McMaster University

FINAL ASSESSMENT REPORT

Institutional Quality Assurance Program (IQAP) Review

Computational Science and Engineering (M.Eng., M.A.Sc., M.Sc., Ph.D.)

Date of Review: April 11th – 13th , 2021

In accordance with the University Institutional Quality Assurance Process (IQAP), this final assessment report provides a synthesis of the external evaluation and the internal response and assessments of the graduate programs offered by the School of Computational Science and Engineering. This report identifies the significant strengths of the program, together with opportunities for program improvement and enhancement, and it sets out and prioritizes the recommendations that have been selected for implementation.

The report includes an Implementation Plan that identifies who will be responsible for approving the recommendations set out in the Final Assessment Report; who will be responsible for providing any resources entailed by those recommendations; any changes in organization, policy or governance that will be necessary to meet the recommendations and who will be responsible for acting on those recommendations; and timelines for acting on and monitoring the implementation of those recommendations.

Executive Summary of the Review

In accordance with the Institutional Quality Assurance Process (IQAP), the School of Computational Science and Engineering submitted a self-study in February 2022 to the Vice-Provost and Dean of Graduate Studies to initiate the cyclical program review of its program. The approved self-study presented program descriptions, learning outcomes, and analyses of data provided by the Office of Institutional Research and Analysis. Appendices to the self-study contained the CVs for each full-time member in the department.

Two arm's length external reviewers and one internal reviewer were endorsed by the Dean, Faculty of Science, and selected by the Vice-Provost and Dean of Graduate Studies. The review team reviewed the self-study documentation and then conducted a virtual review on from April 11th – 13th, 2022. The review included interviews with the Provost; Vice-Provost and Dean of Graduate Studies, Associate Dean, Grad Studies and Research, Director of the program and meetings with groups of current students, full-time faculty and support staff.

The Director of the program and the Deans of the Faculty of Science, Engineering and Business submitted responses to the Reviewers' Report (March 2024). Specific recommendations were discussed and clarifications and corrections were presented. Follow-up actions and timelines were included.

- **Strengths**

The reviewers highlighted the program's interdisciplinary nature, its flexibility (which makes it accessible to students with a broad range of backgrounds and interests), and the very high quality of the students and faculty engaged in the program. The program was noted for its creative and innovative form of the comprehensive PhD exam, the inclusion of data analytics and artificial intelligence in the program (these are new areas of importance), engagement found in student-run seminars, and providing students with solid fundamentals in scientific computing in its core courses. The program also aligns perfectly with McMaster University's commitment to interdisciplinary learning.

- **Areas for Improvement**

The first theme is to ensure long-term viability of the program by developing a medium-term teaching plan for our core courses, broadening participation by a diverse group of faculty, and negotiating for more recognition and resources for interdisciplinary programs. The second theme, in recognition of the fact that many of our students pursue careers in industry, is to add more opportunities for development of professional skills; increase engagement with industry via alumni-focused seminars and social events; and add opportunities for co-op placements and internships. The third theme of improvement is to increase student engagement and sense of community by (among other activities) fostering a graduate student association and securing a dedicated office/interaction space for students.

Summary of the Reviewers' Recommendations with the Department's and Dean's Responses

Implementation Plan

Recommendation [bracketed numbers refer to IQAP review recommendations]	**Proposed Follow-Up**	**Responsibility for Leading Follow-Up**	**Timeline for Addressing Recommendation**
Theme: sustainability			
Broaden the governance structure through an expansion of the Advisory Council with attention paid to increase the diversity of the members [2]	This recommendation is straightforward to implement. The two major challenges are (1) avoiding overburdening people from underrepresented groups (who are often saddled with extra service duties to support EDI (Equity, Diversity, and Inclusion) initiatives) and early-career researchers; (2) the limited diversity within the faculty members of the School as a whole. To address (1), we will consider limiting terms of service to 1 year; addressing (2) requires a more general effort, which depends on appropriate recruitment by the university (i.e., new faculty who are both computationally oriented and members of underrepresented groups). To begin to address this issue, the director/administrator will annually review the list of new hires in all participating faculties to identify any who might be suitable for CSE. We will replace at least one member of the advisory council with an ECR/member of an underrepresented group this year and will initiate a more formal rotation of advisory council membership (3-year terms with exceptions as stated above).	Director, Associate Director (Nedialkov), Administrative Assistant (Attar-Elbard) [assisting with annual review of new hires]	Initiate immediately (recruit one new advisory council member starting fall 2023)

Develop a longer-term instructional plan (3+ years) for core courses at a minimum. This should involve identifying full-time faculty who are potential instructors for the courses, and assigning instructors on an, e.g., 3-year, basis, alternating through faculty/ department as appropriate. Faculty funding for these should flow to the departments to ensure that no extra burden is put on the particular department that supplies the instructor. [3]	In the absence of additional resources, we can best approach a sustainable plan by reaching out to chairs/graduate chairs of relevant departments and discussing how CSE needs can be met in the context of departmental procedures and plans (e.g., the departments of Math & Stats and Biology only develop teaching plans one year at a time). For planning purposes, it will be useful to maintain a list of all CSE members who could be called on to teach the core courses. CSE 745 (which is best taught by SHARCnet technical staff) and CSE 780 (cross-listed as STATS 780, and subject to growing demand from all departments) are of less concern.	Director, Associate Director (developing faculty list)	Initiate discussions fall-summer 2022-2023; plan ready by fall 2023 if possible, or fall 2024 at the latest
Theme: External engagement			
Explore the introduction of co-op/internship programs [4]	The Faculty of Engineering has an existing graduate co-op program; the Faculty of Science is considering developing such a program. The administrative demands of such a program are high, but hopefully we can piggyback on the existing structures in the Faculty of Engineering or new developments in the Faculty of Science (contact: Alice O'Carroll, Director, Student Careers and Co-operative Education); the other requirement for a successful co-op program will be to work with the co-op office to develop connections with industry through our alumni and through existing industrial/agency partnerships of CSE members (e.g. Dofasco, Public Health Agency of Canada). We envision internships/co-op activities as extending the study period of a student (as with McMaster's undergraduate co-op programs), rather than needing to be	Director, Advisory Council Members, Associate Deans of Graduate Studies (Science, Engineering, Business)	Pilot offering for fall/winter 2024-2025

	done concurrently with courses and thesis research (as is done in the existing eHealth co-op program). In the interim, we will make sure that students are aware of funding and project opportunities through MITACS (although these projects will have to be pursued in the context of the supervisors' and students' research programs, rather than as standalone activities).		
Educational objectives of the Graduate Symposium be expanded to include professional development and include networking with guest lectures from alumni and other industry professionals [5]	We believe the best way to provide such skills is through the MacPherson Institute's (MI) offerings and newly launched Faculty of Science graduate student career and mentorship program pilots. We will encourage students to take advantage of these opportunities. We are unconvinced of the wisdom of adding requirements to the program; we will consult with students and alumni and add an appropriate mandate (e.g., for completing a specified number of hours of MI training of the student's choice) if it seems justified. The Science career and mentorship opportunities will be available to our students including the Graduate Mentorship Program and Graduate Student Career Services. These programs include workshops, alumni presentations, individual development plans, and career-related guidance by trained staff. In addition, our students have access to alumni social events organized by the Science Graduate Student Association (SciGSA) alumni events every year. These events consist of round table discussions on non- academic careers, practical advice, and Q/A session. We will also discuss with students and MI staff the possibility of developing additional CSE-focused professional	Director, Advisory Council Members, Associate Dean Graduate Studies	Ongoing; implement new requirements (if any) for incoming students in fall 2023.

	development opportunities, if these are warranted. We prefer to keep the CSE symposium focused on research and networking (see next item), rather than trying to squeeze in professional development activities as well Discussion of these options would be one important topic for an upcoming School retreat.		
Expand networking/alumni engagement [5, 9]	We will add at least one alumni seminar each term as part of the biweekly seminar schedule and plan an annual evening alumni networking event with refreshments (panel discussion + mixer), offering small honoraria to the panel speakers. This event will (hopefully) be organized by the graduate student association, with input and support from the director and admin. As mentioned above, the SciGSA and Engineering Graduate Society run alumni socials are other events that are available to our students. We will institute an annual e-mail to alumni including an opportunity to opt out of future communications or provide updated contact information.	CSE Graduate Student Association, Outreach Coordinator, Director, Administrative Assistant	Late winter/spring 2023; alumni seminars to start winter 2023 if possible, otherwise fall 2023
Theme: Student and faculty engagement			
Establish a dedicated space to the CSE program, specifically desk/working space for students and shared spaces for student interactions [6]	Like several other items above, this item depends on external resources. We will make this part of our post-IQAP discussions with Deans and the Provost (in the context of initiating the Provost's review). In the short term, we will see whether any space may be available in library facilities. If possible, we will engage with the campus master planning exercise to advocate for space for interdisciplinary programs.	Director, Advisory Council Members	Space secured by beginning of fall 2024, if possible.
Enhanced orientation for	We will add a social event and short	Director,	Immediate (fall

incoming students in addition to the information session that is currently provided with interaction between incoming and more senior students. The orientation should include a follow- up meeting with each individual student to ensure any residual issues the student may have been addressed. The graduate coordinator should take responsibility for communicating with the graduate coordinators of the incoming students' home departments to ensure that the incoming students are properly integrated into their home departments. [7]	'entrance interviews' to the standard orientation activities. We will develop a standard set of questions for graduate chairs of supervisors' home departments (e.g., "what provisions are there for desk/office space? are CSE students included in orientation activities/added to departmental mailing lists?") and communicate before the beginning of the term.	Administrative Assistant (assemble list of graduate chairs; assist in scheduling interviews)	2022)
Initiate a CSE Graduate Student Association [8]	We are in the process of assembling an exploratory committee of graduate students to form a CSE graduate student association. The students will decide which themes they would like to emphasize but organizing social activities (weekly/biweekly/monthly) will be encouraged.	Graduate students, with input/encouragement from Director	Immediate (fall 2022)
Graduate student participation in advisory council, outreach etc.; student activities/ outreach coordinator [3, 8]	We plan to continue the participation of a graduate student liaison on the Advisory Council. It may work to combine this role with the presidency of the proposed CSE graduate student association (GSA), but we will consult with the students before making this decision (for example, if the CSE GSA focuses on organizing social events, it may make sense for these to be separate roles). Ideally, the CSE GSA would nominate one or more candidates for the	Director, Graduate Students	Hiring graduate student outreach coordinator in winter 2023

	liaison position. We do not think it makes sense to organize a formal graduate student caucus; we will leave the organization of graduate student consensus/decision-making up to the students, to be communicated with the director and advisory council via the graduate student liaison. To our knowledge it is unusual for graduate student association presidents or liaisons to be paid a stipend. Instead, we envision recruiting one student volunteer per year as an admin/outreach coordinator. This position may (but would not necessarily) go to the same student who is serving as GSA president/liaison. The student's duties would include connecting with the Science Graduate Career manager, Science alumni coordinator, and SciGSA to help organize the annual networking/panel event and maintenance of the web site.		
More robust and systematic surveys and exit interviews of current students and alumni [9]	We will implement an annual spring survey of current students, covering current plans (more feedback on PhD student progress/planned completion will be helpful, although the University-administered supervisory committee reports can also shed light on this) and intended next steps for finishing students; course enrolment plans and requests for the next academic year; and general sentiment/opportunity to express concerns. Periodic alumni surveys (every 3-5 years).	Director, Associate Director, Outreach Coordinator	Spring 2023
Development of a Faculty mentorship model to encourage participation of young faculty in interdisciplinary supervisions [10]	Faculty mentorship will also be considered by new faculty members' home departments; we will communicate with home-department chairs about how CSE can complement existing mentorship plans, and to open the discussion about how appropriate	Director, Associate Director	Social event "immediately" (October 2022); discussions with chairs before fall 2023.

	credit can be given for teaching courses and supervising students in CSE. We will hold an informal social event in October (after the first rush of McMaster onboarding etc.), inviting all incoming CSE faculty and including some established faculty.		
Hold a regular School retreat (e.g., every two years) [11]	We will plan a retreat for December 2022. We are still deciding on the scope (faculty plus 'graduate caucus' vs. including all graduate students); it may work to hold a retreat/full-group meeting every year, alternating between faculty- focused and graduate-focused events.	Director, Associate Director, Administrative Assistant	Initial retreat mid-December 2022 (this event was run, and was well attended by faculty and students)
Introduce resources and have enhanced information for prospective students. Ensure applications are processed on the same timeline or before those of participating departments. [12]	In addition to enhancing material on the web (see Recommendation #13 below), we will hold at least one live/synchronous informational session for prospective students; this will be held online via Zoom, for the benefit of prospective students from outside McMaster, but we will publicize the event within McMaster as well, especially by contacting instructors of potential "feeder" courses (upper-level numerical and computational science courses).	Director, Associate Director, Administrative Assistant	Mid-November 2022
Improve online presence with a view to enhance student recruitment. Complete a periodic review of the information, links and program membership displayed on the web pages [13]	Issues with the size of the faculty list and faculty web page links (trimming and link-checking) are already resolved. We will reorganize and add material for prospective students, specifically useful information, and tips for identifying a prospective supervisor.	Director, Outreach Coordinator	First round of improvements (focused on prospective students) by November 1 (opening of application window for fall 2023); other improvements on an ongoing basis,

Faculty Response

We sincerely thank all the reviewers for their thorough and constructive review of McMaster's School of Computational Science and Engineering (CSE) graduate program. This Dean's response is submitted jointly between the Faculties of Science, Engineering, and DeGroote School of Business given the CSE Graduate Program is a joint program between these three Faculties.

The CSE Program leadership has provided a detailed, point-by-point response, along with specific actions, and timelines. We have reviewed the program's response to the review and agree with proposed plans and timelines for improvement and enhancement. Many of the recommendations are already implemented or will be addressed soon. Below is our response to their recommendations.

Program Governance [2, 8]: We recognize that the inclusion of a diverse membership including students within the CSE Advisory Council is critical. CSE has identified next steps and how this diverse governance body will be achieved moving forward. As noted in the program response, graduate students are part of the Advisory Committee and participate in decision making. We will work with CSE to review the current process and ways to improve future involvement and communications with the student community. We will encourage the formation of a CSE Graduate Student Association by working with the Science Graduate Student Association (SciGSA).

Long-term Instruction Plan [3]: We support CSE's response to this recommendation while recognizing that additional faculty and instructional resourcing is limited. We will work with CSE in identifying an optimal solution to the need for a longer-term instructional plan while recognizing and working within the resources that are currently available.

Explore the introduction of co-op / internship programs [4]: The Faculty of Engineering will offer guidance to the Faculty of Science as it explores opportunities for Work Integrated Learning (WIL) within graduate programs through the Associate Dean of Graduate Studies

(Science) office and the Science Career & Cooperative Education (SCCE) office. The demand for WIL was expressed in a Career Needs Assessment for Science Graduate Students conducted earlier in 2023. SCCE will continue to explore opportunities for WIL over the 2023/24 academic year. Students in CSE graduate programs will have the opportunity to participate in these initiatives and be able to network with alumni, receive career guidance, acquire new sets of skills through workshops and microcredentials, and have experiential learning opportunities.

Expand professional development opportunities [5]: We will continue to support students in CSE expand their professional development opportunities through existing groups and activities

such as McMaster's MacPherson Institute, the SciGSA, and the Faculty of Science's Graduate Mentorship Program and Graduate Student Career Services. They may also use online tools for professional development already built by the Faculty of Engineering. We see these as critically important opportunities for our students given that many will not continue in academia and instead work in the private or public sector.

Expanded Engagement: Opportunities for expanded engagement with alumni [5, 9] and students and faculty [7] were noted in the review. The issues of expanding networking and alumni engagement, improved orientation activities, interaction between junior and senior graduate student collaborations and cross-disciplinary activities is important. The program response has mentioned a few ideas that are being explored. We support CSE in taking steps to address the recommendations and look forward to working with them in meaningful ways. In addition, the School of Graduate Studies (SGS) recognizes that the creation of community among our graduate students is critical. Alumni engagement and networking is also being explored by the SCCE office through the inclusion of Work Integrated Learning (WIL) as part of its graduate programming initiatives.

CSE Program Space [6]: We recognize the importance for programs to identify space as their own which enable a touch point for students, staff, and instructors alike. Given space and budget constraints on campus, however, there is little opportunity to provide dedicated space to CSE. We will continue to work with CSE and to identify alternatives.

Student surveys [9]: We appreciate the recommendation of developing more robust and systematic surveys and exit interviews of CSE students. While not all options will be time effective and informative, we will draw on examples of how other units in Science survey students and work with CSE to identify the best way(s) to survey students on an ongoing basis.

Faculty mentorship [10]: We recognize that faculty mentorship, particularly for new faculty, is a critical component of successful career development. Together with the Provost's Office and the MacPherson Institute, the Faculty of Science implemented a new faculty mentorship program in 2019-2020. We will continue to foster mentorship and faculty teaching and research collaborations across the Faculties to ensure that students have access to the excellent supervision and research opportunities in all three Faculties.

Regular School Retreats [11]: Regular retreats are encouraged to develop community and discuss plans and needs for the unit. We support CSE's response and will encourage these provided there is a clear mandate for events.

Student recruitment [12, 13]: We recognize the importance of student recruitment events and ensuring resources are available for students interested in the program. CSE has identified online recruiting events for prospective students and are encouraged to continue these. In

addition, SGS holds several on-campus recruitment events, and we will encourage CSE participation in these.

Quality Assurance Committee Recommendation:

McMaster's Quality Assurance Committee (QAC) reviewed the above documentation at the May 2024, meeting. The committee recommends that the **Computational Science & Engineering** program should follow the regular course of action with an 18-month progress report and subsequent full external cyclical review to be conducted no later than eight years after the start of the last review.