

ACADEMIC COUNCIL REPORT

ACTION REQUESTED:

Recommendation	☐
Decision	☐
Discussion/Direction	☐
Information	☒

DATE: 26 April 2022

FROM: CIQE

SUBJECT: Program Review UNIVERSITY NETWORK OF EXCELLENCE IN
NUCLEAR ENGINEERING (UNENE)

In accordance with Articles 10 and 11 of the Ontario Tech University Institutional Quality Assurance Process (IQAP) Cyclical Program Review (CPR) Procedures, the appropriate standing committee of Academic Council (USC or GSC) is normally responsible for examining the outcomes of the review and approving the Final Assessment Report (FAR), Action Plan, and 18-Month Follow-up Report. These reports are then presented to Academic Council for information and subsequently posted to the Ontario Tech corporate website.

The MEng in Nuclear Engineering presented in the attached is unique, in that it is a multi-university program administered by UNENE. As such, the CPR process is also unique. As outlined in the letter from Dr. Nikola Popov below, McMaster University lead the CPR process with participation from all associated universities. The process was designed to meet the IQAP requirements of all institutions and the results are being presented to each for information.

SUPPORTING REFERENCE MATERIALS:

- Letter to Universities Regarding Collaborative Cyclical Program Review
- External Reviewers' Report
- Action Plan
- Action Plan Progress Report



UNENE University Network of Excellence in Nuclear Engineering

Dr. Nikola Popov, Program Director
c/o Engineering Physics, JHE-A315

McMaster University
1280 Main Street West
Hamilton, ON L8S 4L7

Office: 905-525-9140 ext. 20168
Mobile: 416-566-8233
Email: npopov@mcmaster.ca
Email: nik.popov@rogers.com

Date: 11 June 2020

To:

Dr. Langis Roy
Langis.roy@ontariotechu.ca
Ontario Tech University
School of Graduate and Postgraduate
Studies (SGPS),
Office of Graduate Studies,
Campus Corners, Suite 1400
2000 Simcoe Street North,
Oshawa, Ontario, L1G 0C5

Dr. Siva Sivotththaman
sivotththaman@uwaterloo.ca
University of Waterloo,
Associate Dean, Graduate Studies,
200 University Avenue West,
Waterloo, Ontario, N2L 3G1

Dr. Brian Surgenor
brian.surgenor@queensu.ca
Interim Vice-Dean (Graduate Studies &
Recruitment), Faculty of Engineering
and Applied Science
Queen's University,
99 University Avenue,
Kingston, Ontario, K7L 3N6

Dr. Kamran Siddiqui
ksiddiqui@uwo.ca
Western University,
Associate Dean, Graduate and
Postdoctoral Studies, in Engineering,
1151 Richmond Street,
London, Ontario, N6A 3K7

Objective: **Participation in UNENE Program Review**

Dear Sir,

I am writing to you regarding the M.Eng. in Nuclear Engineering administered by UNENE (University Network of Excellence in Nuclear Engineering). The UNENE M.Eng. is a co-operative multi-university program. Each of your Universities (plus McMaster University) admits students to the UNENE M.Eng., gives one or more courses, recognizes the courses given by the other UNENE Universities, and grants the M.Eng. degree to students who have enrolled with you and have completed the M.Eng. requirements.

You may also know that McMaster enrolls the majority of the UNENE students and delivers the largest number of UNENE courses.

UNENE received its initial approval from the Ontario Council on Graduate Studies (OCGS) in December 2004. It is due for its program review, which will be done under the Quality Assurance



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Framework established by the Quality Council. McMaster has a procedure based on this framework and will review the UNENE M.Eng. accordingly.

The UNENE Graduate Program is subject to a 7-year cycle of program reviews. The last program review was conducted in 2013. As agreed by the five participating universities at that time, McMaster University led the program review, and with your participation, successfully completed it. I propose that the program review this year be conducted using the same process as in 2013.

Since there are five Universities which can grant the UNENE M.Eng., it would again be appropriate to have one review in which all five participate, instead of five separate reviews. I would again like to request your agreement to a joint review. I further propose that the review be led by McMaster, as it was last time, as it holds a major part of the program.

The participation of your universities in this review must be sufficient to:

- Provide evidence to the Quality Council that all degree-granting Universities in UNENE have been actively a part of the review
- Satisfy any of your own requirements.

I therefore propose the following:

- I will draft the UNENE Program Review Plan (Guide) (which is the basis for the Program Review) and send it to you for information.
- I will compile a list of potential External Reviewers (with input from your UNENE representatives) and send it to you. UNENE can only recommend reviewers – McMaster will decide and will communicate with the External Reviewers.
- UNENE and McMaster staff will arrange a Workshop with UNENE instructors as a supplement to the Program Review Guide. All University instructors for UNENE courses will be invited to participate. Part of this Workshop will be devoted to a review of the Learning Outcomes and evaluating how UNENE performs with respect to them, as well as a review of the lessons learned, feedback received so far, and identifying opportunities for improvement in future.
- You or your designate will be invited to attend the two-day External Review session at McMaster and interact as required with the External Reviewers. The format will depend on the COVID-19 situation at the time.
- We will have a close-out meeting (probably by telecon) to assess the reviewer comments and decide on any significant actions.

The Program Review consists of two phases. In the first phase, known as the Self-Study phase, UNENE will collect documents and information on the UNENE program covering the past 7 years, perform a study and assessment of this information, and prepare a Self-Study report by the end of January 2021. In the second phase, the Self-Study report will be reviewed by McMaster and each of your universities, and will then be submitted to the External Review team. By end of March 2021 the review team will meet with the UNENE management and the representatives from McMaster and the participating universities and will discuss their comments.



Participation in UNENE Program Review

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McMaster University was consulted during the preparation of this year's program review, and agreed to lead the UNENE program review this year.

Please let me know if this approach is acceptable and let me know any comments. If you have questions or need to discuss any aspects of this Self-Study, I can arrange a telecon separately with each core university.

Thank you in advance for your cooperation,

Yours sincerely,

Dr. Nikola Popov
UNENE Program Director, and
Industry Professor at McMaster University

c: Dr. Michael Thompson
Associate Dean for Graduate Studies
Faculty of Engineering
McMaster University

Mrs. Christina Bryce
Assistant Graduate Secretary
Faculty of Engineering
McMaster University

Dr. Ray LaPierre
Chair, Engineering Physics
McMaster University

External review (Spring 2021) of the University Network on Excellence in Nuclear Engineering Masters of Engineering graduate program.

Respectively submitted on, June 2, 2021 by:

J. M. K. C. Donev – University of Calgary,

K. Ivanov – NC State University

R. Selvaganapathy – McMaster University

Preamble

Overall, the University Network on Excellence in Nuclear Engineering Master of Engineering (UNENE) graduate program is successfully delivering a quality education experience. Many of the people interviewed believe that the program needs to grow in order to ensure its survival. This report will look at possible ways that the program could seek to increase enrolment. The report will also outline a number of areas to strengthen the program that were brought forward by various parties or were observed by the review team.

To open with, we believe that the M. Eng program offered by the University Network on Excellence in Nuclear Engineering (UNENE) is largely accomplishing what it sets out to do. The students who completed the program seem satisfied and pleased with the content and delivery of the program. Certain opportunities arise from this being a niche program. People working at nuclear power plants have an excellent opportunity to pursue a deeper knowledge related to most aspects of the engineering related to the current CANDU fleet. The instructional team have deep knowledge of the content, and the content is focused and relevant. This program is *sui generis* within Canada; the collaboration among five major universities to offer a graduate program (and further universities for research purposes) is unique as far as we were able to determine in the country.

The program has low enrolment; small enough that normal fluctuations of enrolment numbers may cause problems in trying to sustain the program. With 70,000 people in the Canadian nuclear industry, the size of this program is surprisingly small. While the students who enter and succeed in this program are happy with the program, the small number of people who enter this program may speak to a certain selection bias in that assessment that should be investigated.

There are specific concerns about how the courses are delivered and about representation. While it is quite impressive that UNENE manages to collaborate among five principal universities (with other universities involved on the research side, but not in delivering the graduate program, which is the focus of this report), balancing the collaboration of five universities seems to have led away from some of the

resources that individual universities can contribute to the success of this program like the marketing team, the teaching resource centres, and the office of Diversity and Inclusion.¹

The program does not seem to be doing enough to meet its program goal of teaching effective communication skills. This could be addressed within the context of improved pedagogical approaches, or a dedicated course.

While the program is already successful in meeting many of its goals, reflecting on the suggestions in this report should lead to incremental improvement in the size and quality of the program. The biggest suggestions are making sure to survey the program from the standpoint of Equity, Diversity, and Inclusion and to review the pedagogical methods used for the course delivery, especially to expand the availability of the courses. These explorations will lead to greater interest in the program from potential students and a more robust program.

Areas of strength and success

The students and faculty were clear that there were several aspects of the program that they wanted to keep exactly as it is right now. These included:

Practical Content

The program content focuses on practical, industry-related skills. Information in the courses come from industry experts and is presented with an emphasis on what the student professional needs to know. This focused content was clearly a well-thought-out goal, which the program hits very well. There is little question in the minds of the student as to why they are studying any particular subject. Work is directed and purposeful. The “student survey” approach to determining which courses will be offered is both innovative and well-appreciated by the students that we spoke with, and further surveying would almost certainly lead to similar results.

The program could do more to address proposed nuclear reactor technology, and is already taking strides to include Small Modular Reactors (SMRs) in their courses and will be launching a new course on SMRs soon. This response to the student needs is an additional strength of the program, but this will hopefully remain an area of focus in the coming years.

Expert instructors

Instructors have a deep understanding of the parts of the nuclear industry that are taught within the program. Instructors have deep experience and extensive skills. The decades of practical experience that these industry professionals have allows for a dissemination of the practical content in a focused way. The subject matter mastery of the instructors include the ability to provide context for all of the above-mentioned practical content. Compared to other M. Eng. programs in Canada, this focused content is a real strength that the students were clear should be kept.

Review courses

The optional, and free, review courses level the playing field for the heterogeneous backgrounds of the students who take this program. These pre-flight courses mean that any of the enrolled students can

¹ The Office of Diversity and Inclusion is the name at McMaster University. The other universities use slightly different terminology. Each of the five universities have offices that support the universities in addressing these issues and the review team has not spent the time weighing which option would be best to work with.

choose to take any course within the program. This dramatically expands the availability of the presented curriculum to the students enrolled in the program. In the absence of these review courses, many of the students wouldn't have nearly as much choice about which classes they'd be able to participate in.

In addition to the review courses, several of the instructors that we spoke with discussed with us the extra hours that they put in to helping students succeed in their courses if the review courses were insufficient. They also talked about the difficulties that they had prior to instating the review courses. Again, this seems to have been a specific goal that the program was setting out to meet, and has met it.

Availability for professionals

Holding classes on the weekends gears the program for the working professional. All of the courses in the program are compatible with the standard workday, for people working normal business hours. This modality in course delivery makes it possible for the working professionals to enrol and succeed in the program. The universities also were able to provide classroom space for this program relatively easily, as University courses rarely run on weekends. The alternating weekend style, while tiring, gives the students "digestion time" for the content. There are weaknesses on this front that will be addressed below. To be clear, the strength is not that the alternating weekend format is the one that is best suited for this program, but the focus on making sure that the program is available to the intended students: the working professional in the nuclear industry.

The review team agreed with the instructors and students on all these points; these are strengths that should be maintained in any changes that are undertaken. Many people involved with the program expressed a desire for growth. The ideas that we suggest implementing for growth and improvement should be considered with the caveat that the successes of this program should not be weakened. We do believe that a thoughtful approach to what is being done well will allow the incorporation of new ideas that will allow for increased enrolment while maintaining or even improving the strengths of UNENE's delivery.

Areas of concern

Talking with more than a dozen people associated with this program revealed themes that should be looked at closely. These include:

- The program is small enough that there is concern about maintaining the program. A larger average number of enrolled students would make the program more robust. This was the most consistent concern expressed throughout the interviews. The reviewers agree with the people within the program that this is an issue that should be addressed.
- While the weekend course delivery is advantageous for the professionals in this program, there are significant drawbacks. These drawbacks include fatigue for both student and instructors. There is also concern about accessibility of the courses, which influences enrolment.
- Considerations about Equity, Diversity and Inclusion need to be evaluated.
- The pedagogical approaches in this class should be evaluated.
- The small portion of the nuclear industry that this M. Eng. is relevant for.

The first point was the biggest concern, but the remaining points lead to actions that could address the enrolment numbers. The report will postulate ideas to consider for addressing these areas. While the authors of this report have thought as deeply as we can about how to address these issues, we still have limited knowledge of the day-to-day realities of the program. We believe the observations below should be viewed as a perspective on the program and turning the ideas into actions will require the careful thought of people who are more intimately familiar with the operation of the UNENE program.

Equity, diversity, and inclusion

The American Institute of Physics did a report² that demonstrated how investing in inclusion of various forms strengthens and often increases the size of programs. There would be significant benefit to this program by considering how to make the program more accessible to women and visible minorities. The research is clear that addressing those needs in STEM programs improves the attractiveness of the program to all potential students, not just the visible minorities. Almost no mention was made in the documents we received of any attempts to pursue or quantify equity, diversity, or inclusion.

In addition to this form of diversity, there are other forms of diversity that would benefit this program as well. A review of the documents provided to the committee seems to indicate that only one course in the entire program is taught by a woman (UN0603 Project Management for Nuclear Engineers). There was no information provided about the relative enrolment rate of women vs. men, or any visible minorities. The lack of tracking or attention creates concerns that need to be looked at. Several of the administrators we spoke with were shocked at the lack of any attention paid to equity, diversity, or inclusion.

There are additional concerns that coursework that requires years of losing entire weekends would disproportionately disadvantage people with more extensive family obligations. Working with the McMaster office of Diversity and Inclusion (for example, or the same office at other institutions) and consulting with the professional organization Women in Nuclear could dramatically improve the needs of all the students. According to the Team-up study cited above, this care has improved the retention of students in other, similar programs and improve the retention of information that students are trying to learn. Women in Nuclear, as an organization, is also a strong advocate for training and education among their members. Their investment in the UNENE program would have wide-ranging benefits in making the program more visible. Collaborating with them would dramatically increase interest in people enrolling in the UNENE program.

The structure of this program makes the cohort rather insular, which does create a strong cohesion, with many good benefits. There would also be some benefit to having students from other backgrounds mixing in with one course throughout the program. Finding some coursework that the students can participate in outside of the nuclear silo could help the students get a broader exposure while retaining its rigor and focus. A course with a wider, more heterogeneous class list could enrich the educational experience of the students.

²The report would be very worthwhile to read in its entirety and is available here:
<https://www.aip.org/sites/default/files/aipcorp/files/teamup-full-report.pdf>

Curriculum

The curriculum is still very CANDU focused. We were pleased to hear that McMaster has embraced SMRs as an important emerging technology. UNENE is quite involved with SMRs on the research front, but this has not trickled down to the curriculum sufficiently. The one new course on the books that has not been offered yet does not seem to reflect the direction the Canadian nuclear industry is moving, and this shift in focus of the industry is almost certainly reflected in the desires of the students.

Collaboration with other universities who are interested in SMRs could also increase the resilience and attractiveness of this program. For example, NC State offers extensive online coursework at the masters' level. This collaboration could provide some flexibility for the students in the program.

The review courses prepare students for specific courses of the program, which is good. Other graduate programs have an "Introduction to Nuclear Engineering" course which would benefit those students who do not have an undergraduate background in nuclear engineering. Since this course would be of great benefit to some students, but of limited utility for other students, careful thought must be put into how to meet the needs of this heterogeneous student background. Perhaps this course could appear at different points in the student's program. Perhaps the course could be offered asynchronously and self-paced, so there would be no minimum number of students needing to take the course at any given point.

This course will give all of the enrolled students a more even footing on understanding the nuclear engineering that runs power plants. An additional benefit of this course, especially offered asynchronously with a self-paced format, would be its broad applicability. Many vendors and utilities would like their non-nuclear engineers to take a course on the basics of nuclear engineering to broaden the understanding of other types of engineers who work at nuclear facilities (such as civil, electrical, or mechanical engineers).

Pedagogical approach

While this entire report attempts to address the questions: "What makes this degree desirable? What would make this degree more desirable?" This section will look specifically at the teaching methods employed in the UNENE program and how that relates to the desirability of the degree program.

A thorough, collegial review of the pedagogical approaches used in the different classes will lead to both better retention of information and an increasingly attractive program. There is an additional opportunity here, with the instructors of record having course content that will also feel more alive, and responsive to the specific needs of the particular cohort of students. A proper review of the pedagogy will also shed light on where the content may be improved. In short, looking carefully at the teaching means everyone wins.

In talking with the instructors of record for the course, the instructors of record were unfamiliar with best practices in pedagogy. The courses would benefit from improved engagement strategies and training the instructors in enhancing the delivery of their content. These pedagogical changes could improve the experience of the student and the instructor.

Some improvements to the pedagogy can be done relatively easily. Greater transparency in the course expectations by creating specific rubrics that are shared with the students *before* the material is graded will allow students to focus more on the content and less on the performance in the class. Likewise, going over the course syllabuses with a teaching expert could clarify student expectations and improve the deliverables in the course. Some of the courses have already implemented a balanced approach to the assessment. These courses use formative assessment (like homework and peer review of projects) as well as summative assessment (like tests and final presentation of projects). Experience has shown this balanced approach leads to a better student experience, with more retained skills. Currently, several courses place all the emphasis on test performance, which reduces content retention and program retention. Courses with this kind of structure rarely inspire the enthusiasm for the program that will lead to alumni encouraging colleagues to actively seek the opportunity to enrol. Courses with distributed assessment feel “fairer” to students. They also lead to a better relationship across cohorts.³

The MacPherson Institute has been working with engineering at McMaster to improve teaching, but not this program specifically. In addition to proposing that the instructors of record work with the MacPherson Institute, we also propose that they work with instructional stream faculty members at one of the five universities. The MacPherson Institute focuses on strong pedagogy, but having people with some subject matter expertise would strengthen the application of the pedagogical practices to these particular subjects.

In particular, the UNENE program should discuss the “Flipped classroom model” with pedagogical experts (either instructional stream faculty members or McPherson Institute experts). This would make for far more efficient use of time on the weekend sessions. Everyone agreed that the weekend sessions (class all day Saturday and all-day Sunday) were absolutely required because of people’s work schedules, but that it was also cripplingly difficult for the students and instructors alike by Sunday afternoon. A flipped classroom model would energize both the students and instructors.

Implementing a flipped classroom model would provide greater latitude in extending the student body outside of the Greater Toronto Area. Repeatedly people expressed a sincere desire to open enrolment up to people in New Brunswick, or even Bruce County Ontario (where the Bruce power plants are, near Lake Huron). This would not only improve the engagement levels of the students in the program, it would allow for a much wider draw for prospective students who currently feel disinclined to attempt the program.

This flipped classroom could also include some significant opportunities for curricular shifts. For example, case studies and peer driven learning would dramatically increase the intellectual investment of remote students. These case studies would make the curriculum more relevant (and more accessible) to people from other jurisdictions. With Saskatchewan and Alberta signing an MOU with Ontario and

³ One of the reviewers use a case studies teaching model where students teach each other course material. The students enjoy it so much that alumni of the program come back in subsequent years to see what the current students are doing. Additionally, people from the nuclear industry attend and enjoy participating in the audience. This leads to a significant increase in visibility of the program, which could benefit UNENE and the cohort of students.

New Brunswick, this is a superb time to explore any possibility of extending into those provinces.⁴ This shift would also address the need to improve the teaching of communication skills within the program.

Along with this flipped classroom model, moving towards a different model of understanding the material will improve the students' retention. Moving away from the "Sage on the Stage" approach that is currently employed in the UNENE classrooms to a "Guide on the Side" would show dramatic improvements. Knowledge in modern classrooms has shifted from traditional ideas:

"Knowledge does not come packaged in books, or journals, or computer disks (or professors' and students' heads) to be transmitted intact from one to another. Those vessels contain information, not knowledge. Rather knowledge is a state of understanding that can only exist in the mind of the individual knower; as such, knowledge much be constructed or reconstructed"
From Sage on the Stage to Guide on the Side by Prof. A. King.⁵

The program outcomes specify that effective communication skills will be developed by this program. There was little evidence either in the documentation or in the conversations with the instructors of record that this program outcome is sufficiently addressed by the current curriculum. This skill is important enough to be considered a program outcome and the reviewers believe that communication is an important skill and should be taught. Any M.Eng. is expected to be able to communicate ideas effectively, and nuclear engineers are no exception. While one could imagine a course that entirely focuses on these skills (and there is value in that), integrating this program outcome across the entire curriculum would give students a better chance to develop the skills. An iterative approach to communication skills provides a much higher likelihood that the skills will mature and develop over the program. This contrasts with a "one and done" approach which tends to reward those students who have already developed the communication skills and is quite punitive to those who have not.

Looking over the presented packages of course deliverables with their corresponding syllabuses, too many of the courses emphasize test performance over project-based comprehension. Having the students learn specific subject matter and present it to classmates could dramatically improve the learning experience of the students and the teaching experience of the instructors. This would also strengthen the communication skills that are not currently being sufficiently served by this model.

One instructor talked about presentations being done in his class. While the specifics of the project aspect of the course were not discussed because of limitations of time, the synopsis showed that there is much good in this method within the course it is used in. There would be considerable benefit from investigating the possibilities of using this method elsewhere. This could create discipline-specific self-directed study, within a broader subject matter class. We suggest using case studies to keep the subject matter vibrant and current.

The one place that we heard about this project component of the course being done emphasized students finding things *wrong* with their classmates' presentations. When doing these peer-instructional case studies, we suggest a shift of emphasis to having them find things *right* with those presentations.

⁴Full disclosure: one of the authors teaches in Alberta and works closely with universities in Saskatchewan about teaching nuclear power in the Canadian prairies. This recommendation would be of significant benefit to that author.

⁵ Available here: <https://faculty.washington.edu/kate1/ewExternalFiles/SageOnTheStage.pdf> accessed April 28, 2021.

Not only will this improve cohesion of the cohort, but it also will shift the learning. A peer-review process at the formative stage (while people are learning the skills) rather than at the summative stage (while students are demonstrating that they *have* learned the skills and are getting graded for it) will have a dramatic shift in the student enthusiasm, which will have significant impacts on the overall program enrolment.

We propose that UNENE create a specific position created for looking at quality pedagogical practices for this program. This is equivalent to what a traditional department would have to promote teaching excellence within a degree stream. This position could potentially be shared with a home department at one of the five principal universities (for example, Ontario Tech has a program that could have a great deal of confluence of teaching excellence here, likewise the McMaster Engineering Physics program could have such a position). While we understand that this would have significant expense, we believe the long-term financial gains from increased enrolment would easily justify this cost.

Interface of degree with the broader nuclear industry

The people interviewed expressed interest in making the UNENE M. Eng. program more visible within the industry. In addition to being more visible, steps should be taken to make this program more attractive to the prospective students and their management. We believe that a significant area for growth for UNENE would include broadening the definition of what is included when talking about the nuclear industry.

The UNENE M. Eng. program brings in students from a small number of the companies within the Canadian nuclear industry. While the current program meets the needs of the students coming from OPG and the CNSC, there are quite a few other companies that do not send students. The CNSC has a strong history of professional development, which would explain the number of students from their organization, and OPG seems to have a strong hand in what is taught within the UNENE program. That being said, Bruce Power, Kinectrics, Hatch, NWMO, AECOM, Cameco, BWXT, SNC Lavalin, and Canadian Nuclear Laboratories are not sending many, or in some cases any, people to this program. We suggest a discussion with the CNA and OCNI about how a wider net could be cast. The program meets the needs of the students who show up, but with 70,000 people in the Canadian nuclear industry, the dozens of students that UNENE gets seems like an uncomfortably small fraction of their potential market.

Likewise, conversations with professional organizations like North American Young Generation Nuclear and Women in Nuclear could provide useful insights as to how to appeal to a wider range of students. Likewise, conversations with CNA and OCNI could provide useful insights to the needs of the people who would want to take this program. Getting feedback from these organizations could not only provide improvements to the program but could create a sense of collaborative ownership that encourages them to promote the program within their membership.

This promotion would increase the awareness, but also the perception of the utility of students taking this M. Eng. Some of the people we spoke with during this review indicated that the perception is that upper management and the intended audience both find this series valuable, but middle management does not. Getting support from upper management to get candid feedback from middle managers who control the training budget to find out what *they would* like to see would help clarify where people are interested or not. These organizations (CNA, OCNI, WiN, and NA-YGN) talk with professionals at every

level of the companies that the UNENE program is targeting. This could address some of the concerns that managers may not see the utility in spending their finite training budget on these programs.

While the UNENE coursework has created a strong framework for people working within the regulatory part of nuclear power, or directly in the power plants, the nuclear industry in Canada is considerably wider than that.⁶ This increased diversity of background will enrich the experience of the students throughout the program. It may also be possible for UNENE to offer courses that will help engineers at this longer list of companies current in their field. As stated in the NSPE code of ethics, point 2e:

“Engineers shall continue their professional development throughout their careers and should keep current in their specialty fields by engaging in professional practice, participating in continuing education courses, reading in the technical literature, and attending professional meetings and seminars.” National Society of Professional Engineers Code of Ethics, available: <https://www.nspe.org/resources/ethics/code-ethics> accessed April 22nd, 2021

There is considerable need for engineers in the Canadian nuclear industry to remain current in the field by taking courses. There may also be personal and professional interest as well as the professional ethical requirement.

Areas for Growth

In addition to the Areas for Concern, we have listed some Areas for Growth which we believe the program will benefit from looking at.

- Instructors of Record
- Succession Planning
- Student Advising
- Course Offerings
- University Resources

By considering the Areas for Concern thoroughly, many of these Areas for Growth will be addressed, and vice versa. Attention to these growth areas will lead to increasing and stabilizing the enrolment numbers, by more efficiently deploying existing university resources.

Instructors of Record

This program is largely housed at McMaster and includes graduate students and courses from four other universities. The eminence of McMaster in running the program (for example, the location of their administrative offices and the administrative structure conducting this review) means that the principal tie is with McMaster University, as the leader in this consortium. It was disconcerting, and problematic, that there are no tenured or tenure-track faculty members from McMaster University teaching any of the courses in this program, or directly involved in the delivery of this graduate program. There are

⁶ Numbers vary on how big the Canadian nuclear industry is, but numbers to the tune of 60 000 – 80 000 people are normal. See for example, the CNA’s report from November 2019 claims 76 000 with 30 000 being people under 40 who would likely be the principle target demographic: <https://cna.ca/2019/11/08/new-study-finds-nuclear-industry-accounts-for-76000-jobs-across-canada/> 90% of the jobs are highly skilled and 42% require a university degree or higher while 47% are highly skilled trade jobs.

McMaster professors who receive UNENE funding to do research, and while that is good for the overall relationship between UNENE and McMaster, it is insufficient from the standpoint of the graduate program. This was further confounded by the interesting fact that the courses are not *taught at* McMaster, but in Oshawa.

There is a double-edged sword at play: the strong focus on industry-experienced sessional instructors does lead to a relevant reservoir of experience for teaching the courses. On the other hand, the lack of faculty involvement from McMaster means that many of the resources at McMaster University (the MacPherson teaching resources, the engineering marketing program, the Office of Diversity and Inclusion, as examples) do not support the program as much as they should; in fact, they may not be aware of the existence of the program. Likewise, the other four universities are even less likely (with the current set up) to contribute their resources to the success of this program.

The paucity of traditional faculty members also reduces or even eliminates the tenured faculty members for doing service work in support of this program. That service work could include advising students, recruiting students, and creating opportunities for students outside of class. Service is an important part of any faculty member's work, but sessional instructors are rarely compensated for this invisible but essential part of the student experience.

Succession Planning

An additional difficulty brought about by the lack of traditional faculty members involved in the program is the retention of institutional knowledge about the operation of the program. There is a lack of continuity of the program with the turnover of instructors. The program needs to ensure that there is a way of maintaining institutional knowledge (what does a course include, what resources are needed to teach a particular course, rubrics, educational material, etc.) when one of the instructors stops teaching a course.

Lori Cole's retirement created a real difficulty of maintaining the program. Areti Tsiliganos, despite her extensive McMaster administrative experience, had to call on Ms. Cole extensively, in her retirement, to be able to operate the program in the absence of the administrator who had facilitated the program since its inception. Many of the faculty members teaching these courses are retired from the nuclear industry, which has some real benefits, but could also create significant difficulties in the event of them no longer being available as time goes on. The program needs to be robust in the face of these upcoming transitions.

Student Advising

On the student side of the management of this program, UNENE has unique challenges. This program does not create clearly defined cohorts that traditional programs have. The flexibility of students being able to tailor their courses to their needs, and stretch or condense their timelines, means that students take classes with people who enter in different years. This lack of cohort structure requires each student to receive individual advising to ensure their progress towards completion. The long time to graduation and students not necessarily enrolling every semester leads to confusion about who is continuing with the program and who is not.

A 20-minute meeting with every student in the program, once a semester, would yield significant improvements in retention and program self-awareness. It would also improve program understanding of where the coursework is and is not meeting its intended goals. These regular conversations would

also illuminate student needs far better than the current informal system. Students are falling through the cracks. The Team-Up report cited above indicates this would also help with diversity issues. Feedback on the program will be far more fulsome if regular, formalized two-way conversations are happening.

This advising would make the program more robust when students change companies, or just move on to different positions within the same company. Collaborations discussed in the pedagogical approach section could be instructive in setting up effective advising and mentoring within the program. Additionally, the abovementioned professional organizations (WiN and NA-YGN) could illuminate effective advising practices for these young professionals.

Course Offerings

The university administration is willing to support the expansion of the number of classes offered if requested by the program. Confusion within the program about what is needed to get a new course on the books was striking to the outside reviewers. Internal communication between UNENE and the universities themselves is sorely needed. We recommend creating documentation about how to create new courses, which would help this process going forward.

Many students at the five universities who are not part of the UNENE courses would benefit from having access to these courses. Several of the instructors involved with UNENE saw this as essential for the success of their non-UNENE students, but the UNENE administration kept saying it was impossible. When probing the administration, the only concern that was expressed (although there may be others we are not aware of) was financial. We recognize that the difference in price would make this difficult to pursue, but we recommend taking a look to see if there are possible solutions.⁷ This would increase the enrolment of these programs, but it would also increase the exposure of the cohorts of students to other students who will also be working within the nuclear industry. This would also have workload benefits for the faculty members at other institutions who are teaching at UNENE.

Utilization of University Resources

Repeatedly we heard some version of the sentiment that the biggest threat to the program is its low enrolment numbers. In other sections we discuss how Equity, Diversity and Inclusion, improved pedagogical approaches, and expanded nuclear content could address some of this; this section will address how existing university resources could help make this program more robust.

There are resources within McMaster University (and the other universities) that are not being employed. To address the awareness within the industry, there is a marketing team in the McMaster engineering program, we suggest that the UNENE program director and academic director meet with them and see what they suggest and how they can help. The separate nature of this inter-university program seems to create a conceptual disconnection from the resources available at any of the individual universities that can support this program. The university resources can be used to further the

⁷ For example, one possible solution would be to have UNENE students enrol in non-UNENE courses and have the difference in tuition be transferred in some sort of equalization payment. Another, potentially simpler solution would be to have the courses be dually listed for UNENE and non-UNENE students. People within the program will probably be able to come up with better solutions.

cause of this program and should be. The directors of this program should meet regularly with people from the university, perhaps focusing on McMaster University specifically as a starting point, to see how the university's resources can be better deployed to the end of aiding this program.⁸

Introducing more actively distance education components to the program has the potential to expand the program internationally especially for countries operating CANDU reactors now (and SMRs in the future) as well as to offer more flexibility to the domestic students, thus leading potentially to increasing the size of the program.

Closing

The UNENE program delivers an effective M. Eng program to people working in the Canadian nuclear sector. The review team found that UNENE is achieving most of their stated program goals:

- Focused, relevant content for the nuclear professional needing an M. Eng.
- Experienced Nuclear professionals sharing deep experience pertinent to careers of students
- Review courses to level the field for the heterogeneous background of the students
- Timing of course so working professionals can enroll in program
- Collaboration with the university network
- Small class size and individual attention for students in the courses

Improvements to the program are possible, and suggestions have been provided for consideration to that end. Specifically, we hope these suggestions will enable smoother operation of the overall program and increase enrolment in the program:

- Work with University office of Diversity and Inclusion to evaluate accessibility of the courses
- Evaluate the pedagogy used, especially the weekend long, lecture focused course delivery
- Institute regular, structured advising for students in program
- Explore increasing target audience within the nuclear industry and diversifying course offerings
- Create stronger ties to the rest of the university, to better use university resources
- Develop mechanism for maintaining institutional knowledge about the program

Care should be taken to ensure that any improvements do not erode what has been effectively working. There are many opportunities to expand what has already been working well to allow the program to include a much broader base of students in the coming years. Overall, the future for this program seems bright.

⁸ This is in addition to the suggestion of approaching the McPhearson teaching institute specifically.

UNIVERSITY NETWORK OF EXCELLENCE IN NUCLEAR ENGINEERING

IQAP Audit Response Plan

Dr. N. Popov
Sep 24, 2021

No	Recommendation	Proposed Follow-Up	Responsibility for Leading Follow-Up	Timeline for Addressing Recommend.
1	Work with University office of Diversity and Inclusion to evaluate accessibility of the courses.	<u>Action 1.1</u> UNENE will gather information from member organizations regarding EDI practices, and hold a workshop with the objective to identify how to adopt and apply some of the recommended guidelines and activities specific to nuclear education and research and to UNENE.	Jerry Hopwood	Sep 2022
2	Evaluate the pedagogy used, especially the weekend long, lecture focused course delivery.	<u>Action 2.1</u> The current four-alternate weekend format is the result of experimentation early in the program. The current format, while not as good as a 13-week semester, is a compromise to accommodate working students. We have not identified anything better that fits our constraints. UNENE will further evaluate options in cooperation with stakeholders and propose changes if a better model is identified.	Nik Popov	Sep 2022
		<u>Action 2.2</u> Action UNENE will meet with the MacPherson Institute at McMaster University and seek their advice about making our pedagogy more effective. The Teaching and Learning Centre at Ontario Tech. University fills a similar role, and might also assist us, especially for digital classrooms. Assuming they give useful guidance, we will pilot the ideas in one or more selected courses in 2022/2023, and then decide on broader implementation.	Nik Popov	Sep 2022
		<u>Action 2.3</u> We will also pilot a “flipped classroom” for one or two selected topics in one of our	Victor Snell	Jan 2022

No	Recommendation	Proposed Follow-Up	Responsibility for Leading Follow-Up	Timeline for Addressing Recommend.
		2021/2022 courses. The four-weekend format of UNENE courses poses a special challenge in implementing this approach (for example it cannot be sprung on students at the first weekend), so the pilot will tell us what does and does not work.		
3	Institute regular, structured advising for students in program.	Action 3.1 UNENE already regularly requests student feedback on the completed courses, and input in scheduling future courses. Also, UNENE conducts discussions with student groups when required. UNENE will introduce regular student meetings twice a year.	Nik Popov	Jan 2022
		Action 3.2 UNENE will introduce regular student meetings with each student individually to discuss student progress, needs and plans.	Nik Popov	Jan 2022
4	Explore increasing target audience within the nuclear industry and diversifying course offerings.	Action 4.1 UNENE already has contacts with industry partners in terms of finding ways to increase student admissions. UNENE will continue with meetings with the senior management from the industry with the intent to find ways for increased student population.	Jerry Hopwood	Dec 2022
		Action 4.2 UNENE will explore possibilities with the CNS, OCNI and other industry organizations to organize webinars and seminars as part of the outreach to employees in various industry organizations.	Jerry Hopwood	Sep 2022
		Action 4.3 UNENE will explore ways to use graduate students and alumni students as “ambassadors” of UNENE in their organizations and will explore objectives and methods to be used for increasing awareness of employees with the UNENE M.Eng. program.	Nik Popov	Sep 2022
5	Create stronger ties to the rest of the university, to better use university resources.	Action 5.1 UNENE will organize regular annual meetings with their university colleagues at McMaster SGS as well their partner universities to communicate and share developments on resources, policies and procedures such as	Nik Popov	Mar 2022

No	Recommendation	Proposed Follow-Up	Responsibility for Leading Follow-Up	Timeline for Addressing Recommend.
		academic integrity, grading tools, petitions, and admissions processes.		
6	Develop mechanism for maintaining institutional knowledge about the program.	Action 6.1 UNENE officers with M.Eng. program responsibilities to compile the UNENE program handbook and prepare a description of their on-going duties and activities regarding the program, to allow transfer of duties if needed.	Nik Popov	Sep 2022
		Action 6.2 UNENE to prepare archive materials of all courses delivered, to provide basis for a new instructor to come in more readily in future.	Areti Tsiliganos	Sep 2022

UNIVERSITY NETWORK OF EXCELLENCE IN NUCLEAR ENGINEERING

Dr. N. Popov
February 4, 2022

UNENE IQAP AUDIT RESPONSE PROGRESS

No	Recommendation	Proposed Follow-Up	Responsibility for Leading Follow-Up	Timeline for Addressing Recommend.
1	Work with University office of Diversity and Inclusion to evaluate accessibility of the courses.	Action 1.1 UNENE will gather information from member organizations regarding EDI practices and hold a workshop with the objective to identify how to adopt and apply some of the recommended guidelines and activities specific to nuclear education and research and to UNENE. Status: [4-Feb-2022] Ongoing.	Jerry Hopwood	Sep 2022
2	Evaluate the pedagogy used, especially the weekend long, lecture focused course delivery.	Action 2.1 The current four-alternate weekend format is the result of experimentation early in the program. The current format, while not as good as a 13-week semester, is a compromise to accommodate working students. We have not identified anything better that fits our constraints. UNENE will further evaluate options in cooperation with stakeholders and propose changes if a better model is identified. Status: [4-Feb-2022] UN804 completed in 8-day format over three months. Same format used in the ongoing UN803 course. Students' feedback indicated agreement with the above change, at least for the online delivery.	Nik Popov	Sep 2022
		Action 2.2 Action UNENE will meet with the	Nik Popov	Sep 2022

No	Recommendation	Proposed Follow-Up	Responsibility for Leading Follow-Up	Timeline for Addressing Recommend.
		MacPherson Institute at McMaster University and seek their advice about making our pedagogy more effective. The Teaching and Learning Centre at Ontario Tech. University fills a similar role, and might also assist us, especially for digital classrooms. Assuming they give useful guidance, we will pilot the ideas in one or more selected courses in 2022/2023, and then decide on broader implementation. Status: [4-Feb-2022] - Several meetings held with representatives of MacPherson Institute do discuss some elements and new approaches. - Some suggestions and guidance taken into consideration in UN804 and UN803, such as to take a step-by-step approach, and to consider previous experience with new approaches where available.		
		Action 2.3 We will also pilot a “flipped classroom” for one or two selected topics in one of our 2021/2022 courses. The four-weekend format of UNENE courses poses a special challenge in implementing this approach (for example it cannot be sprung on students at the first weekend), so the pilot will tell us what does and does not work. Status: [4-Feb-2022] - Modifications to the lecture format in the UN804 course were introduced, such as previous lecture students’ recap at every follow-up lecture, students’ pre-reading of lectures and a summary before every lecture, etc. Students’ feedback indicated general agreement. - Ongoing with partial implementation in UN803 course currently ongoing.	Victor Snell	Jan 2022
3		Action 3.1	Nik Popov	Jan 2022

No	Recommendation	Proposed Follow-Up	Responsibility for Leading Follow-Up	Timeline for Addressing Recommend.
	Institute regular, structured advising for students in program.	UNENE already regularly requests student feedback on the completed courses, and input in scheduling future courses. Also, UNENE conducts discussions with student groups when required. UNENE will introduce regular student meetings twice a year. Status: [4-Feb-2022] Ongoing.		
		Action 3.2 UNENE will introduce regular student meetings with each student individually to discuss student progress, needs and plans. Status: [4-Feb-2022] Ongoing.	Nik Popov	Jan 2022
4	Explore increasing target audience within the nuclear industry and diversifying course offerings.	Action 4.1 UNENE already has contacts with industry partners in terms of finding ways to increase student admissions. UNENE will continue with meetings with the senior management from the industry with the intent to find ways for increased student population. Status: [4-Feb-2022] Ongoing. EAC subcommittee to further discuss and propose further activities.	Jerry Hopwood	Dec 2022
		Action 4.2 UNENE will explore possibilities with the CNS, OCNi and other industry organizations to organize webinars and seminars as part of the outreach to employees in various industry organizations. Status: [4-Feb-2022] Ongoing.	Jerry Hopwood	Sep 2022
		Action 4.3 UNENE will explore ways to use graduate students and alumni students as “ambassadors” of UNENE in their	Nik Popov	Sep 2022

No	Recommendation	Proposed Follow-Up	Responsibility for Leading Follow-Up	Timeline for Addressing Recommend.
		organizations and will explore objectives and methods to be used for increasing awareness of employees with the UNENE M.Eng. program. Status: [4-Feb-2022] Ongoing.		
5	Create stronger ties to the rest of the university, to better use university resources.	Action 5.1 UNENE will organize regular annual meetings with their university colleagues at McMaster SGS as well their partner universities to communicate and share developments on resources, policies and procedures such as academic integrity, grading tools, petitions, and admissions processes. Status: [4-Feb-2022] Ongoing.	Nik Popov	Mar 2022
6	Develop mechanism for maintaining institutional knowledge about the program.	Action 6.1 UNENE officers with M.Eng. program responsibilities to compile the UNENE program handbook and prepare a description of their on-going duties and activities regarding the program, to allow transfer of duties if needed. Status: [4-Feb-2022] Ongoing.	Nik Popov	Sep 2022
		Action 6.2 UNENE to prepare archive materials of all courses delivered, to provide basis for a new instructor to come in more readily in future. Status: [4-Feb-2022] Ongoing.	Areti Tsiliganos	Sep 2022