankings of the field of Engineering and Technology, Waterloo ranks as the #2 school in the country and the province (see chart below). It is important to note that these rankings really measure research (and for the QS and Times Higher Education, academic reputation – which many would argue is also based largely on research). It is extremely likely that a ranking based solely on undergraduate education would see Waterloo increase in its prominence, especially on the provincial and national scale. UW is renowned for its undergraduate co-operative education program and is largely perceived as the top engineering school in Canada for undergraduate studies, as confirmed by the 2012 Business Insider ranking of

engineering schools in which UW was the #1 Canadian school. This ranking, which is based on an employer survey, reflects in a practical way our "product" from the undergraduate program.

Ranking	Year	Global Rank	National Rank	Provincial Rank
Shanghai (AWRU)	2013	43	2	2
QS	2013	46	2	2
Taiwan (NTU/HEEACT)	2012*	52	2	2
Times Higher Education	2011**	48	4	2

Table 1: International rankings for Engineering at Waterloo. *Rankings not yet released for 2013.
**Waterloo not ranked in top 50 in 2012; rankings not yet released for 2013

Rankings of Specific Disciplines

The Taiwan rankings include a reliable ranking of some sub-disciplines based on research output. The most recent (2012) results for Waterloo are below:

Subject Ranked by NTU	Global Rank	National Rank	Provincial Rank
Electrical Engineering	40	2	2
Computer Science	25	3	2
Mechanical Engineering	83	4	2
Chemical Engineering	44	2	1
Materials Science	145	3	2
Civil Engineering	30	3	2

Table 2: Taiwan rankings of Waterloo Engineering sub-disciplines.

Demographics and Quality of Engineering faculty

The research output (refereed articles, refereed conference proceedings, books, book Chapters, technical reports, conference presentations) as well as awards and honours of Engineering faculty over the last 5 years is available in the faculty Information forms that were prepared for the CEAB accreditation review. Data on the number of faculty members who are journal editors or that sit on editorial boards and/or granting agencies is not collected, but is expected to be high, given the prominent research profile of Engineering at University of Waterloo.

The quality of the faculty in Engineering is clearly indicated by the number and variety of major faculty awards, and importantly the levels of sponsored research. As of 2013, the Faculty includes 17 Canada Research Chairs (Tier 1 and 2), seven NSERC Industrial Research Chairs, four endowed chairs as well as numerous other prestigious awards. From 2009/2010 to 2012/2013, total sponsored research funding averaged ~$59M. Over this same time span, the total sponsored research funding:faculty ratio was ~$229K.

An important consideration for accreditation purposes is the number of faculty members who are licensed professional engineers (PEng). In the 2012/2013 year, 63% of Engineering faculty were licensed (Table 3). This number does not include non-Engineering faculty in the shared programs (Geological Engineering, Nanotechnology Engineering, Software Engineering). The Faculty encourages its faculty to pursue their PEng designations, but current PEO practices do not count university research as practical experience (Vision 2015). Faculty affected by this regulation will be encouraged to apply for Limited Licenses.

Distribution of Regular Faculty by PEng Status, 2012/13

Department	Registered	Applied	Not Applied	Not Eligible	Total
Chemical	20.0	7.0	9.0	0.0	36.0
Civil & Environmental	29.8	3.0	6.0	0.0	38.8
Electrical & Computer	49.5	11.0	26.0	0.0	86.5
Management Sciences	12.3	6.0	4.0	5.0	27.3
Mechanical & Mechatronics	43.0	5.0	5.0	0.0	53.0
Systems Design	14.3	2.0	10.0	1.0	27.3
Other	1.5	1.0	0.0	0.0	2.5
TOTAL	170.4	35.0	60.0	6.0	271.4

Table 3: Faculty statistics showing numbers of registered PEng in each Engineering department, along with related pending application and eligibility data. *Source: Vision 2015*

The Faculty has several measures in place aimed to increase representation of females in its professoriate (Vision 2015). Since 2004, women faculty have increased by 83%, whereas the total number of Engineering faculty increased by 51.5%. The regular faculty complement of 292.3 in 2013 was composed of 269.8 tenured or tenure-stream faculty and 22.5 definite-term and continuing lecturers. The number of women was 44 (15.1%). The number of women in its various departments is variable, ranging from a low of 8% in Chemical Engineering to a high of 36.8% in Architecture. Women faculty in non-departmental "support unit" offices make up 39.8% of the faculty.

Student quality

The incoming average of the first-year Engineering class can be viewed as a proxy for the quality of the program. Maclean's magazine has collected and published this data in its annual fall issue on professional schools (Table 4).

School	2012	2011	2010
Waterloo	90.0%	89.4%	89.2%
Toronto	92.2%	90.9%	90.3%
McGill	90.5%	89.6%	
UBC	90.1%		

Table 4: Waterloo's incoming averages for first-year Engineering students compared to Canadian schools which report higher incoming averages.

Figure 1 below "depicts a steady increase over the past six years in the proportion of undergraduate students entering Waterloo Engineering with incoming final high school averages over 95% and between 90-94%. The record high in 2012 indicates that 65.6% of entering students had a final high school average of 90% or higher, an affirmation of the exceptionally high quality students we attract to our renowned undergraduate program." (Vision 2015)

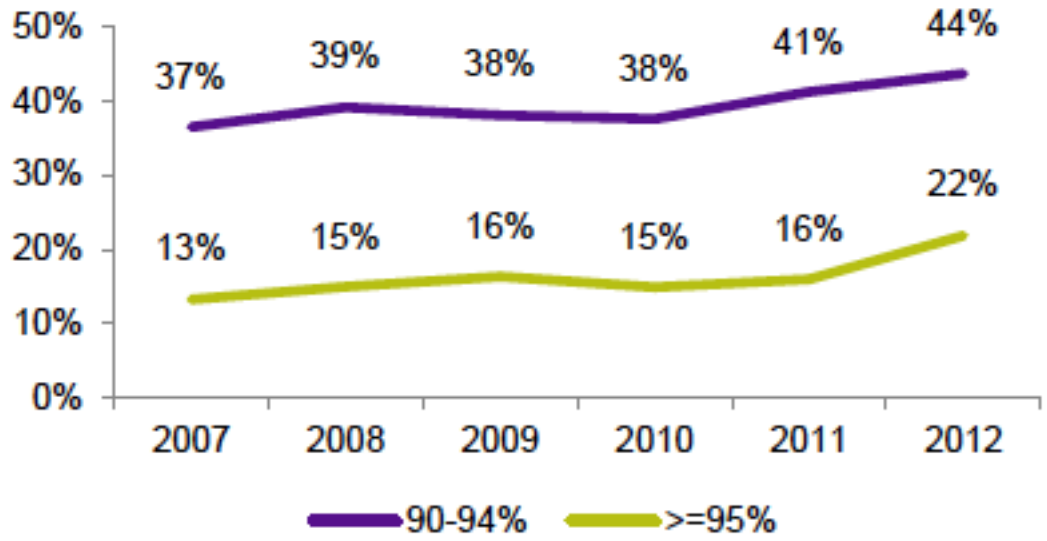

Figure 1: Final entering grade averages for Engineering undergraduates, 2007-2012. *Source: Vision 2015*

Another indicator of program quality is the ratio of undergraduate students to regular faculty (Table 5). The low ratio for Management Sciences reflects the fact that until 2007, it did not have the undergraduate management engineering program.

Department	2009/10	2010/11	2011/12	2012/13
Architecture	17.3	18.2	15.9	15.3
Chemical	19.3	18.0	17.0	18.8
Civil & Environmental	17.0	18.1	18.7	19.5
Electrical & Computer	19.9	20.0	20.4	19.7
Management Sciences	6.4	7.5	7.7	8.2
Mechanical & Mechatronics	18.1	17.5	18.2	19.0
Systems Design	17.0	18.8	18.4	18.9
TOTAL	17.6	17.7	17.6	17.8

Table 5: Undergraduate student:faculty ratios 2009/2010 – 2012/2013

Application – registration statistics

Admissions data from Vision 2015 from Fall 2009 to Fall 2012 shows that for the first 3 years, total year 1 Engineering enrolments were 2-8% above the set targets. In Fall 2012, however, enrollment was 98% of target. Over this time frame, most individual programs were within +/- 5% of their set targets. There is no obvious pattern of Engineering programs that are consistently above or below this range related to their target. Table 6 shows the admissions data for Fall 2012.

Undergraduate Year One New Admissions, Fall 2012

	New Admissions			Total 1A Enrol't			% of	% of
Program	CPR	Int'l	Total	# Women	% Women	Total	total target	int'l target
Architecture	74	1	75	43	56.6%	76	98.7%	16.7%
Chemical	123	18	141	43	29.3%	147	100.7%	90.0%
UAE: Chemical	7	20	27	6	20.7%	29	67.5%	57.1%
Civil	92	14	106	41	36.0%	114	92.2%	93.3%
UAE: Civil	6	24	30	3	9.7%	31	75.0%	68.6%
Electrical & Computer	301	57	358	41	10.8%	380	99.4%	114.0%
Environmental	54	6	60	37	56.1%	66	85.7%	75.0%
Geological	32	0	32	10	28.6%	35	118.5%	0.0%
Management	58	4	62	24	34.3%	70	95.4%	40.0%
Mechanical	176	34	210	23	10.3%	224	100.0%	136.0%
Mechatronics	115	19	134	22	15.5%	142	103.1%	126.7%
Nanotechnology	108	8	116	31	25.6%	121	100.9%	80.0%
Software	118	11	129	21	15.4%	136	103.2%	73.3%
Systems Design	85	2	87	32	34.4%	93	96.7%	50.0%
TOTAL	1349	218	1567	377	22.7%	1664	97.8%	87.2%

Table 6: Year one admissions in Engineering for Fall 2012. Data for the discontinued UAE (Chemical and Civil) programs are not relevant to this report. *Source: Vision 2015*

Engineering at Waterloo continues to be a top choice for students intending to study Engineering. The data presented in Figures 2-7 below were obtained to support the institution's enrollment projections to 2018. The data show clearly increases in all of the numbers associated with various stages of the enrollment funnel, from applications to offers to confirmations to registrants (new admits) on the annual November 1 count date.

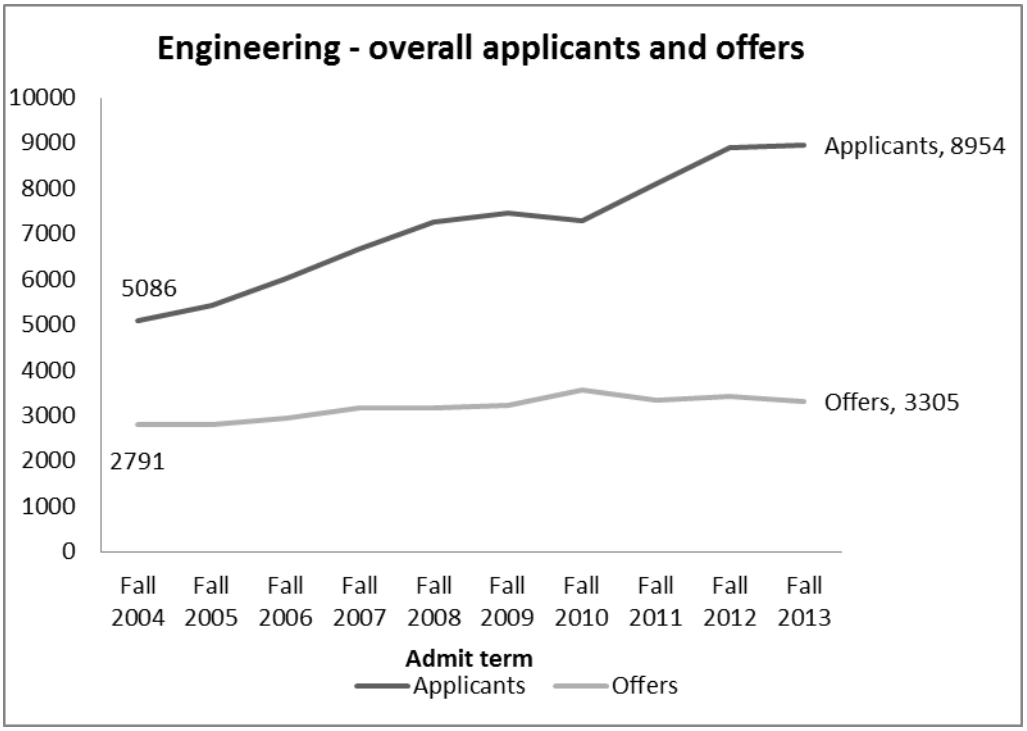

Figure 2: Engineering overall applicants and offers

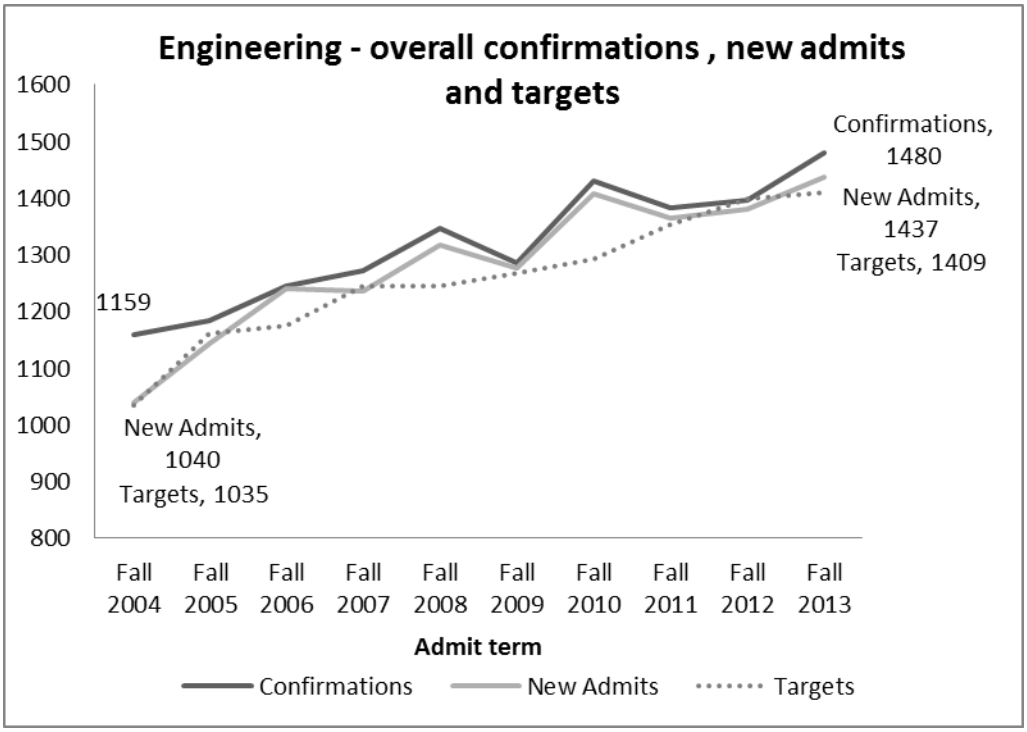

Figure 3: Engineering overall confirmations, new admits and targets

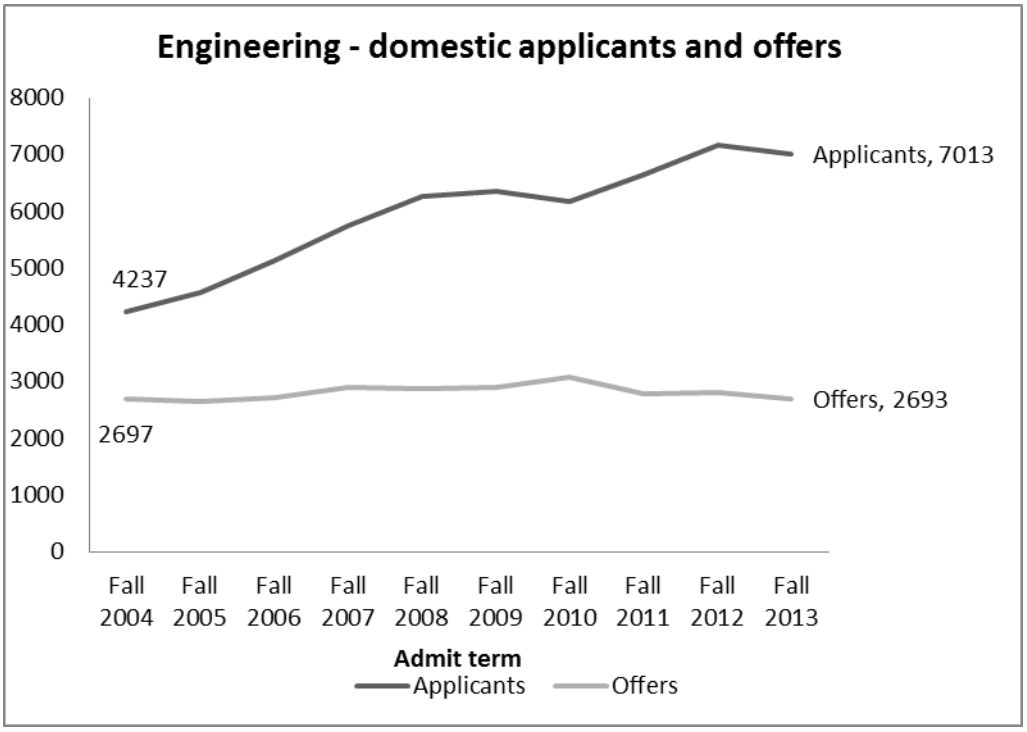

Figure 4: Engineering domestic applicants and offers

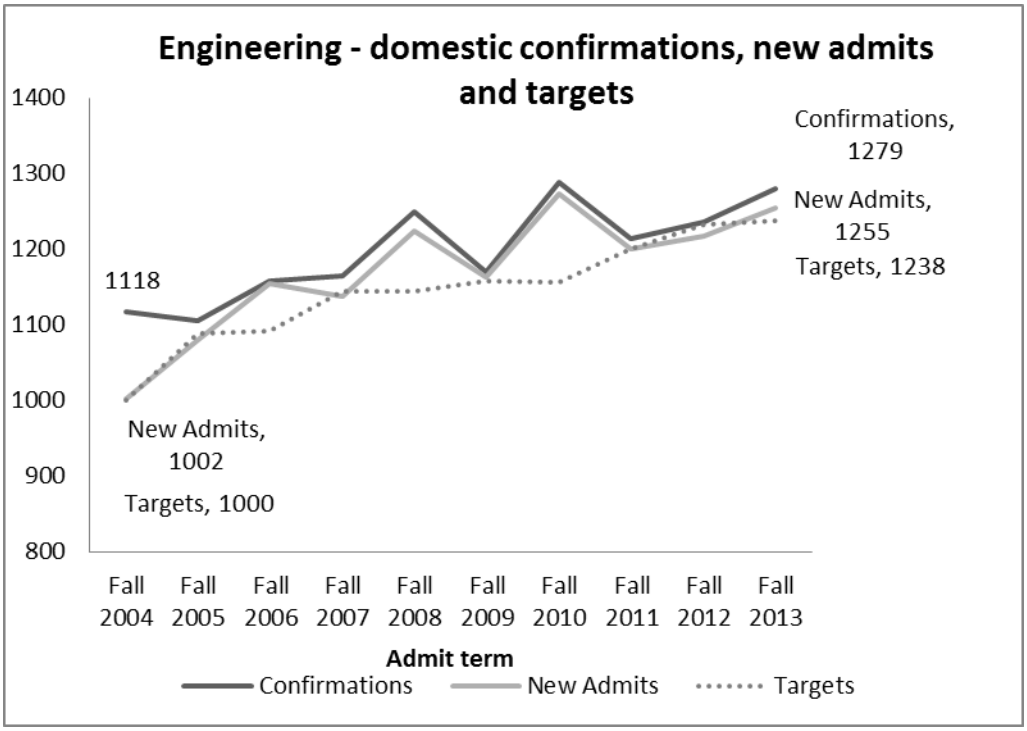

Figure 5: Engineering domestic confirmations, new admits and targets

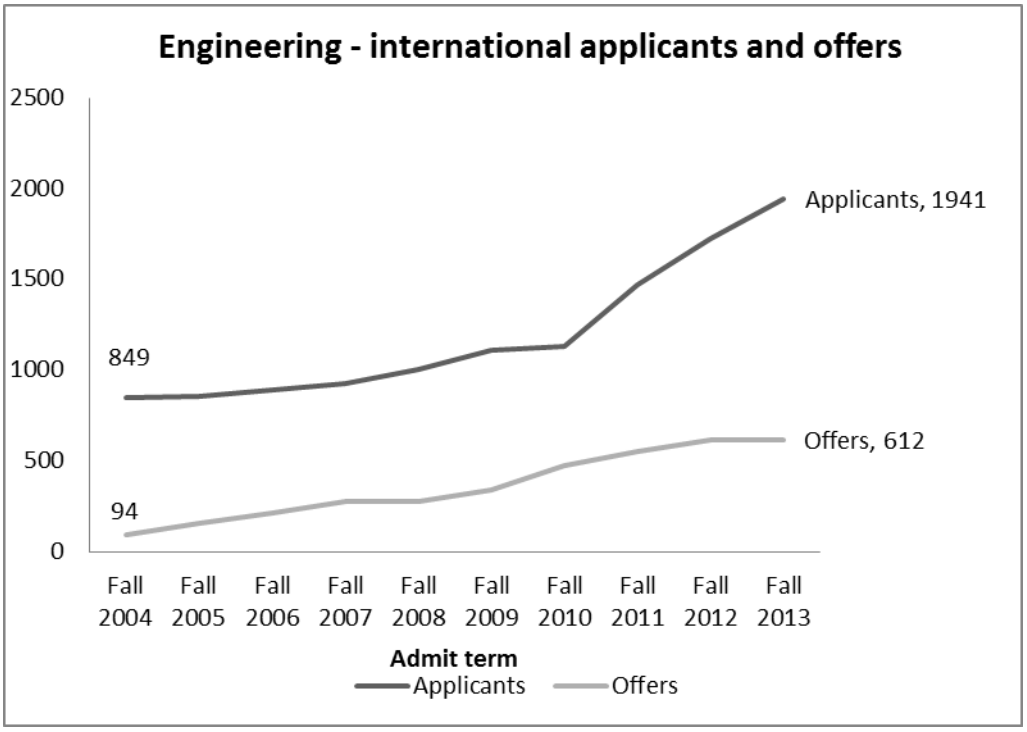

Figure 6: Engineering international applicants and offers

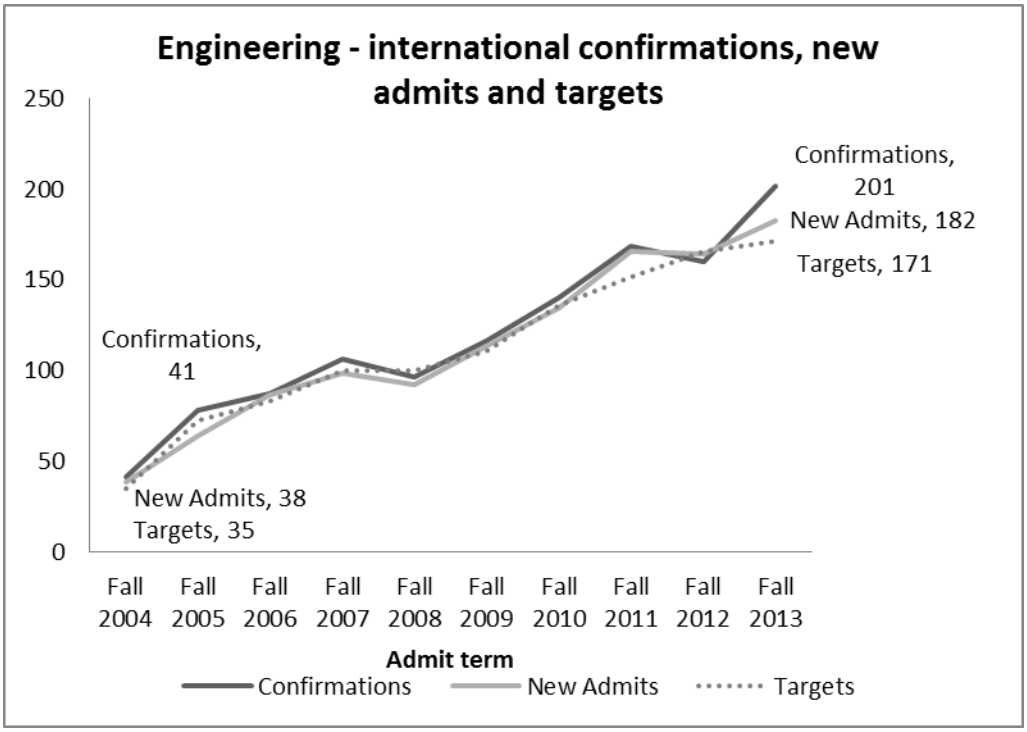

Figure 7: Engineering international confirmations, new admits and targets

Enrollment and graduation data

As of the 2012/2013 academic year, the Faculty of Engineering had 6840 undergraduate students (head count), including 703 international students. This is an increase of ~49% in the last decade (Fig. 8). In terms of FTEs, Engineering undergraduates make up 16.4% and 7.0% of all Engineering undergraduates enrolled in Ontario and Canadian universities, respectively (Vision 2015).

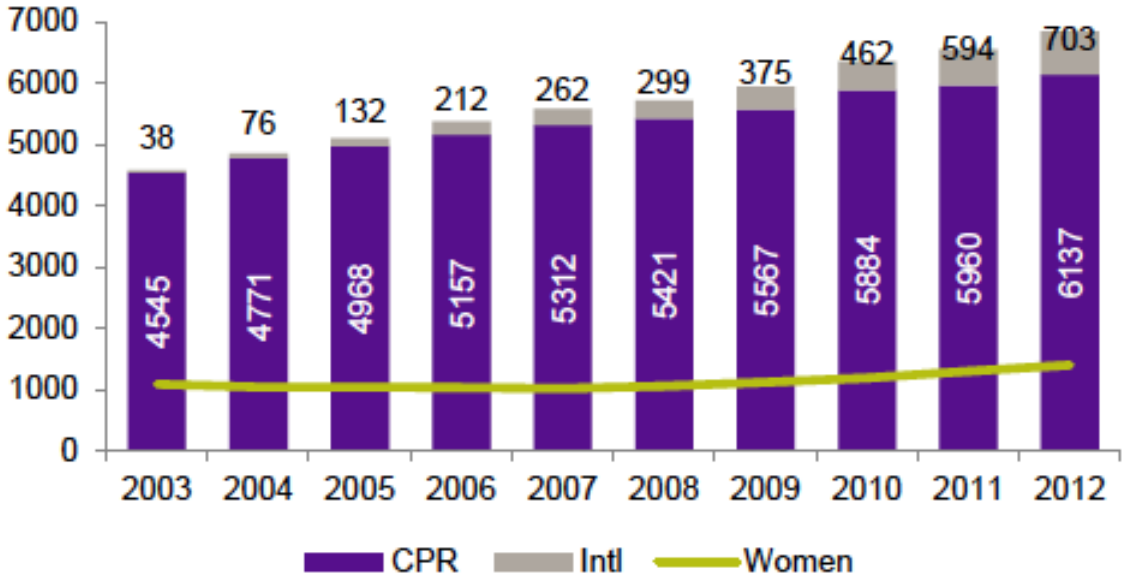

Figure 8: Undergraduate enrollment growth in all Engineering undergraduate programs. *Source: Vision 2015*

Of the twelve programs under review, the highest enrollment in Fall 2012 was in Mechanical Engineering (911) and the lowest enrollment was in Geological Engineering (102; ignoring the the Civil Engineering enrollment in the now defunct UAE campus - see Table 7).

Total Undergraduate Enrolment (head count), Fall 2012

Program	Total	#Female	% Female	#Visa	% Visa
Architecture	370	209	56.5%	5	1.4%
Chemical	616	202	32.8%	81	13.1%
UAE: Chemical	62	16	25.8%	50	80.6%
Civil	554	134	24.2%	60	10.8%
UAE: Civil	57	8	14.0%	45	78.9%
Computer	682	59	8.7%	68	10.0%
Electrical	914	97	10.6%	103	11.3%
Environmental	249	124	49.8%	16	6.4%
Geological	102	26	25.5%	2	2.0%
Management	280	94	33.6%	33	11.8%
Mechanical	911	93	10.2%	94	10.3%
Mechatronics	610	66	10.8%	62	10.2%
Nanotechnology	504	100	19.8%	36	7.1%
Software	517	61	11.8%	38	7.4%
Systems Design	412	117	28.4%	10	2.4%
TOTAL	6840	1406	20.6%	703	10.3%

Table 7: Undergraduate enrollment by program in Fall 2012. *Source: Vision 2015.*

There has been a 36% increase over the last decade in the numbers of degrees awarded annually, reaching an all-time high in 2012 of 1046 undergraduate degrees (Figs. 9, 10).

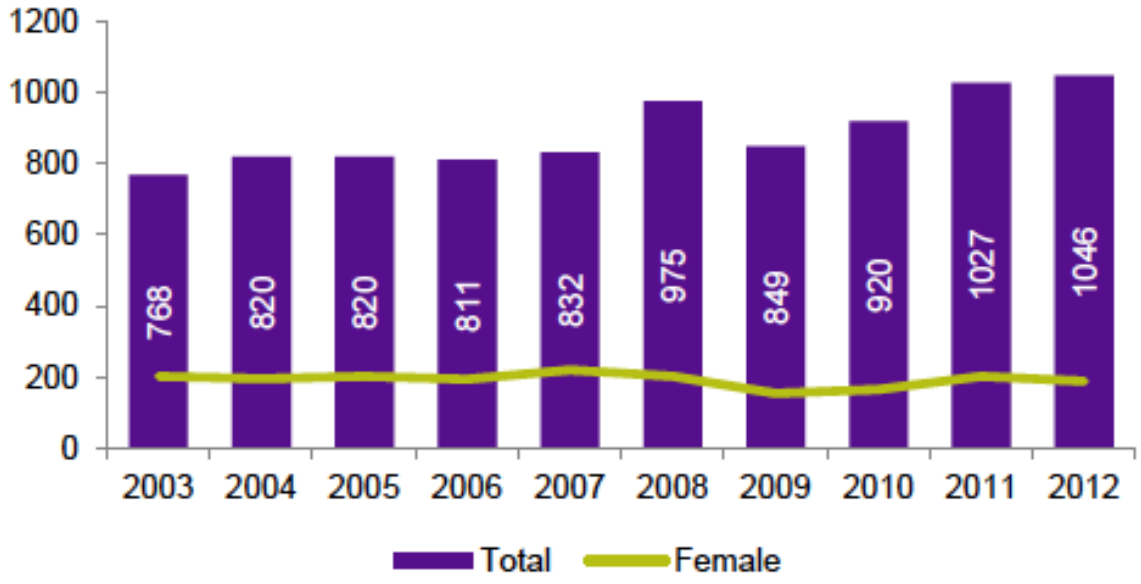

Figure 9: Undergraduate degrees granted in all Engineering programs. *Source: Vision 2015*

Undergraduate Degrees Granted, 2012

Program	Total	#Female	% Female	#Visa	% Visa
Architecture	56	33	58.9%	3	5.4%
Chemical	105	34	32.4%	11	10.5%
Civil	92	28	30.4%	0	0.0%
Computer	89	10	11.2%	3	3.4%
Electrical	156	11	7.1%	8	5.1%
Environmental	34	16	47.1%	2	5.9%
Geological	13	3	23.1%	0	0.0%
Management	38	7	18.4%	4	10.5%
Mechanical	158	11	7.0%	6	3.8%
Mechatronics	88	4	4.5%	4	4.5%
Nanotechnology	70	14	20.0%	4	5.7%
Software	80	8	10.0%	5	6.3%
Systems Design	67	10	14.9%	1	1.5%
TOTAL	1046	189	18.1%	51	4.9%

Table 8: Undergraduate degrees granted by program in Fall 2012. Source: Vision 201

Number of courses taught and enrolment by level of year

The Engineering faculty is fully engaged in teaching in each of the three academic terms. The average number of courses taught in the Fall, Winter and Spring terms in each year since 2007 is 203, 209 and 168 courses, respectively. The last three years have seen a relatively constant number of courses offered in each of the academic terms.

Academic Term	Course Level						
	0	100	200	300	400	Other *	Total
Fall 2007	10	33	68	30	26	9	176
Winter 2008	6	32	34	63	47	10	192
Spring 2008	5	28	37	42	36	8	156
Fall 2008	6	33	72	40	27	13	191
Winter 2009	2	31	35	64	45	11	188
Spring 2009		28	39	42	43	10	162
Fall 2009		36	72	38	38	17	201
Winter 2010		32	35	66	54	15	202
Spring 2010		29	39	40	44	12	164
Fall 2010		37	75	44	41	20	217
Winter 2011		32	40	70	57	16	215
Spring 2011		32	42	40	47	16	177
Fall 2011		33	75	43	44	20	215
Winter 2012		32	44	69	65	20	230
Spring 2012		32	41	40	49	17	179
Fall 2012		34	76	42	44	21	217
Winter 2013		31	45	67	62	20	225

Table 9: Number of courses taught in Engineering per term. Source: IAP Count Date database, special query run on June 3, 2013.

Definitions and Notes:

- All data as of count date (November 1, February 1, and June 30) in each listed term.
- 00 level courses are offered to current Engineering students. Some courses are restricted to particular programs, or to students in an exchange program. An example of this is CHE 37 – Applied Mathematics 2, offered in academic year 2007/08.
- Courses may have several sections; however each section is not counted in the table above. A course with multiple sections is counted once in each term.

- Includes: courses not offered by the Faculty of Engineering where 90% or more enrolled students are registered with the Faculty of Engineering, or Software Engineering. For example, Italian 155 has only Architecture students enrolled and so is included in the 100 level course count.
- Excludes: PDEng, PD, Work report and Graduate level courses. Courses with less than 5 students enrolled are also excluded.
- "Other" column includes lab and seminar courses.

The Engineering faculty has seen a steady increase in teaching activity since 2007. Fall enrollments have increased ~34% from 2007 to 2012 (17,940 to 24,024 individual course enrollments); from 2008 to 2013, Winter enrollments have increased ~22% (16,145 to 19,633); from 2008 to 2012 Spring enrollments have increased ~19% (13,069 to 15,548).

Academic Term	**Course Level**					
	00s	100	200	300	400	Other*
Fall 2007	484	7605	5861	2006	1242	742
Winter 2008	283	4050	3736	4414	2474	1188
Spring 2008	244	3281	3426	3104	2166	848
Fall 2008	280	8177	6157	2364	1185	1058
Winter 2009	148	4094	3659	4846	2363	1192
Spring 2009		3617	3478	3448	2543	986
Fall 2009		7988	6284	2854	1790	1624
Winter 2010		4094	3735	4833	3029	1487
Spring 2010		3416	3337	3352	2829	1341
Fall 2010		10243	7084	2934	2083	1861
Winter 2011		4650	3759	5260	3144	1658
Spring 2011		3717	3490	3706	2883	1703
Fall 2011		8610	7282	3031	1941	2110
Winter 2012		4617	3964	5779	3278	1900
Spring 2012		3467	3735	3356	2951	2039
Fall 2012		8841	7639	2940	2221	2383
Winter 2013		4773	3693	5177	3835	2155

Table 10: Enrollment in Engineering courses per term according to level. Source: IAP Count Date database, special query run on June 3, 2013.

Definitions and Notes:

- All data as of count date (November 1, February 1, and June 30) in each listed term.
- A particular student may register in more than one course. As a result, a unique student is counted multiple times in each term.
- 00 level courses are offered to current Engineering students. Some of these are restricted to particular programs, or to students in an exchange program. An example of this was CHE 37 – Applied Mathematics 2, offered in academic year 2007/08.

- Includes: courses not offered by the Faculty of Engineering where 90% of more enrolled students are registered with the Faculty of Engineering, or Software Engineering. For example, Italian 155 has only Architecture students enrolled and so is included here.
- Excludes: PDEng, PD, Work report and Graduate level courses. Courses with less than 5 students enrolled are also excluded.
- "Other" column includes lab and seminar courses.

Student course evaluation data for 2010/11 to 2012/13

Course evaluations are carried out by the Engineering Society and the summary results are available to all Engineering students and faculty members.

The evaluation questionnaire consists of 18 questions that can be answered and scored on a five point Likert-type scale plus space for providing written comments to the course instructor. Data are converted to a percentage scale, with higher numbers indicating more positive responses. A separate report is available that presents detailed aggregated information on the teaching evaluations for undergraduate courses in Engineering.

Considering scores in aggregate, students generally rate the teaching quality in their first to fourth year courses favourably, with scores ranging from 73.6% to 78.5%. Similarly, students' overall appraisal of their courses is favourable, with scores in the same time interval ranging from 67.6% to 72.8%. Fourth year courses are rated more favourably than those in the first three years.

Student gender ratios in year 1

Undergraduate studies in Engineering are still overwhelmingly dominated by males but the data suggest this is changing slowly. Software engineering, compared to the aggregated numbers for all engineering programs, has 6-11% more male students.

Fiscal Year	Female Proportion	Male Proportion	Total Students
2007/08	17.4%	82.6%	2479
2008/09	18.9%	81.1%	2583
2009/10	19.1%	80.9%	2594
2010/11	18.1%	81.9%	2727
2011/12	19.7%	80.3%	2838

Table 11: Gender proportions of year 1 students in Faculty of Engineering. Total students (also for tables 12-14) refers to the number of unique students counts in a fiscal year, including registrations on work terms. A student with 1, 2 or 3 registrations in a fiscal year would all count as 1 unique student. Source: IAP Count Date database, registration cube, extracted on June 6, 2013

Software Engineering – year 1 students

Fiscal Year	Female Proportion	Male Proportion	Total Students
2007/08	8.4%	91.6%	225
2008/09	9.6%	90.4%	230
2009/10	8.5%	91.5%	234
2010/11	9.4%	90.6%	245
2011/12	13.4%	86.6%	253

Table 12: Gender proportions of year 1 students in Software Engineering. Source: IAP Count Date database, registration cube, extracted on June 6, 2013

Definitions and Notes:

- All data as of count date (November 1, February 1, and June 30) in each fiscal year.
- Unique student counts are for each fiscal year. Students who register for more than 1 term are counted once.
- Includes: all students registered to the Faculty of Engineering or Software Engineering at least once in the listed fiscal year.

Proportion of domestic/international students in year 1

International student enrollments in undergraduate Engineering programs have increased over the period of the self-study and closely tracked, within 2%, the institutional numbers over the same time period. In the 2007/2008 fiscal year, Engineering visa students constituted 7% of the total enrollment, whereas the institutional number for the same year was 9%. In the 2011/2012 year, visa students in engineering constituted 12.8% of the total where as the institutional number was 11%.

Fiscal Year	Domestic	International	Total
2007/08	93.1%	7.0%	2479
2008/09	92.9%	7.2%	2583
2009/10	91.4%	8.8%	2594
2010/11	89.3%	10.7%	2727
2011/12	87.2%	12.8%	2838

Table 13: Proportion of domestic vs. international students in Engineering. Source: IAP Count Date database, registration cube, extracted on June 6, 2013

Software Engineering – year 1 students

Fiscal Year	Domestic	International	Total
2007/08	208	17	225
2008/09	215	15	230
2009/10	220	14	234
2010/11	226	19	245
2011/12	230	23	253

Table 14: Proportion of domestic vs. international students in Software Engineering. Source: IAP Count Date database, registration cube, extracted on June 6, 2013

Definitions and Notes:

- All data as of count date (November 1, February 1, and June 30) in each fiscal year.
- Visa status is based on the fees paid by the student, not their citizenship. For example, an international student may have a diploma from a secondary school in Ontario, but did not qualify to pay domestic fees; this student would be counted as international.
- Unique student counts are for each fiscal year. Students who register for more than 1 term are counted once.
- Includes: students registered to the Faculty of Engineering or Software Engineering at least once in the listed fiscal year.

Attrition rates between year 1 and year 2

Retention between year 1 and year 2 varied little from 2007/08 to 2010/11, ranging from 82.9% to 85.5%. However, the retention of the 2011/12 was notably weaker at 73.4%. By contrast, retention of Software Engineering students has steadily decreased from 2007/08 (98.2%) to 2009/10 (97.4%), followed by sudden drops for the 2010/11 and 2011/12 cohorts (92.4% and 88.5%, respectively). The reason for the apparent jump in the number of 'not retained' students in 2011/12 (265/16.65%) is most likely the result of the implementation of new progression rules for first-year engineering students together with a new streaming schedule for some students. Additional data for subsequent years is needed to fully assess whether the reported figure indicates a trend or is an anomaly.

	First Registration Fiscal Year				
Year 1 to Year 2 Status	2007/08	2008/09	2009/10	2010/11	2011/12
Retained between year 1 and year 2	1162	1244	1213	1351	1168
Not Retained	79	75	91	100	265
Started with advanced standing	118	141	159	152	159
Total	1359	1460	1463	1603	1592

Table 15: Retention (unique student counts) in Faculty of Engineering. Source: IAP Count Date database, application cube, extracted on June 12, 2013

Faculty of Engineering – proportions

	First Registration Fiscal Year				
Year 1 to Year 2 Status	2007/08	2008/09	2009/10	2010/11	2011/12
Retained between year 1 and year 2	85.50%	85.21%	82.91%	84.28%	73.37%
Not Retained	5.81%	5.14%	6.22%	6.24%	16.65%
Started with advanced standing	8.68%	9.66%	10.87%	9.48%	9.99%

Table 16: Retention (proportions) in Faculty of Engineering. Source: IAP Count Date database, application cube, extracted on June 12, 2013

Software Engineering – unique student counts

	First Registration Fiscal Year				
Year 1 to Year 2 Status	2007/08	2008/09	2009/10	2010/11	2011/12
Retained between year 1 and year 2	108	114	110	121	108
Not Retained	2	3	3	8	14
Started with advanced standing	0	0	0	2	0
Total	110	117	113	131	122

Table 17: Retention (unique student counts) in Software Engineering. Source: IAP Count Date database, application cube, extracted on June 12, 2013

Software Engineering – proportions

	First Registration Fiscal Year				
Year 1 to Year 2 Status	2007/08	2008/09	2009/10	2010/11	2011/12
Retained between year 1 and year 2	98.18%	97.44%	97.35%	92.37%	88.52%
Not Retained	1.82%	2.56%	2.65%	6.11%	11.48%
Started with advanced standing	0.00%	0.00%	1.07%	1.53%	0.00%

Table 18: Retention (proportions) in Faculty of Engineering. Source: IAP Count Date database, application cube, extracted on June 12, 2013

Definitions and Notes:

- All data as of count date (November 1, February 1, and June 30) in each fiscal year.
- Students who register for more than 1 term in a fiscal year are counted once.
- Retained: student who progressed to year 2 by the next Fall term.
- Not retained: student who did not progress to year 2 by the next Fall term, or did not register at the institution after year 1.
- Started with advanced standing: began their undergraduate career with some credits transferred, and/or entered the institution at the level higher than 1A.
- Includes: full time undergraduate students who registered to the Faculty of Engineering or Software Engineering at least once in the listed fiscal year.
- Excludes: Graduate students, part-time students.

Retention of student cohorts between year 1 and graduation by department

On average, for the 3 cohorts being reported on whose initial enrollment occurred in the 2004/05, 2005/06 and 2006/07 academic years, 75.4% graduated within six years of initial enrollment. 15.4% left ("withdrew") the university with no degree from any Faculty. The best completion rates overall in the Faculty of Engineering are found in the Architecture program (79.6%), but in the Engineering programs being considered in this review, the best completion rates are by students who enrolled initially in Mechanical Engineering at 78.2%. The weakest rates of graduation are of students who enrolled initially in Electrical and Computer Engineering programs at 69.3%

Cohort Fiscal Year	Completed	In Progress	Not Registered	Withdrew	Cohort Size
2004/05	75.18%	8.93%	1.88%	14.02%	1120
2005/06	74.98%	6.49%	1.99%	16.54%	1155
2006/07	76.19%	6.52%	1.53%	15.77%	1243

Table 19: Student status six years after initial enrollment in all undergraduate programs in Engineering. Source: IAP Count Date database, retention cube v2, extracted on June 10, 2013

Cohort Fiscal Year	Completed	In Progress	Not Registered	Withdrew	Cohort Size
2004/05	71.34%	11.46%	1.27%	15.92%	157

2005/06	81.03%	3.45%	1.72%	13.79%	232
2006/07	78.69%	4.51%	0.82%	15.98%	244

Table 20: Student status six years after initial enrollment in Chemical Engineering. Source: IAP Count Date database, retention cube v2, extracted on June 10, 2013

Cohort Fiscal Year	Completed	In Progress	Not Registered	Withdrew	Cohort Size
2004/05	77.24%	7.59%	2.76%	12.41%	145
2005/06	75.16%	5.88%	3.27%	15.69%	153
2006/07	80.00%	2.78%	0.56%	16.67%	180

Table 21: Student status six years after initial enrollment in Civil Engineering. Source: IAP Count Date database, retention cube v2, extracted on June 10, 2013

Cohort Fiscal Year	Completed	In Progress	Not Registered	Withdrew	Cohort Size
2004/05	67.63%	12.14%	1.73%	18.50%	346
2005/06	70.19%	6.52%	1.86%	21.43%	322
2006/07	70.14%	8.99%	2.61%	18.26%	345

Table 22: Student status six years after initial enrollment in Electrical and Computer Engineering. Source: IAP Count Date database, retention cube v2, extracted on June 10, 2013

Cohort Fiscal Year	Completed	In Progress	Not Registered	Withdrew	Cohort Size
2004/05	81.29%	5.48%	2.26%	10.97%	310
2005/06	77.78%	8.08%	2.02%	12.12%	297
2006/07	75.49%	7.19%	0.98%	16.34%	306

Table 23: Student status six years after initial enrollment in Mechanical Engineering. Source: IAP Count Date database, retention cube v2, extracted on June 10, 2013

Cohort Fiscal Year	Completed	In Progress	Not Registered	Withdrew	Cohort Size
2004/05	80.95%	0.95%	0.00%	18.10%	90
2005/06	75.47%	5.66%	1.89%	16.98%	85
2006/07	77.12%	0.85%	0.85%	21.19%	86

Table 24: Student status six years after initial enrollment in Software Engineering. Source: IAP Count Date database, retention cube v2, extracted on June 10, 2013

Definitions and Notes

- All data as of count date (November 1, February 1, and June 30) in each fiscal year.
- Students who register for more than 1 term in a fiscal year are counted once.

- Withdrew - student did not register again at the undergraduate level in any Faculty.
- In progress – student is still registered at the undergraduate level in any Faculty.
- Not registered – as of selected term, student is not registered, but does register again in the future.
- Completed – student has graduated within six years of initial enrolment.
- Six years defined as 18 calendar terms since start of undergraduate career.
- Includes: full time, degree seeking undergraduate students who first registered to the Faculty of Engineering or Software Engineering at least once in the listed fiscal year.
- Excludes: Graduate students, part-time students.

Student exchanges

Engineering students are actively engaged in international exchanges, as shown in the following data from the 2012 Exchange report.

Year	ST_{in}	ST_{out}	Total
2005	123	96	219
2006	176	85	261
2007	162	58	220
2008	163	65	228
2009	180	74	254
2010	204	89	293
2011	215	92	307
2012	205	91	296
2013	212	132	344
Average 2008-2013	192	86	277

Table 25: Engineering student exchange from 2005-2013. "ST_{in}" are inbound exchange and "St_{out}" are outbound UW students.

Geographically the 2012 distribution of exchange student origins (ST_{IN}) and destinations (ST_{OUT}) is as shown in Table 26 (there were 7 other ST_{in} students for destinations that had no corresponding ST_{out} students)

	ST_{IN} 2012			ST_{OUT} 2012	
Germany	57			Singapore	26

France	52			Germany	9
Switzerland	21			Denmark	8
Sweden	17			England	7
Australia	15			Japan	7
Singapore	10			France	6
China	6			Hong Kong	6
Finland	5			Sweden	6
Denmark	4			Switzerland	6
England	4			Holland	4
Austria	2			Czech Rep	3
Holland	2			Australia	1
India	2			India	1
Chile	1			Italy	1

Table 26: Engineering student exchanges in 2012 according to destination and origin.

Co-operative Education

Co-operative education is one of the defining factors in the success of undergraduate programs in Engineering. All Engineering undergraduate programs are given in the co-operative education mode of study. Engineering students continue to experience high employment rates (Table 27), with high employer and student satisfaction with their work terms.

Co-op Employment, 2012

Discipline	Seeking Employment	Employed	Unemployed	% Employed	% Int'l Work Terms
Architecture	399	385	14	96.5%	29.8%
Chemical	750	707	43	94.3%	4.6%
Civil	670	650	20	97.0%	5.8%
Computer	745	731	14	98.1%	13.0%
Electrical	1034	990	44	95.7%	12.8%
Environmental	287	274	13	95.5%	4.4%
Geological	97	84	13	86.6%	1.2%
Management	306	289	17	94.4%	9.1%
Mechanical	1032	993	39	96.2%	6.6%
Mechatronics	699	685	14	98.0%	13.0%
Nanotechnology	601	584	17	97.2%	23.9%
Software	590	585	5	99.2%	33.8%
Systems Design	476	463	13	97.3%	14.7%
TOTAL	7686	7420	266	96.5%	14.5%

Co-op Employment, 2013

Discipline	Seeking Employment	Employed	Unemployed	% Employed	% Int'l Work Terms
Architecture	404	387	17	95.8%	31.0%
Chemical	800	764	36	95.5%	8.0%
Civil	694	684	10	98.6%	7.3%
Computer	760	752	8	98.9%	13.3%
Electrical	1024	1003	21	97.9%	9.5%
Environmental	289	268	21	92.7%	3.0%
Geological	125	112	13	89.6%	3.6%
Management	315	308	7	97.8%	11.0%
Mechanical	1099	1068	31	97.2%	8.1%
Mechatronics	744	733	11	98.5%	13.0%
Nanotechnology	564	553	11	98.0%	20.8%
Software	602	597	5	99.2%	36.5%
Systems Design	481	478	3	99.4%	13.6%
TOTAL	7901	7707	194	97.5%	14.6%

Table 27: Co-op employment statistics for 2012 and 2013. Source: 2012 data is corrected from Vision 2015; 2013 data from Martha Foulds, Faculty of Engineering.

A full report on co-op programs is available upon request. Excerpts from this report are included below.

- The number of co-op students scheduled out each term is growing with Spring term showing the largest growth of students scheduled out. Most programs are showing either increasing or steady numbers, with the exception of Computer Engineering which has a highly variable rate of students scheduled out to work, and is showing an overall decreasing trend.

- Co-op employment rates have remained above 92.5% over the past 7 years, however some programs consistently lag behind the average (Chemical, Electrical, Mechanical, Environmental, Geological).

- In Winter and Spring terms, employment rates are lower as a result of first work term students. First work term students that struggle with employment are encouraged to go to their home country (international students) and incentive funding has been provided by the Dean to increase on campus hiring. Bridging Entrepreneurs to Students (BETS) is another program that has been developed to provide paid opportunities to 20 first work term students in Winter and Spring. Although these programs are very popular, they have not eliminated unpaid on campus jobs. The trend for unpaid jobs is decreasing.

- How and when students find employment also differs from term to term and program to program. In Fall term students are more successful through JobMine and find jobs earlier in the recruiting term. In Spring term, many students find jobs after the start of the work term as this term has the most competition from other co-op programs and regular students seeking summer jobs.

- There is a significant difference between programs of the numbers of jobs posted in a given term. Computer and Software have the highest number of jobs posted every term and Geological and Nanotechnology have the least number of jobs posted per term.

- There is a notable increase in students working in the US, and highly variable rates of students working internationally. The international work term rates are affected by international students that find work at home for their first work term – many of whom would have preferred to work in Canada had they been able to find employment here. The high US numbers are predominantly Software and Computer students going to Silicon Valley, although we are starting to see more diversity with both types of students and US locations.

- The top two industries that Engineering students work in are manufacturing and professional, scientific and technical Services. There is an increasing interest for finance jobs , with 10% of students from Computer, Management, Software and Systems Design having had these jobs over the past 7 years.

Strengths and challenges identified from the accreditation summaries, Vision 2015 and the CEAB report

Strengths

1. Engineering continues to bring into its offerings well-enrolled, innovative programs that attract top students. Mechatronics (start date 2003), Nanotechnology (start date 2005), Management Engineering (start date 2007) and Biomedical Engineering (start date 2014) are the most recent examples. The Faculty regularly reviews and refines its undergraduate curricula for its various programs in order to offer its students the high quality Engineering education they expect from Waterloo.

2. The Engineering undergraduate experience is enhanced by the quality of the professoriate and staff, and enriched by the large number of graduate students in the Faculty that are available to undergraduates as course TAs. The program is also enhanced by strong relationships with industry and a strong emphasis on safety.

3. Engineering continues to meet its undergraduate enrollment targets with very high quality students. Small increases to future enrollment targets to 2017 are consistent with the Faculty's wish to maintain a high-quality program.

4. Engineering undergraduates are well supported by the Engineering Undergraduate Office and a Faculty commitment to ensuring high quality teaching and a modern, high-quality learning environment (support for capstone design projects, upgraded undergraduate labs, computing facilities, learning space, retention initiatives/recovery programs, appointment of an Associate Dean of Engineering for Teaching, etc.). The CEAB Visiting Team noted generally the high level of engagement of faculty with their students, and a generally satisfied and enthusiastic undergraduate body in Engineering.

5. Co-operative education is well integrated into Engineering undergraduate programs at Waterloo and is a strong differentiator from other engineering programs in Ontario and nationally. Co-op employment statistics are strongly positive and speak to the value employers place on Waterloo Engineering students. The CEAB Visiting Team noted broadly the value that co-operative education brings to the program.

6. The curricula of all Engineering programs, with minor exceptions (noted below), meet with the Curriculum Content criteria of the CEAB. All programs received PN ("progress noted") as it relates to the CEAB's graduate attributes[2].

Challenges

1. Females as Engineering faculty and as undergraduate students continue to be underrepresented relative to the gender balance in the Canadian population[3]. However, the participation of females in the Faculty of Engineering both as students and professors at Waterloo is on par or above Ontario and Canadian averages. In fact, Waterloo, being one of the largest engineering schools in Canada, represents 913 women or ~8% to the total women in engineering across of the country.

Part of the imbalance of the participation of women in engineering, stems from the fact that there is a smaller number of young women who are "engineering ready" and have the needed courses to enter an engineering program by the end of high school. For example, only 33% of the engineering ready high school pool in Ontario were young women and would be eligible to apply to an engineering program. To address this imbalance, the Faculty has worked tirelessly over the past decade to support and promote Waterloo Engineering to females as the destination of choice to study, do research and become a professor. The result is that Waterloo has had a remarkable increase in the number of young women entering Engineering programs as showcased by the percentages of women entering 1st year engineering (15% in 2007 vs. 21% in 2013). This is due in large part to the efforts of UW's Women in Engineering committee and their devotion to helping promote a career in

[2] Graduate attributes are the following: (1) a knowledge base for engineering, (2) problem analysis, (3) investigation, (4)design, (5) use of engineering tools, (6) individual and team work, (7) communication skills, (8) professionalism, (9) impact of engineering on society and the environment, (10) ethics and equity, (11), economics and project management, and (12) life-long learning.

[3] Information on gender balance in Engineering is from Prof. Mary Wells, Associate Dean of Outreach in Engineering and Chair of Women in Engineering.

engineering to young women through outreach programs such as GoEngGirl (started in 2005), Badge Day (started in 2010), the CATALYST Women's conference (started in 2011) and Women in Engineering applicant events (started in 2010).

2. The number of professionally-licensed engineers in the Engineering professoriate continues to be an issue as flagged by the recent CEAB accreditation exercise. The Report of the Visiting Team on the Accreditation Visit rated the following programs as "unacceptable" in this regard: Civil, Computer, Electrical, Environmental, Mechanical, Software and Systems Design. The Geological Engineering program was rated as "marginal". There were no issues related to professional licensure in Chemical, Management, Mechatronics and Nanotechnology programs. Further discussion on professional licensure is presented in the following section.

3. After re-allocating curriculum content, the Visit Team report noted that three Engineering programs do not meet the Curriculum Content requirements of the CEAB. Computer Engineering and Management Engineering are both deficient in the number of natural sciences AU[4]. Geological Engineering is deficient in the number of Engineering science and Engineering design AU and received an "unacceptable" rating for the "Significant design experience" criterion. Further discussion on design content is presented in the following section.

4. The CEAB Visit Team did note for a number of program that curricular improvements could be made in program and course content, course sequencing, lecture or lab scheduling and balance of course load over the program.

5. Participation in student international exchanges could be stronger. Only 7% of Engineering undergraduate students participate in an international experience during their programs. However, co-op employment statistics from 2009 to 2012 show a stead increase in the number of international placements, from 10.0% of the total in 2009 to 14.7% in 2012.

[4] The CEAB defines Accreditation Units (AU) "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 of that activity between the student and the faculty members, or designated alternates, responsible for delivering the program". AU are recognized across a series of disciplines: mathematics and natural sciences (min 420 AU), mathematics (min 195 AU), natural sciences (min 195 units), Engineering science and design (min 900 AU), Engineering science (min 225 AU), Engineering design (min 225 AU), complementary studies (min 225 AU). The Engineering program curriculum is also assessed via other Engineering science content, modern Engineering tools and laboratory experience. Three scores are possible or each category: acceptable, marginal, and unacceptable.

Overview of program responses to the "Report of the Visiting Team on the Accreditation Visit"

Each of the concerns raised by the Visit Team were responded to by the Faculty of Engineering in their "Response to the Report of the Visiting Team on the Accreditation Visit to University of Waterloo" document. In some cases, however, the findings of the CEAB Visit Team were challenged, and a program position defended or clarified.

The response document provides details as they relate to each Engineering program where an "unacceptable" or "marginal" rating was received vis a vis the CEAB criteria on Curriculum Content, Faculty and Financial Resources. Changes to be implemented span a wide spectrum and include course revisions and program changes, setting up task forces to examine specific issues, improving communications strategies, appointing specific champions to address certain issues and appointing curriculum advisors for individual programs (where there is more than one program in a department), and issues related to the structure and function of curriculum committees.

Responsibility for overseeing and resourcing changes lies with the Chair of each of the Engineering departments, and where appropriate, their Associate Chairs responsible for undergraduate studies. Resources, where needed, will come from departmental or Faculty budgets. The timing of changes will vary - some will be implemented immediately, others are dependent on the calendar submission schedule, and still others will depend on various issues that affect personnel.

Two prominent issues were the deficiencies in professional registration of instructors in the program (point #2 in previous section) and the teaching of Engineering design (point #3). Increased professional registration is an objective in the Faculty strategic plan, and all new faculty contracts now indicate the necessity for professional registration within five years. One of the responsibilities of the Associate Dean, Co-operative Education and Professional Affairs is to assist with this process in the Faculty.

Regarding Engineering design AUs in courses, it was noted in the program response that this was due to the Visit Team's reallocation without consultation with program leaders and therefore conclusions reached by the Visit Team were questionable. In fact, "all Engineering programs at Waterloo now culminate with a capstone design sequence of at least two courses that provide a significant opportunity for students to conduct an open-ended design" and "Upon graduation, all of our programs provide substantial opportunities for students to acquire design skills within a combination of constrained and open-ended contexts". Lastly, the Faculty feels that "it is inappropriate to expect

that all opportunities for design education be open-ended". The Faculty will pay particular attention in the coming years to focus on design in the context of its students graduate attributes.

Final report and decisions of the Canadian Engineering Accreditation Board

After due consideration of the Engineering response document, a CEAB accreditation meeting took place May 31 to June 1, 2014. Overall, the Engineering undergraduate programs under review for accreditation were positively appraised. The CEAB decision (June 26, 2014) was as follows:

- Accreditation was granted to the following Engineering programs for six years to June 30, 2020 – Chemical, Civil, Environmental, Management, Mechanical, Mechatronics, Nanotechnology, Software and Systems Design.

- The Computer, Electrical and Geological engineering programs were each accredited for three years to June 30, 2017 with a report required by June 30, 2016.

For the programs accredited to 2017, the professional status of the professoriate was identified as a weakness or deficiency, and for the Electrical Engineering and Geological Engineering programs, there were also issues related to curriculum content that required addressing. With the exception of the above issues, all three programs were still generally positively appraised. All of the other Engineering programs either had no issues identified or just a small number of concerns where there was the potential for non-satisfaction in the near future.

Program Action Plans for Engineering Programs in response to the CEAB Accreditation Review

Prepared by:

Wayne Parker
Associate Dean, Cooperative Education and Professional Affairs

With support from:

Department and Electrical and Computer Engineering
Department of Civil and Environmental Engineering

October 2014

Background

The Faculty of Engineering employs an integrated approach for the CEAB accreditation and undergraduate program review processes. The CEAB process is employed as the primary external assessment of the program quality. In the recently completed accreditation cycle, three programs (Electrical, Computer and Geological) received comments that resulted in decisions that will require the submission of reports to the CEAB after 3 years while the remaining 9 programs received the maximum accreditation of 6 years. The following document provides the actions that have been identified by the associated Departments to address the specific concerns of the CEAB.

Computer Engineering

Weakness: Engineering Design taught by faculty licensed to practice engineering in Canada, is marginal. (Criterion 3.5.5)

Response: All new faculty hires in our department are contractually required to become licensed as Professional Engineers, and we therefore expect to have greater numbers of licensed faculty available to teach ED-intensive courses over time. In the meantime, licensed faculty have been reassigned to teach ED-intensive courses, such that we easily meet minimum ED constraints based on the accreditation team's extensive revisions to our AUs.

Electrical Engineering

Weakness 1: The program is marginal in the specific areas of statistics and numerical analysis. (Criterion 3.4.3.1)

Response: We still contend that the accreditation team largely ignored the statistics content in ECE 200A and the extensive numerical methods laboratories that are part of ECE 205/MATH 211, ECE 206/MATH 212, and MATH 215. We however recognize that it was not explicitly stated in the calendar descriptions for these courses, and see this as an opportunity to strengthen both topics in our programs. The laboratory components of ECE 205/MATH 211, ECE 206/MATH 212, and MATH 215 will be separated and become two new courses, ECE 204A Numerical Methods I and ECE 204B Numerical Methods II, to be offered to 2A and 2B students starting in Fall 2015. Furthermore, we currently have a task force looking into our ECE 316 Probability and Random Processes course, with the objective of

revising the course into a new Probability and Statistics Course. We expect departmental approval for the new course in Fall 2014.

Weakness 2: The number of Accreditation Units in Engineering Design delivered by licensed engineers is marginal. (Criterion 3.5.5)

Response: All new faculty hires in our department are contractually required to become licensed as Professional Engineers, and we therefore expect to have greater numbers of licensed faculty available to teach ED-intensive courses over time. In the meantime, licensed faculty have been reassigned to teach ED-intensive courses, such that we easily meet minimum ED constraints based on the accreditation team's extensive revisions to our AUs.

Geological Engineering

1. There is insufficient engineering design content and engineering science. (Criterion 3.4.4)

Program Response:

Reallocation of Academic Units (AUs) by the Visiting Team reduced the total engineering design (ED) and engineering science (ES) content below the minimum required by CEAB.

The Department of Civil and Environmental Engineering and the Geological Engineering Board initiated a complete review and revision of the Geological Engineering (GEOE) curriculum in 2012 (it should be noted that the civil engineering and environmental engineering programs have also been reviewed and revised in parallel). The outcome of this process was an extensive revision of the GEOE curriculum from first year through fourth year. The revised curriculum has been approved by the Geological Engineering Board, Faculty Undergraduate Studies Committee, and Engineering Faculty Council in 2014. Approval by the Senate Undergraduate Council will be requested at the October 2014 meeting.

The curriculum revisions will increase the ES and ED content in the GEOE program. Revisions have focused on the timing of existing course offerings, condensing the current set of courses into a smaller subset, and introducing new courses while removing others. This will introduce more ES+ED into the curriculum for a total of 932 ES+ED AU, which is greater than the CEAB minimum of 900. This analysis accounts for adjustment of the AU content by the Visiting Team for ENVE 100, ENVE 127, GEOE 153, CIVE 381, EARTH 390, and Work Reports 200/300/400.

Responsibility for Action:

Director of Geological Engineering
Dept. Chair and Associate Chair for Undergraduate Studies, CEE Dept.
CEE Curriculum Committee (incl. GEOE)

Resources Required:

Minimal. The curriculum revisions have been completed within the constraint of not adding teaching tasks or other resource requirements.

Timeline:

Pending approval by the Senate Undergraduate Council in October 2014, the new curriculum will be implemented in the 2015/2016 UW Calendar. The first GEOE class with the new curriculum will graduate in 2020.

2. In many cases the significant design experience is a research project. (Criterion 3.4.4.4)

Program Response:

The fourth year design project or capstone project is a two course project (GEOE 400/401) that accounts for a substantial portion of the ED content in the AU analysis of the GEOE curriculum. Starting in the Fall 2013 term, the format of the GEOE 400/401 Capstone Design Project was significantly altered to better meet the CEAB expectations for engineering design. The Program Visitor reviewed samples from a previous format of this course, some of which were research-based and not consistent with the CEAB expectation for design.

Since the Fall 2013 term, the GEOE 400/401 project course has been held in conjunction with the environmental engineering students in ENVE 430/431. This course model is for a group design project, with strong emphasis on innovative development of design alternatives, explicit consideration of constraints including social, economic and environmental impacts, and multi-objective analysis and optimization of alternatives. There were some transition issues for GEOE students and technical (faculty) advisors in shifting to the ENVE 430/431 course model.

Starting in early 2014, a CEE Capstone Design curriculum committee was formed to review the course objectives, design project requirements and course implementation for the civil, environmental and geological programs. A course Terms of Reference was developed to define the course expectations, requirements and delivery. A CEE Capstone Design Coordinator was appointed to oversee the course development and implementation of new initiatives. This will be an ongoing appointment.

The Fall 2014 term represents the second implementation of GEOE 400/401 with ENVE 430/431. The Capstone Design Coordinator is one of the GEOE 400/ENVE 430 instructors for the Fall 2014 term to help ensure the new initiatives and emphasis on design. This includes communication with faculty technical advisors with regards to the project design requirements, and working with the students and technical advisors to develop project concepts with appropriate design emphasis rather than research.

The ongoing efforts to enhance the GEOE capstone design courses (as well as civil and environmental) reflect the importance of these courses to the ED content in the curriculum,

and will prevent a future occurrence of the deficiency noted during the 2013 CEAB visit. Assignment of teaching tasks for the capstone design courses will be done to ensure consistent implementation of the new course model and initiatives for GEOE 400/401.

Responsibility for Action:

Director of Geological Engineering
Dept. Chair and Associate Chair for Undergraduate Studies, CEE Dept.
CEE Capstone Design Coordinator

Resources Required:

Minimal. The capstone design course curriculum revisions to date have been completed within the constraint of not adding teaching tasks or other resource requirements.

Timeline:

The revised course curriculum for GEOE 400/401 has been implemented for F14/W15 in parallel with the ENVE 430/431 course. These changes will affect GEOE graduates starting with the 2015 graduating class.

3. *There is insufficient engineering science and engineering design taught by faculty licensed to practice engineering in Canada. (Criterion 3.5.5)*

Program Response:

The Department of Earth and Environmental Sciences as well as the Department of Civil and Environmental Engineering have agreed to the following timeline to ensure all unlicensed (non PEng) faculty teaching ES and ED in core courses and technical electives within the GEOE Program will comply with the following schedule:

1. All unlicensed faculty will apply for their PEng license by August 31, 2014. Those with undergraduate degrees in engineering (BASc or equivalent) will apply for a full license. Those with an undergraduate degree in science (BSc or equivalent) will apply for a limited license.
2. All unlicensed faculty must pass the professional practice exam before April 30, 2015.

Following the GEOE curriculum revision, the minimum path AU count for ES+ED as taught by licensed PEng has been increased to comfortably exceed the minimum required by CEAB. The assignment of teaching tasks will be continuously reviewed to ensure that licensed engineers are teaching key courses with ES and ED content in the curriculum.

Responsibility for Action:

Dean of Science, Chair of Earth Sciences
Dean of Engineering, Chair CEE Dept.

Resources Required:

The Faculty of Engineering will continue to reimburse faculty for expense incurred during the process of obtaining professional engineering licensure (application fees, exam fees, etc.)

Timeline:

All unlicensed faculty will apply for their PEng license by August 31, 2014.
All unlicensed faculty must pass the professional practice exam before April 30, 2015.

Concern:

4. *The quality of the education experience may be adversely affected by the morale of the students. (Criterion 3.5.1.1)*

Program Response:

The Program Visitor noted three key morale-related issues based on interviews with GEOE students:

1. Identity – As a small program, the students stressed that they did not feel like they were part of the program until 3rd year.
2. Communication – Students feel that are not a priority in either CEE or the EES departments. Because of this, they feel that there isn't a clear line of communication for things like scheduling conflicts for lectures and lab times
3. Capstone Design – Students expressed strong dissatisfaction with a perceived lack of suitable design projects in the recently established group-based design course, which combines GEOE and ENVE students.

The Director of the GEOE program and the CEE Dept. have implemented a number of initiatives to addresses the morale issues raised by the students.

Identity

The director of the GEOE program will establish a "town hall" meeting at the beginning of each term so that all GEOE students on campus can attend. This will allow all GEOE students to interact with their fellow GEOE colleagues across all years, establish a GEOE community, and provide the opportunity for mentoring to grow organically.

During F13 and S14, the Director of GEOE held "town hall" meetings with all of the GEOE students on campus. It was very evident at these meeting that 1A and 1B students entirely defer to the advice that upper-year students provide on how to make decisions to manage their time and resources in order to succeed in the program. In previous years, the 4th year GEOE students had their own space, which was provided by CEE. It is imperative that EES and CEE allocate resources to enable all GEOE students to co-exist in the same space. Given that this pool of students is about 120, it would be analogous in size to the CIVE study area provided by CEE. Various room options are being considered at this time.

Communication

The implementation of regular "town hall" meetings will improve communications between the GEOE cohorts and the Director. In addition, all GEOE student cohorts (starting in 1A) will be assigned a class professor who will be responsible to follow each cohort through their undergraduate career. The class professor will serve as the first-point of communication for program and related issues. They will meet bi-weekly (6 times/term) with each cohort during the scheduled class-professor time slot. The GEOE director will be responsible to communicate with each class professor and convey concerns that cannot be rectified to the Associate Chairs for Undergraduate Studies or the Department Chairs (Civil and Environmental Engineering and Earth and Environmental Sciences).

Starting immediately, faculty members from CEE and EES will be assigned as class professors for all GEOE classes.
Dr. Dipanjan Basu has been assigned the position of Associate Director of the GEOE Program effective May 2014.

Capstone Design
As described in the response to Item 2. under "Deficiencies," the capstone design course model for the GEOE program has been revised considerably. The course requirements and expectations have been more clearly defined, and are being communicated to the students and faculty technical advisors by the Capstone Design Coordinator and course instructor. The W14 course instructor met with the 3B students in advance of their 4A term to ensure that this cohort of students (who entered the GEOE Capstone Design Project course in the F14 term) had a clear indication of the course expectations, and where to seek appropriate guidance to help them develop a suitable design project.

Responsibility for Action:
Director of Geological Engineering
Chair, Earth Sciences
Chair, CEE

Resources Required:
Minimal. The implementation of town hall meetings and Class Professors does not add teaching tasks or other resource requirements.
There is a commitment to assign all GEOE students with an appropriate study space; however, at this time various room options are being considered.

Timeline:
The town hall meetings and Class Professors have already been implemented. Ongoing actions will be implemented on a term-by-term basis by the Director of GEOE.