

Final Assessment Report

Nanotechnology Collaborative Program

(MSc, MAsC, PhD)

May 2019

Summary of the Program Review:

In accordance with the University's Institutional Quality Assurance Process (IQAP), this final assessment report provides a synthesis of the external evaluation and the internal response and assessments of the collaborative program in Nanotechnology (Nano program) delivered by the Faculty of Science and the Faculty of Engineering. Six departments collaborate on the program: Chemistry, Physics and Astronomy, Chemical Engineering, Electrical and Computer Engineering, Mechanical and Mechatronics Engineering, and Systems Design Engineering. A self-study (Volume I) was submitted to the Associate Vice-President, Graduate Studies and Postdoctoral Affairs on May 15, 2017. The self-study presented the program descriptions and learning outcomes, an analytical assessment of these programs, including the data collected from a student survey along with the standard data package prepared by the Office of Institutional Analysis & Planning (IAP). The CVs for each full-time faculty member in the Department were included in Volume II of the self-study.

Two arm's-length external reviewers were selected from Volume III of the self-study. Dr. Pulickel Ajayan, Professor of Materials Science and NanoEngineering, Rice University, and Dr. Spiros Pagiatakis, Professor of Earth Sciences and Geomatics Engineering, University of Toronto were selected by the Associate Vice-President, Graduate Studies and Postdoctoral Affairs, as well as one internal reviewer (Dr. Paul Malone, Associate Professor from the Department of Germanic and Slavic Studies).

Reviewers appraised the self-study documentation and conducted a site visit to the University on May 25-26, 2017. The visit included interviews with the Associate Vice-President, Graduate Studies and Postdoctoral Affairs; Dean of Engineering; Dean of Science; Associate Deans of Graduate Studies, Engineering and Science; Director of the Program, Department Chairs, Graduate Nanotechnology Committee members, faculty members, staff and current graduate students. The review team also had an opportunity to visit meet with representatives from the Library and to tour laboratories in the Quantum-Nano Centre.

This final assessment report is based on information extracted, in many cases verbatim, from the self-study, the external reviewers' report and the program response.

Program characteristics:

The Graduate Nano program bridges the Faculties of Engineering and Science to provide a stimulating educational environment spanning basic research through to application. This collaborative program includes 12 separate degrees: master's and doctoral level degrees for each of the six departments in the Graduate Nano program.

Each member department maintains its own Graduate Nano program requirements, controls admission into its own master's and doctoral programs, coordinates student supervision, determines its own requirements for graduation and confirms that students have met those requirements before the University confers a degree. While each department has its own degree requirements, there are similarities among the member departments' requirements, including the nanotechnology core courses, the nanotechnology electives and the nanotechnology seminars.

Completion of the collaborative program is indicated by a transcript notation on the 'home' department's degree. The following degrees are currently offered:

- MSc and PhD in Chemistry (Nanotechnology)
- MSc and PhD in Physics (Nanotechnology)
- MSc and PhD in Chemical Engineering (Nanotechnology)
- MSc and PhD in Electrical and Computer Engineering (Nanotechnology)
- MSc and PhD in Mechanical and Mechatronics Engineering (Nanotechnology)
- MSc and PhD in Systems Design Engineering (Nanotechnology)

An MSc and PhD in Biology (Nanotechnology) were offered until 2015/16. However, effective September 2016, the Department of Biology suspended their participation in the Nano program due to minimal uptake from biology graduate students and a lack of congruency with the background and interests of biology students.

Summary of strengths, challenges and weaknesses based on self-study:**Strengths**

- **Multidisciplinary Focus:** Graduate Nano students can tailor their nanotechnology education by selecting unique combinations of courses from several disciplines to meet the requirements of their academic and/or employment goals. This inter-departmental collaboration in conjunction with the option to add a nanotechnology transcript notation to an established Waterloo degree is appealing to students.
- **Hands-on Lab Experience:** The faculty members who supervise Graduate Nano students are doing exciting nanotechnology research, using state-of-the-art technology and equipment. Prospective students know that the research they will conduct provides

opportunities for hands-on experience and learning, as well as meaningful skills that they can use elsewhere.

- **Research Output:** Waterloo's Graduate Nano program is attractive to a very high calibre of students, with excellent grades and relevant experience, who contribute to the University's reputation for innovation and high-quality research output. In the process of becoming independent scholars, these Graduate Nano students help Waterloo's faculty create and publish innovative research that is recognized on a global stage, thus elevating the institution's profile and credibility at home and abroad.
- **Nanotechnology Investment:** The University of Waterloo has invested significantly in nanotechnology, through both the Waterloo Institute for Nanotechnology and the creation of the undergraduate Nanotechnology Engineering program. The associated state-of-the-art facilities, cutting edge equipment and technology, and roster of distinguished nanotechnology experts on faculty, many of whom are world-class researchers, all contribute towards and benefit from the on-going success of the Graduate Nano program.

Challenges

- **Physical and Financial Resources:** Given its position as a collaborative program dependent on the involvement of several departments, the Graduate Nano program has no direct responsibility for or control over the physical and financial resources on which its students rely. Based on our discussions with departmental representatives and surveys of Graduate Nano students, each member department has appropriate physical and financial resources to support their students in the Graduate Nano program. What is missing, however, is a common space, where students from our member departments can meet, interact and socialize, while feeling that they are on 'common ground,' rather than in a particular department's space. A common space would encourage and facilitate a sense of community and collaborative endeavour among our students.
- **Competition for Students:** When it launched, Waterloo's Graduate Nano program was one of the first such programs in Canada and, therefore, faced little competition for students. The past few years have seen an increase in the number of international and domestic universities that offer graduate nanotechnology/nanoengineering/nanoscience programs, including John Hopkins, North Carolina State, UC Riverside, Guelph, Toronto, McGill and Alberta.
- **Program Promotion:** The program itself has no independent online presence or influence over the promotion that has been done on its behalf. Furthermore, with the program promoted in several places by many unique groups, it is difficult to track and manage the multiple unique presentations of program information.

Weaknesses

- **Program Funding:** Since its inception, the Graduate Nano program had no central budget to support its objectives and encourage long-term program enhancement. Member departments received per-student funding for those in the program, with no obligation to dedicate any of it to program-specific needs. There is no arrangement for support of the program as a whole. Support for a permanent full-time staff, program promotion, student recruitment and student funding would greatly enhance the operation and success of the program.
- **Student Support:** Because each member department is understandably focused on spending its funds for the greater good of its entire student population, the sub-set of Graduate Nano students is under-supported. Sufficient and on-going operating funds for Waterloo Institute for Nanotechnology Graduate Student Society (WINGSS) activities would give Graduate Nano students the capability to reduce home-department segmentation. Their activities could create a foundation for the relationship development that spurs the cross-pollination of ideas and, eventually, research partnerships.

Summary of key findings from the external reviewers:

Overall, the Collaborative Nanotechnology Graduate Program is unique in Canada and its nanotechnology research is multidisciplinary, collaborative and transformational. The uniqueness of the program is founded on its collaborative nature as six strong member departments contribute to it. The program naturally has its own growing challenges, particularly stemming from the undeveloped true coordination of the constituent departments, their lack of flexibility and the lack of central administrative organization of the academic curriculum. It is evident that the Faculties and Departments have a solid understanding of these issues and have already taken initial steps for remedial actions.

The two Faculties need to play a much stronger role in support of the program and the students by facilitating institutional organizational structure, providing oversight, student advocacy, compliance, coordination and facilitation of graduate study and post-doctoral fellowship programs to ensure consistent regulations and high impact research within the Quality Assurance Framework and Guidelines of the Ontario Universities Council on Quality Assurance (OUCQA).

Program response to external reviewer recommendations:

Recommendations

1. **Curriculum Authority:** *The program should consider that the current Graduate Nanotechnology Committee receive formal approval and responsibilities on curriculum matters with the aim to revise all courses related to the program.*

Response

- Determine if member department representatives on the Graduate Nano Committee may have responsibility for and authority to approve minor Graduate Nano Program core curriculum changes.
- Determine if, after approval of Curriculum Committee motions by the Graduate Nano Committee, those motions could be forwarded directly to the Faculty level, after approval via email from the Chairs or Associate Chairs of the member departments.
- Update: there is no agreement on either of these options.

2. **Full Time Administrative Coordinator:** *The program should consider that the Administrative Coordinator position become permanent. The administrative coordinator should serve in the Graduate Nanotechnology Committee and play a leading role in the student advisement.*

Response

- Maintain the administrative coordinator position at a part-time level.
- The administrative coordinator is already involved with the Graduate Nano Committee and student advisement, as appropriate, given that member departments advise their own students. The role will continue to act as a single point of contact for program-related questions from students, administrative staff and faculty that cannot be answered at a departmental level.
- Assign the administrative coordinator additional tasks related to the administration of the Curriculum Committee, online and recruitment communications, program promotion and administrative documentation.
- Monitor the administrative coordinator's program-related workload.
- Approach the Associate Deans of Graduate Studies for the Faculties of Science and Engineering, via the Program Director, if evidence indicates that the position requires increased FTE to support the collaborative program.

3. **Departmental Collaboration:** *The Graduate Nanotechnology Committee should work closely with the departments to develop a truly collaborative program by removing inflexible traditional administrative practices and developing effective interdependence among the founding departments. A more coordinated effort between departments and the Nanotechnology Program Committee should be considered for recruiting students with truly interdisciplinary interest.*

Response

- Investigate opportunities to enable Graduate Nano Committee members with limited departmental authority to approve changes on behalf of their department to reduce the complexity and increase the speed of the program's approval process.
- Create and maintain a centralized Graduate Nano Program section within the University's website (www.uwaterloo.ca/nano-graduate) that includes information about its various degree options and links directly to the program descriptions in the [Graduate Studies Academic Calendar](#).

- Collaborate with University - and member departments - to promote the Graduate Nano Program to potential students via the university website and departmental and Faculty recruitment events, as resources permit.
- Work with WINGSS and member departments to coordinate student-centric programs and events that will promote positive student experiences and collaboration among students in member departments.

4. **Curriculum Map Task Force:** *The Graduate Nanotechnology Committee should consider forming a task force to develop a comprehensive curriculum map according to the Quality Assurance Framework and Guidelines of the Ontario Universities Council on Quality Assurance (OUCQA). This will provide the framework for developing clear pathways to achieving the specified program learning outcomes and degree level expectations. A handbook could be developed to provide clear documentation for the incoming students detailing expectations, requirements, time-lines and other important instructions for fulfilling the degree requirements.*

Response

- Create, with representatives from each member department, a Curriculum Committee that reports to the Graduate Nano Committee.
- Develop a comprehensive curriculum map.
- Review core course content, delivery and sequencing to ensure that the core course offerings are comprehensive, appropriate and delivered effectively.
- Recommend curriculum changes to the Grad Nano Committee.

After clear information for students regarding expectations, requirements, timelines and other important instructions will have been placed online in a new Graduate Nano website section, determine if a separate handbook would be useful for students.

5. **Reduction in Required Courses:** *The program should consider reducing the number of required courses as partial fulfilment of the degree sought (particularly for PhD) in favour of intensification of research.*

Response

- This is outside of the power of the Graduate Nano Committee. However, this suggestion will be brought up with the Associate Chairs after the new Curriculum Committee has re-designed the nano courses.

6. **Faculty Support:** *The supporting Faculties should consider providing more direct support to the program, facilitating institutional organizational structure, providing oversight, student advocacy, compliance, coordination and facilitation of graduate study and post-doctoral fellowship programs.*

Response

- Formalize the current Graduate Nano Program structure through an official document endorsed by the Deans of Science and Engineering.
- Secure program funding commitment from the two Faculties and six departments involved in the program.

- Create a governance document that outlines the various commitments, processes and expectations of the departments and Faculties involved in the program.
 - Invite a Waterloo Institute for Nanotechnology Graduate Student Society (WINGSS) member to join Graduate Nano Committee meetings as a student advocate / representative.
 - No involvement with the nanofellowships program from the Graduate Nano Committee is needed because the nanofellowships program is run by the Waterloo Institute for Nanotechnology (WIN).
7. **Graduate Funding Model:** *The graduate funding model should be revisited and revised to meet the needs of the graduate students. In addition, the member departments should provide a small annual flexible fund to the program for enabling nano-program centric activities, such as seminars and workshops that involve the students.*

Response

- The graduate funding model is outside the scope of the Graduate Nano Committee mandate.
- Maintain WINGSS' responsibility for creating an annual plan and budget for nano-program centric activities, such as seminars and workshops, and approaching the Program Director to request funding.
- Require WINGSS to continue developing annual budgets rather than engaging in long-term planning that would require multi-year, advanced funding commitments from departments.
- Approach the member department chairs to request investment into the budget, via the Program Director, if he/she approves the WINGSS budget and objectives.
- Maintain the department chairs' ultimate authority to determine the amount of support their department will provide to WINGSS.

Recommendations that were not selected for implementation:

Research Promotion: *The program should consider developing a plan for promoting nanotechnology research to industry. This plan should also include mentorship activities that promote collaborative research between academia and industry.*

Response

- WIN promotes nanotechnology research to industry, and there is no need for the Graduate Nano program to duplicate its efforts.

Implementation Plan:

	Recommendations	Proposed Actions	Responsibility for Leading and Resourcing (if applicable) the Actions	Timeline for addressing Recommendations
1.	<p>Curriculum Authority: The program should consider that the current Graduate Nano Committee receive formal approval and responsibilities on curriculum matters with the aim to revise all courses related to the program.</p>	<ul style="list-style-type: none"> Determine if member department representatives on the Graduate Nano Committee may have responsibility for and authority to approve (minor) Graduate Nano Program core curriculum changes. Determine if, after approval of Curriculum Committee motions by the Graduate Nano Committee, those motions could be forwarded directly to the Faculty level – ensuring the opportunity for departmental review of changes while eliminating the time-consuming process now required to attain formal multi-departmental approval. If possible, grant authority to Graduate Nano Committee to approve curriculum matters in the program 	<p>Program Director</p> <p>Program Director</p> <p>Deans and Chairs</p>	<p>Update: we are unable to make these changes.</p> <p>Update: we are unable to make these changes.</p> <p>Update: we are unable to make these changes.</p>

2.	<p>Full-Time Administrative Coordinator: The program should consider that the administrative coordinator position become permanent. The administrative coordinator should serve in the Graduate Nano Committee and play a leading role in student advisement.</p>	<ul style="list-style-type: none"> • Maintain the administrative coordinator position at a part-time level. • The administrative coordinator is already involved with the Graduate Nano Committee and student advisement, as appropriate, given that member departments advise their own students. The role will continue to act as a single point of contact for program-related questions from students, administrative staff and faculty that cannot be answered at a departmental level. • Assign the administrative coordinator additional tasks related to the administration of the Curriculum Committee, online and recruitment communications, program promotion and administrative documentation. • Monitor the administrative coordinator’s program-related workload. • Approach the associate deans of graduate studies for the Faculties of Science and Engineering via the program director, if evidence indicates that the position requires more time. 	<p>Administrative Coordinator</p> <p>Administrative Coordinator</p> <p>Program Director</p> <p>Program Director</p>	<p>On-going</p> <p>On-going</p> <p>On-going</p> <p>On-going</p>
3.	<p>Departmental Collaboration: The Graduate Nano Committee should work closely with the departments to develop a truly collaborative program by removing inflexible traditional administrative practices and developing effective interdependence among the founding departments. A more coordinated effort between departments and the Graduate Nano Committee should be considered for recruiting students with truly interdisciplinary interest.</p>	<ul style="list-style-type: none"> • Investigate opportunities to invest Graduate Nano Committee members with limited departmental authority to approve changes on behalf of their department to reduce the complexity and increase the speed of the program’s approval process. • Create and maintain within the University’s website a centralized Graduate Nano Program section that includes information about its various degree options. • Collaborate with University- and member department-resources to promote the Graduate Nano Program to potential students. • Work with WINGSS and member departments to coordinate student-centric programs and events that will promote positive student experiences and collaboration among students in member departments. 	<p>Program Director</p> <p>Administrative Coordinator</p> <p>Administrative Coordinator</p> <p>Administrative Coordinator</p>	<p>Update: we are unable to increase our authorities.</p> <p>Completed</p> <p>Ongoing</p> <p>Ongoing</p>

4.	<p>Curriculum Map Task Force: The Graduate Nanotechnology Committee should consider forming a task force to develop a comprehensive curriculum map according to the Quality Assurance Framework and Guidelines of the Ontario Universities Council on Quality Assurance (OUCQA). This will provide the framework for developing clear pathways to achieving the specified program learning outcomes and degree level expectations. A handbook could be developed to provide clear documentation for the incoming students detailing expectations, requirements, time-lines and other important instructions for fulfilling the degree requirements.</p>	<ul style="list-style-type: none"> • Create, with representatives from each member department, a Curriculum Committee that reports to the Graduate Nano Committee. • Develop a comprehensive curriculum map. • Review core course content, delivery and sequencing to ensure that the core course offerings are comprehensive, appropriate and delivered effectively. • Recommend curriculum changes to the Grad Nano Committee. • After clear information for students regarding expectation, requirements, timelines and other important instructions has been posted online in a new Graduate Nano website section, determine if a separate handbook would be useful for students. (See <i>Recommendation</i> – Error! Reference source not found.). 	<p>Program Director</p> <p>Curriculum Committee Curriculum Committee</p> <p>Curriculum Committee</p> <p>Graduate Nano Committee</p>	<p>One term – completed</p> <p>Ongoing – pending departmental approvals</p>
5.	<p>Intensification of Research: The program should consider reducing the number of required courses as partial fulfilment of the degree sought (particularly for PhD) in favour of intensification of research.</p>	<ul style="list-style-type: none"> • Discuss after finalizing the grad course schedule and learning outcomes. • Suggest changes to the Graduate Nano Committee 	<p>Curriculum Committee</p>	<p>Completed – pending departmental approvals</p>

6.	Faculty Support: The supporting Faculties should consider providing more direct support to the program, facilitating institutional organizational structure, providing oversight, student advocacy, compliance, coordination and facilitation of graduate study and post-doctoral fellowship programs.	<ul style="list-style-type: none"> Formalize the current Graduate Nano Program structure through an official document endorsed by the Deans of Science and Engineering. Secure program funding commitment from the two Faculties and six departments involved in the program. Create a governance document that outlines the various commitments, processes and expectations of the departments and Faculties involved in the program. Invite a WINGSS member to join Graduate Nano Committee meetings as a student advocate/representative. No involvement with the nanofellowships program from the Graduate Nano Committee is needed because the nanofellowship program is run by WIN. 	Program Director Program Director Administrative Coordinator Program Director	Pending departmental approvals One year – Mar. 2019 Pending departmental approvals Completed
7.	Graduate Funding Model: The graduate funding model should be revisited and revised to meet the needs of the graduate students. In addition, the central administration should provide a small annual flexible fund to the program for enabling nano-program centric activities, such as seminars and workshops that involve the students.	<ul style="list-style-type: none"> The graduate funding model is outside the scope of the Graduate Nano Committee mandate. Maintain WINGSS' responsibility for creating an annual plan and budget for nano-program centric activities, such as seminars and workshops, and approaching the program director to request funding. Require WINGSS to continue developing annual budgets rather than engaging in long-term planning that would require multi-year, advanced funding commitments from departments. Approach the member department chairs to request investment into the budget, via the program director, if he/she approves the WINGSS budget and objectives. Maintain the department chairs' ultimate authority to determine the amount of support their department will provide to WINGSS. 	Program Director Program Director Program Director Graduate Nano Committee	Ongoing Ongoing Ongoing Ongoing

The Department Chair/Director, in consultation with the Dean of the Faculty shall be responsible for monitoring the Implementation Plan.

Date of next program review:

2022-2023

Date

Signatures of Approval:



26 Oct. 2018

Chair/Director

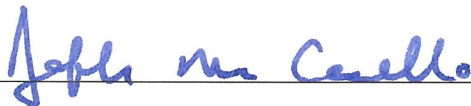
Date

AFIW Administrative Dean/Head (For AFIW programs only)

Date


Faculty Dean R.P. Lemieux
Dean of Science
P. Sullivan
Dean of Engineering Date29 Oct 2018Associate Vice-President, Academic
(For undergraduate and augmented programs)

Date

13 November 2018Associate Vice-President, Graduate Studies and Postdoctoral Affairs
(For graduate and augmented programs)

Date