Final Assessment Report and Implementation Plan

Department of Chemical Engineering

Undergraduate Programs

Faculty of Engineering

September 2024

Cyclical Program Review for
Department of Chemical Engineering
Faculty of Engineering

Final Assessment Report and Implementation Plan

Programs Reviewed

Engineering Technology Diploma (Chemical Engineering)
Bachelor of Engineering (Chemical Engineering)
Bachelor of Engineering (Chemical Engineering) – Co-operative Education/Internship option

Review Team

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Background

In accordance with the Lakehead University Institutional Quality Assurance Process (IQAP), a Final Assessment Report has been prepared to provide a synthesis of the external evaluation and internal response and assessments of the undergraduate programs offered by the Department of Chemical Engineering in the Faculty of Engineering. This report identifies the significant strengths of the programs, the opportunities for program improvement and enhancement, and sets out and prioritizes the recommendations that have been selected for implementation.

The report includes an Implementation Plan that identifies:

- the group or individual responsible for providing resources needed to address recommendations from the external reviewers or action items identified by the university;
- who will be responsible for acting on those recommendations; and
- specific timelines for acting on and monitoring the implementation of those recommendations.

Review Summary

The Department of Chemical Engineering, a unit in the Faculty of Engineering, submitted a Self-Study in September 2017. Volume I presented the program descriptions and outcomes, an analytical assessment of the program, and program information along with institutional information and statistical data. Volume II provided course syllabi. Volume III provided the CVs for core faculty contributing to the delivery of the program.

The Review Team for this cyclical program review included one external reviewer and one internal reviewer selected by the Senate Academic Quality Assurance Sub-Committee (SAC-QA) from a set of proposed reviewers. The reviewers examined materials and completed a two-day site visit on October 22-24, 2017. The site visit included meetings with the Provost and Vice-President (Academic), Deputy Provost, Dean of Engineering, the Chair of the Department, full-time, tenure-track faculty members, the technical staff, a group of undergraduate students, the Associate Vice-President, Research & Graduate Studies, the University Librarian and Liaison Librarian, and a group of alumni and community partners. The Review Team observed and/or toured laboratory facilities on the Thunder Bay campus, the Chancellor Paterson Library including the Teaching Commons and Northern Studies Research Centre (fifth floor).

In their report (December 2017), the Review Team provided feedback that describes how the programs delivered by the Department of Chemical Engineering meet the Quality Assurance Framework evaluation criteria and align with the University mission, strategic plan and academic plan. The Review Team notes that the programs are of

high quality and offer students a regionally connected and learner-centred experience supported by the creative and scholarly contributions of the full-time faculty members and technologists.

At the undergraduate level, students must meet the standard University admission policies which are appropriate for the Program Learning Outcomes. Curriculum structure and delivery, and teaching and assessment methods are appropriate, are aligned with comparable programs across Canada at the undergraduate level, reflect the current state of the discipline, and are effective in preparing graduates to meet defined program outcomes and the University's Undergraduate Degree Level Expectations.

Strengths Summarized

The reviewers described the following key strengths:

1. The faculty members are caring and committed to the program and students spoke positively about that.
2. The faculty members have excellent records of research funding and publications. There are two Canada Research Chairs in the faculty and the other faculty members are highly productive.
3. As one of the smaller departments in the Faculty, the faculty-to-student ratio is good.
4. The program includes a large design project covering all aspects of chemical engineering and involving most of the faculty members in Year 4.
5. Many upper year courses have a laboratory component.
6. The laboratory facilities are managed and maintained well.
7. The laboratory technologist provides a wealth of knowledge and experience to the teaching process in the labs.

Opportunities for Improvement

The Review Team identified several opportunities for improvement as part of their summary. Opportunities, unlike Recommendations, are not commented on as part of the FAR.

The reviewers suggest:

1. Review curriculum and course scheduling and to improve the overall program structure and facilitate graduation by both Direct and Transfer students.
2. Consider opportunities to provide course coverage to ensure that faculty can be released to perform administrative duties and research (including sabbaticals).
3. Co-operative education could be reevaluated. We got two opposite messages from students and the Chair

Recommendations

As per the IQAP, responses from the Department (in italics) and Dean of the Faculty of Engineering to each of the Review Team Recommendations are included below.

RECOMMENDATION 1: To better understand the progress towards learning objectives, it would be helpful to track retention and graduation data for both Direct Entry and College transfer students separately.

Department Response: *Retention and graduation data for both Direct Entry and College transfer students for the past 10 years is already tracked separately. The data for Direct Entry students are provided in pages 47 and 48 of the Institutional Quality Assurance Process - 2017 Data Pack. The data for College transfer students are provided in pages 2 and 3 of the Supplement to IQAP 2017 Data Pack – Retention and Graduate Rate for Post-Diploma Chemical Engineering Students. Please note that these data refer to retention and graduation in the chemical engineering program.*

The data pack also contains data for retention and graduation data that include students who first registered in Chemical Engineering but then transferred to other Lakehead programs. These are provided on pages 49 and 50 of the Institutional Quality Assurance Process - 2017 Data Pack and pages 4 and 5 of the Supplement to IQAP 2017 Data Pack – Retention and Graduate Rate for Post-Diploma Chemical Engineering Students.

Engineering Decanal Response: *I concur with the Department responses.*

RECOMMENDATION 2: Review the curriculum and sequencing of classes in years 3 and 4 and identify opportunities to improve the order of classes and any potential to reduce student course load in those years.

Department Response: *The reviewers explain that this recommendation was made as a result of students raising concerns about the heavy course load and sequencing of classes. They noted that this issue is especially germane to college transfer-students (Reviewers' report, page 8).*

The students interviewed by the reviewers were mostly Year 4 students who had not experienced changes made to the curriculum in 2017-18 because the changes applied to new students joining Year 1 and Year 3 (our two entry points in the program). These changes have been made to reduce the overall number of courses and to better even out the course load among year levels.

The following courses were removed:

- *Engineering 1633 - Introduction to Engineering Drawing and CAD. This course is seldom required in other undergraduate Chemical Engineering programs in Canada. Since it is not required in most colleges either, it was very often a makeup course for college transfer students, which contributed to lengthening their stay at Lakehead beyond 2 years.*

- *Chemistry 2231 - Organic Chemistry II. A second organic chemistry course is unusual in other undergraduate Chemical Engineering programs in Canada. This course was very often a makeup course for college transfer students. This change also decreased the course load in the winter term of Year 2, which was very high.*
- *Engineering 3453 - Heat Transfer Design. Heat transfer is introduced in Engineering 1554 (Unit Operations I), which is all about heat transfer fundamentals as well as design of heat exchangers and evaporators. Heat transfer is further developed in Engineering 2555 (Unit Operations Laboratory) and in Engineering 4432 (Chemical Plant Design). Hence, Engineering 3453 was mostly redundant in the program.*
- *Mathematics 4030 – Probability and Statistics. The topics covered in Mathematics 4030 were already covered in sufficient depth in Math 2070 (Applied Analysis II). Therefore, Mathematics 4030 was mostly redundant in the program.*

A new lab course was added:

- *Engineering 4231 (Reactor Engineering and Process Control Laboratory). This new course includes and adds to labs previously done in Engineering 4150 (Chemical Reactor Design) and Engineering 2434 (Engineering Measurements and Instrumentation). The labs have been replaced by tutorials in Engineering 4150 and 2434 to provide more opportunities to students for practicing problem solving.*

The distributions of instructional time (sum of lecture, lab, and tutorial times) over the four years of the program before and after the curriculum and scheduling changes implemented since 2017-2018 are compared in Figure 1. (Please note that the vertical axis starts at 200 hours). The effects of these changes are summarized below:

- *The total number of instructional hours (Years 1 to 4) has decreased by 5.3% from 2478 to 2346.*
- *The number of instructional hours in Years 3 and 4 has decreased by 4.0% from 1212 to 1164.*
- *The instructional hours are more evenly distributed during most of the program, i.e., between the winter of the first year (1W) and the winter of the third year (3W). Each term during that period contains approximately 315 instructional hours.*
- *The number of instructional hours are significantly reduced during the fall of the first year (thus providing an adaptation period to students transitioning from high school) and during the fourth year (thus allowing Year 4 students devote more time to the capstone design project).*

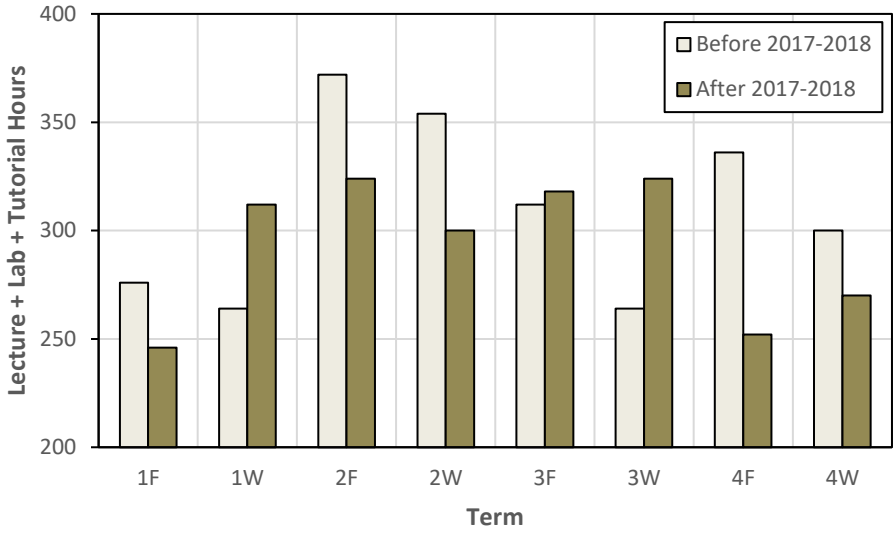

Figure 1: Distribution of instructional time during the 4 years (8 terms) of the program

Plan & Action: Continue implementing the curriculum and scheduling changes described above. In 2018-2019, these changes will apply to nearly all students since the current Year 1 and 3 students will progress to Year 2 and 4. The changes will not apply to the small number of students who joined Year 1 or Year 3 before fall 2017.

Engineering Decanal Response: *The Department seems to have this recommendation well under control by implementing changes made to the curriculum in 2017-18. In addition, academic pathways have been developed and implemented in 2018-19 that enable further sequencing of classes in all programs across the campus and particularly post-diploma engineering programs. The pathways seem to be working and alleviated many of the frustrations the college transfer-students experienced in the past.*

RECOMMENDATION 3: Examine the feasibility of delivering more courses in the spring/summer semesters, including the possibility of online courses in certain topics.

Department Response: *Until now, the number of faculty members in the department (7 in total including two Canada Research Chairs with reduced course load) has severely limited the feasibility of delivering courses in the spring/summer terms. Non-engineering courses taken by our students (e.g., math, computer science, complementary studies) are regularly offered during the spring/summer terms. Fortunately, the department was recently allowed to advertise a new 3-year limited term appointment (LTA). The new faculty member is expected to start in August 2018 and will teach 6 courses per year. This will facilitate teaching more courses in the spring/summer terms.*

Online courses are currently restricted to complementary studies and computer science courses given during the spring and summer terms. There are no plans to teach engineering courses online.

Plan & Action: Advertise the new LTA and hire a suitable candidate to start teaching courses in fall 2018. Examine the feasibility of teaching engineering elective courses or core engineering courses (e.g., those having a high failure rate) during the spring/summer to help students progress faster through the program.

Engineering Decanal Response: *The 3-year LTA was started in in August 2018 and ever since has been offering 6 courses per year. This has facilitated teaching more elective/graduate courses throughout the year. Increasingly more complementary studies elective courses have been delivered online in spring/summer session. In the past two years, each Engineering Department has been offering at least two graduate level courses as well as undergraduate courses with high demands during spring/summer. The Department has received approval for a tenure track position that will be co-appointed as Research Chair in BRI. This candidate will have the capacity to teach 1 FCE for the Department in an academic year. If this additional faculty member is added to the current faculty complement, the Department will be able to deliver more courses thought the year, including the spring/summer semesters. Qualified Ph.D. candidates have been employed to teach courses throughout the year in accordance to CEAB's accreditation requirements.*

RECOMMENDATION 4: Examine opportunities to cover teaching requirements to accommodate teaching releases and sabbaticals without reducing the quality or quantity of courses offered. As part of the human resources planning process, consider if there are opportunities for PhD students to teach some courses in accordance to CEAB's accreditation requirements.

Department Response: *The department will request sessional instructors and/or additional LTAs to accommodate teaching releases and sabbaticals. In the past, some courses that did not include design academic units have been taught by postdoctoral fellows. The creation of a new Ph.D. in Chemical Engineering (currently being considered) is expected to increase the number of Ph.D. students with background in chemical engineering. Hence, there may be more opportunities for Ph.D. students to teach some courses in the future.*

Plan & Action: Request sessional instructors and/or additional LTAs to accommodate teaching releases and sabbaticals. Plan the creation of a Ph.D. program in Chemical Engineering.

Engineering Decanal Response: *This issue has been addressed in the previous Decanal response.*

RECOMMENDATION 5: Consider opportunities to expand the laboratory spaces and resources available to the Chemical Engineering department.

Department Response: *Two faculty members (Drs. Fatehi and Liao) will move some of their research equipment and graduate students to the new Centre for Advanced Studies in Engineering and Sciences (CASES) in 2018. This will liberate undergraduate laboratory space that is currently shared with graduate students, specifically in Room CB 1024.*

Plan & Action: Use the liberated space in CB 1024 to provide space for additional undergraduate experimental setups, e.g. in Engineering 4231 (Reactor Engineering and Process Control Laboratory).

Engineering Decanal Response: *The Department's proposed action plan has been completed. The Department's research capacity/space has been significantly increased with the addition of CASES in 2018. The Department currently has some of the most state-of-the-art research laboratories in the region.*

RECOMMENDATION 6: Assess barriers to participation and provide greater opportunities for students to participate in the co-operative education program.

Department Response: *Participation in co-operative education is limited by two factors: 1) the requirement for students to maintain a 70% cumulative average and 2) the availability of suitable positions.*

The department is open to the idea of decreasing the required cumulative average to 65 or 60%. However, this change would have to also be approved and implemented by other engineering departments to maintain consistency among programs.

The Lakehead University's Co-operative Education program, which is run through the Lakehead Student Success Centre, maintains a website listing available coop positions. Each position is evaluated for suitability and approved by the departmental coop coordinator (i.e., the department Chair in Chemical Engineering). Unfortunately, there are fewer positions open to chemical engineering students than students interested in coop. To a large extent, this is due to the limited number of industries that employ chemical engineers in Thunder Bay and Northwestern Ontario. Students often rely on other internet search tools as well as their personal networks to identify available coop positions throughout Canada.

Plan & Action: Continue discussing with the Dean of Engineering and other departments the possibility of decreasing the cumulative average requirement for participation in co-operative education.

Engineering Decanal Response: *All Lakehead Engineering programs with co-op option have a minimum grade point average 70% requirement, which seems to be no more limiting than those co-op requirements in many other engineering programs*

across Canada. The Faculty has always promoted cooperative education and experiential learning and continues to do so in the future. Although one can argue the effect of limited co-op positions in Thunder Bay on student participation in the co-op program, this relationship is not evidenced by data. The low participation in our co-op programs could also be related to the unique structure of our engineering programs where the technology (experiential learning) is an integral part of our BEng programs. College transfer students also bring a rich set of hands-on experiences to our classrooms that may be significantly different than those of students in other universities. Nevertheless, I will work with the Department and Lakehead Student Success Centre – Co-operative Education on a plan for engaging more students into the co-op program.

Clarifications

The unit identified that no clarifications were necessary, based on the Review Team report.

Implementation Plan

Recommendation Priority 1
Tracking retention and graduation data separately for Direct Entry and College transfer students.
(In reference to Recommendation 1)
Actions for Implementation:

- Continue tracking retention and graduation data separately for Direct Entry and College transfer students.
- Ensure that updated data is consistently included in future Institutional Quality Assurance Process (IQAP) Data Packs.
- **Role/Person Responsible for Implementation:**
  Department Chair, Faculty of Engineering administration, and Institutional Research Office

Timeline:
Ongoing, with updates provided in the next IQAP reporting cycle.

Recommendation Priority 2
Reviewing curriculum and sequencing of classes in years 3 and 4 to improve the order of classes and reduce course load.
(In reference to Recommendation 2)
Actions for Implementation:

- Continue implementing the curriculum and scheduling changes initiated in 2017-18.
- Monitor the impact of changes on student experience and adjust if necessary.
- Collect student feedback on course load distribution and sequencing.
- Provide ongoing assessment of the effectiveness of changes made.
- Revise course descriptions to minimize overlap between courses, ensuring students understand course content in advance.
- Replace certain courses with new ones taught by chemical engineering faculty members to better align with program requirements.

Role/Person Responsible for Implementation:
Department Chair, Undergraduate Curriculum Committee
Timeline:
Ongoing, with periodic assessment every two years.

Recommendation Priority 3
Expanding course offerings in spring/summer semesters and assessing the feasibility of online courses.
(In reference to Recommendation 3)

Actions for Implementation:

- Integrate additional elective and high-demand courses into the spring/summer terms.
- Assess faculty capacity for additional course delivery in these terms.
- Evaluate the feasibility of offering select engineering courses online.

Role/Person Responsible for Implementation:
Department Chair, Chemical Engineering Faculty members
Timeline:
Ongoing; initial feasibility review by the end of the next academic year.

Recommendation Priority 4
Ensuring adequate teaching coverage during faculty sabbaticals and leaves.
(In reference to Recommendation 4)
Actions for Implementation:

- A new faculty member with a teaching stream is hired, which helps to cover courses during the sabbatical of faculty members.
- Assess opportunities for PhD students to teach courses within CEAB accreditation requirements.
- Develop a contingency plan to manage faculty teaching loads during sabbaticals.

Role/Person Responsible for Implementation:
Department Chair, Dean of Engineering
Timeline:
Ongoing, with annual assessment.

Recommendation Priority 5
Expanding laboratory spaces and resources.
(In reference to Recommendation 5)
Actions for Implementation:

- Utilize liberated space in CB 1024 for additional undergraduate laboratory setups.
- Assess equipment needs for undergraduate experiments and secure funding where necessary.
- Ensure efficient allocation of new research space within CASES to optimize undergraduate and graduate lab use.
- A graduate research space was repurposed for undergraduate laboratory use, and no research activities are conducted in the undergraduate lab spaces.

Role/Person Responsible for Implementation:
Department Chair, Chemical Engineering Faculty Members, Laboratory Coordinator

Timeline:
Completed; ongoing assessment of space utilization.

Recommendation Priority 6
Enhancing student participation in the co-operative education program.
(In reference to Recommendation 6)
Actions for Implementation:

- Continue discussions with the Dean of Engineering and other departments on adjusting GPA requirements.
- Collaborate with the Lakehead Student Success Centre to increase the availability of co-op placements.
- Develop a targeted strategy to engage more students in the co-op program.
- The Dean of the Faculty of Engineering appointed a new Co-op Coordinator to enhance student support and facilitate co-op placement assistance.

Role/Person Responsible for Implementation:
Department Chair, Co-op Coordinator, Dean of Engineering
Timeline:
Ongoing, with review and recommendations presented annually.