

# Faculty of Mathematics and Science

## Academic Plan to 2014

(Revised: September 22, 2008)

### I. Vision & Mission

#### Vision:

The Faculty of Mathematics and Science is determined to be an **internationally recognized centre of excellence in education, research, innovation, and creativity**, as well as a **major partner in the development of the Niagara Region** by 2014. It is committed to playing a leading role in the growth of Brock University into a comprehensive institution.

#### Mission:

Our purpose is the advancement of mathematics and the sciences by engaging undergraduate and graduate students, staff, and faculty in research and in the learning process. We create a scholarly environment in which our research, based on solid scientific methodologies, aims to expand the frontiers of discovery and knowledge. We integrate teaching, learning and research at undergraduate and postgraduate levels. Our students will be responsible citizens who possess the skills of enquiry and the ability to critically evaluate and to disseminate scientific knowledge.

The Faculty of Mathematics and Science is committed to increasing opportunities in both fundamental and applied areas of our disciplines. We feel that the time is ripe to expand our presence in the community by supporting the type of applied research and development that will provide opportunities for graduates of Brock University to find employment in the region that utilizes their skills. At the same time, we are adamant that the current high quality undergraduate programs must be maintained and enhanced in several areas. We are dedicated to helping Brock University to become an engine of growth and development for the new knowledge-based industries that will determine Canada's future as a leader in the new economy.

### II. Analysis

#### Strengths:

Strengths in the Faculty of Mathematics and Science put us in an excellent position to achieve our vision. Our strengths include:

- **Teaching and research** are integrated. The roles of undergraduates, graduates, staff, and faculty are inextricably woven together in our programs.
- **Interdisciplinary undergraduate programs** include: Biochemistry, Biophysics, Biology/Psychology, Chemistry/Biology, Biomedical Sciences, Computer Science/Business, Physics/Biology/Psychology, Neuroscience, Biotechnology, COSC/VISA and engagement with IASC through the Centre for Digital Humanities.
- **Innovative and applied programs** within the Faculty and between Faculties include: Biotechnology, Green Chemistry, Oenology and Viticulture (OEVI), Mathematics Integrated with Computer Applications (MICA), B.Sc./B.Ed. programs in several disciplinary areas, and a stream of Earth Sciences that provides the courses that

ultimately lead to a professional designation by the Association of Professional Geoscientists of Ontario. Recent innovations in courses include the development of the B.Sc./MBA in Biotechnology. A proposed minor in applied computing is under review.

- **Articulation programs** exist between departments in the Faculty with various Colleges in Ontario, including Niagara, Sheridan, and the Radio College of Canada, for a variety of programs, including Computer Science, Chemistry and Physics. Novel programs include a Combined Degree/Diploma in Computing and Network Communications and an honours degree in Physics with concentration in Applied Optics and Laser Technology.
- **Graduate programs** are well supported by the Faculty of Mathematics, with all six of our departments and one of our centres participating. Such programs include M.Sc. programs in Biological Sciences, Biotechnology, Chemistry, Computer Science, Earth Sciences, Mathematics and Statistics, and Physics, and Ph.D. programs in Biological Sciences, Biotechnology and Chemistry. We have seen dramatic growth in graduate enrollments in the past five years.
- **Adjunct appointments** provide resources and collaborative opportunities. These include appointments of Brock professors to other universities (Guelph, McMaster, Toronto) and appointments of adjunct professors to Brock (from Guelph, National Water Research Institute, Agriculture Canada) strengthen research and linkages to other institutions across Ontario.
- **International collaborations** between faculty members at Brock and other universities and research institutes enrich the investigations of faculty members (for example: Max Planck Institutes in Berlin, Stuttgart, Czech Academy of Sciences in Prague, Fraunhofer Institute for Biomedical Research, Centre Nationale de Recherche Scientifique de France, Université de Pau et des Pays de l'Adour, Sheffield University, UK, Cambridge, UK, Comenius University Bratislava, Slovakia, NATO, European Union).
- **Publication output** is very high in Mathematics & Science and indicates vitality and excellence. Publications in high-impact journals continue to grow.
- **Memberships of national and international committees** of scientific societies and memberships of editorial boards of international journals indicate the high esteem in which our faculty members are held by a wide variety of scientific organizations.
- **Awards** to members of the Faculty include both teaching and research awards: Canada Research Chairs, Premier's Research Excellence Awards, 3M Teaching Awards, OCUFA awards, NRC award for Innovation, Polanyi Award and Pouliot Award.
- Holding **patents** is a measure of the inventive capacity for members of the Faculty. Patents are held by a number of faculty members and the number will undoubtedly increase. At this time, Profs. Haj-Ahmad, Hudlicky, Inglis, Brindle and Razavi hold patents.
- The Faculty's success with **placing students** nationally and internationally into graduate programs speaks to the quality of both our students and our programs.
- **Technical support** from the machine shop, electronics shop, glassblowers and science stores facilitates research and provides innovation and design that helps researchers realize novel projects.
- **Tutoring programs** for undergraduate students, including StudyWrite and Students for Students (in Biological Sciences) aim to improve student retention.

- **Outreach programs** such as Scientifically Yours, the Mentoring Program with the District School Board of Niagara (DSBN), Physics Enrichment Program with DSBN and the Catholic School Board of Niagara, annual Scholarship Exams with DSBN, Aboriginal Math Camp, Esso/CMS camps and interactions with the Science Teachers Association of Ontario (STAO) and the Niagara Regional Science Fair encourage youths to study mathematics and science and help attract high quality students to Brock University.
- Teacher professional development programs such as Physics Teachers' Workshop help to maintain the dialog with the Science teachers of the region and to help attract top local students to Brock.

### **Challenges:**

Challenges that impede the Faculty of Mathematics and Science from performing its mission and achieving its full vision include:

- Lack of adequate **space for research**, specifically wet-lab space, is limiting the research capacity (i.e. numbers of graduate and undergraduate students) of a majority of faculty members. This coincides with similar space needs for research and teaching in Applied Health Sciences.
- Growth in **undergraduate enrolments** (i.e. **majors**) has not kept pace with other faculties and needs to increase.
- From 2000/01 to 2006/07, student FTEs in Mathematics and Science rose by 25%, but faculty FTEs rose by only 18%. As a result, our **student:faculty ratio** rose to 27.1. Much of the increase is due to service teaching. The workload currently limits some departments (e.g. Earth Sciences and Physics) from expanding their graduate programs.
- Growth in graduate programs has already **increased faculty workload** in some departments due to inclusion of new graduate courses.
- **Student advising** is generally performed by faculty members in each department, often on an *ad hoc* basis. This exacerbates workload issues, reduces time for teaching and research and does not always ensure quality advising.
- Increases in undergraduate and graduate course enrollments have increased the workload of support staff (senior lab demonstrators and administrative assistants).

### **Opportunities:**

- A number of **research and development initiatives** are growing across the faculty and these include, *inter alia*, a **materials science** interdisciplinary research effort, combining forces from Physics, and Chemistry; interactions with the European Space Agency, capitalizing on existing relationships with Frank Fueten of the Department of Earth Sciences; Industrial research involving various companies and faculty members (Xerox and Melanie Pilkington), (**Agricultural** chemical companies and Vincenzo DeLuca and Charles Despres), (**Pharmaceutical** companies with Tomas Hudlicky, Travis Dudding, Jeffrey Atkinson), (**commodity chemicals** companies, such as detergent manufacturers, with Paul Zelisko), PerkinElmer Corporation with Brindle, the Ontario **Grape and Wine** industry with Reynolds, Pickering, Inglis, and Lesschaeve. New research opportunities are developing in the **environmental** area between, for example, the Ontario Ministry of the Environment (MOE) and Dan McCarthy relating to air pollution monitoring; MOE has reestablished a relationship with Ian Brindle and they are collaborating on analytical method development for trace elements and also on trace organics in the Niagara River –

The National Water Research Institute is also partnering in this venture. Martin Head, Professor of Earth Sciences, recently appointed from Cambridge University, is developing relationships with the oil exploration industry and with researchers engaged in the study of climate change. Fiona Hunter and Mike Bidochka will develop their work on insect-borne diseases and they will continue to develop their research on the West Nile Virus.

- The Faculty of Mathematics and Science is in the middle of **growing its graduate studies and research programs**. There are new M.Sc. programs in Computer Science and Mathematics and Ph.D. programs in Biological Sciences, Chemistry and Biotechnology. Given our success in technology transfer and our growing ventures in research and development, there are opportunities to expand graduate programs, particularly in applied areas. Our increased funding will allow increased graduate enrolments if more wet lab space is acquired.
- New opportunities in the **undergraduate domain** include the recent introduction of a new program in photonics (in cooperation with Niagara College) and a new program in Biophysics. The Department of Physics has just appointed a new tenure-track faculty member, Thad Harroun, to develop and sustain the latter program. There are potential opportunities to develop new programs, such as a B.Sc./MBA program in Biotechnology, an engineering program and new articulated programs with Niagara College in areas such as Earth Science and Oenology & Viticulture.
- As **high school curricula** are reviewed across the disciplines in Ontario, faculty members from various departments will engage with this process to provide appropriate input, including curriculum design, that will provide a university focus and hence an opportunity to steer good students towards the sciences.

### **III. Academic Strategic Plan**

The following is our plan to make the Faculty of Mathematics and Science an internationally recognized centre of excellence in education, research, innovation, and creativity, and a major partner in the development of the Niagara Region by 2014.

#### **OBJECTIVES:**

##### **Research**

- 1. Ensure that there is sufficient space for researchers across the Faculty**
- 2. Improve funding opportunities for research**
- 3. Establish a climate in which faculty can develop to their fullest intellectual potential**

##### **Graduate Studies**

- 1. Develop new graduate programs and help established M.Sc. programs evolve into Ph.D. programs**
- 2. Improve existing graduate programs**

##### **Teaching and Learning**

- 1. Develop new undergraduate programs across the Faculty to attract new constituencies of students**
- 2. Strengthen existing undergraduate programs**
- 3. Improve intake and retention of undergraduate students**

##### **Community Outreach**

1. **Expand services to the community to increase awareness of Mathematics and Science in the Niagara Region and beyond**

## **PLAN TO ACHIEVE OBJECTIVES:**

### **RESEARCH**

1. **Increase wet lab space for research:**

We will work with the Vice President Research and Vice President Advancement to secure funding for a new building to provide space for researchers from the Departments of Biological Sciences and Chemistry and for research and teaching labs in Applied Health Sciences. Because much of this space will be utilized by graduate and undergraduate students, this objective will also have a positive impact on Graduate Studies, Teaching and Learning.

2. **Improve funding opportunities for research**

The Faculty of Mathematics and Science has just hired a new Faculty Advancement Officer who is working with the Office of Advancement to seek new sources of funding for infrastructure, endowments, and researchers. We will seek **endowed chairs and professorships** in areas where we currently have academic strength, as indicated by success in publications and research grants. Such areas of strength include Biotechnology, Green Chemistry, Mathematics Integrated with Computer Applications (MICA), Neuroscience, Oenology & Viticulture (OEVI) and Physics.

3. **Establish a climate in which faculty can develop to their fullest intellectual potential**

- a. The Faculty of Mathematics and Science will designate an **Associate Dean (Research & Graduate Studies)** who will:
  - (i) enhance the research culture in the Faculty of Mathematics and Science by overseeing all research activities
  - (ii) actively encourage faculty members to secure external research funding
  - (iii) act as a liaison with Research Services to up-date faculty members on new funding opportunities
  - (iv) ensure that all grant proposals in Mathematics and Science are prepared in a timely manner and are read by experts and non-experts before submission to Research Services
  - (v) oversee graduate programs in the Faculty of Mathematics and Science and act as liaison with the Faculty of Graduate Studies.

The Associate Dean (Research & Graduate Studies) will report to the Dean of Mathematics and Science and will receive a teaching reduction equivalent to two half-courses.

- b. The Faculty of Mathematics and Science will develop **lecture series** for all departments, bringing in internationally recognized scholars
- c. We will develop a more formal **mentoring** program for new faculty members.
- d. We will work with the Vice President Research to expand opportunities for faculty members to organize regional, national and international **conferences** at Brock University, to provide seed grants for development of new ideas from faculty members,

and to develop funding mechanisms to ensure research continuity for faculty members who have lost research funding.

- e. We will develop thematic areas of excellence within and between Faculties. Possible areas might include:
  - (i) a forensic concentration, which could be articulated with studies in criminology,
  - (ii) Environmental Studies, which could be better consolidated than it is at present,
  - (iii) statistics expertise, which is scattered across the university; since the topic is in great demand, opportunities exist for a consultancy service run by students, as well as a centre for statistics that would comprise of members of the various Faculties across the University,
  - (iv) research on development of plants and microorganisms for the production of value-added products, such as pharmaceuticals and antibodies, could be consolidated into a Centre, involving our Canada Research Chairs in Biological Sciences and Chemistry,
  - (v) research on wine, industry and tourism.

## GRADUATE STUDIES

### 1. **Improve existing graduate programs**

- a. The Faculty of Mathematics and Science will continue to provide **financial support to graduate students** through fellowships. Additional sources of finance for graduate students will be needed to foster the growth of the graduate/research enterprise at Brock University until it becomes self-sustaining. We will work with the Faculty of Graduate Studies to identify funding opportunities for graduate students in areas that are normally relatively poorly funded by granting agencies such as Computer Science and Mathematics. We will encourage students to apply for more prestigious national and international scholarships from appropriate agencies (NSERC, Killam, Commonwealth, NATO, etc.).
- b. The Faculty of Mathematics and Science will work with the Offices of Graduate Studies, Recruitment and Liaison, and the University Office of Communications to develop recruitment programs for **attracting high-calibre graduate students** in all areas of research.
- c. We are currently assessing capacity for graduate students in all departments within Mathematics and Science. We will encourage faculty to train the maximum number of graduate students allowed by their research grants and to apply for larger research grants to **increase capacity**. Faculty members whose capacity is limited by space will be able to increase capacity when the proposed building for Life and Applied Health Sciences is completed. We will also work with faculty members to maximize the number of graduate students in Ph.D. programs.
- d. With graduate student basic income units fully funded under provincial funding programs, we will ensure that faculty appointments are consistent with research programs in departments that reflect the importance of graduate programs.

### 2. **Develop new graduate programs in key areas:**

Several units have expressed a desire to develop **new M.Sc. and programs**. Examples include course-based M.Sc. programs in Earth Sciences and Mathematics, a research-based M.Sc. program in Neuroscience and a Ph.D. program in Earth Sciences and Physics. The Faculty of Mathematics and Science will encourage and assist departments and centres in developing new programs where strength and resources are sufficient.

## TEACHING AND LEARNING

### 1. Strengthen existing undergraduate programs

The Faculty of Mathematics and Sciences will endeavor to renew **faculty** appointments by hiring faculty of the highest quality in key areas. We will service, maintain, up-date and replace **equipment** in our undergraduate teaching labs as necessary in order to provide high quality experiential learning as part of our programs.

### 2. Improve intake and retention of undergraduate students

- a. We will work with the **Co-op** Office to improve the quality of co-op placements in our programs.
- b. We will work with **CTLET** on course delivery to improve pedagogy.
- c. We will work with departments and centres to ensure that undergraduate students have sufficient access to **academic advising** in order to improve retention.
- d. In an effort to attract a larger number of students to Mathematics and Science at Brock, we propose to work with the Faculty of Education to design and deliver courses that train teachers in the field of **science education** at the elementary to high school levels. These courses would differ from those regularly offered within the Faculty of Mathematics and Science and will focus on
  - generating interest in the physical sciences for education students preparing to teach at the elementary/junior/high school levels,
  - learning processes rather than memorizing scientific facts and formulas,
  - promoting scientific methods and lines of inquiry.
- e. We will work closely with Recruitment and Liaison to **advertise** programs to increase enrolments. We will pay particular attention to programs such as Biophysics, Chemistry, Oenology and Viticulture and Physics, and on new programs, such as Applied Physics & Photonics, which is offered in conjunction with Niagara College.

### 3. Develop new undergraduate programs

- a. We are currently discussing the development of a 2+2 program in computer science with Algol College (Guragon, India). We will explore other possibilities for articulated programs involving institutions in other countries.
- b. We will seek **certification** from the Canadian Statistics Society for graduates of the statistical stream of graduates from the Department of Mathematics.
- c. We will explore the possibility of developing an undergraduate program in **Bioinformatics**, since many of our faculty members in the Departments of Biology, Chemistry and Computer Science have research and/or teaching activities related to this field.
- d. We will explore the possibility of developing a new undergraduate program in **Engineering**. This will require a feasibility study to determine (1) whether such a

program could be approved and certified, (2) interest among potential applicants, particularly Niagara, Hamilton and the greater Toronto areas, (3) potential markets for graduates. A new program would have to build on existing academic strengths at Brock, particularly in Mathematics and Sciences. Our current strengths suggest that such a program might focus on one of several areas, such as process engineering (involving biotechnology, biological sciences, chemistry, and OEVI) or materials science (involving chemistry and physics). We will explore the possibility of articulating such a program with one or more colleges that could contribute expertise and experiential components to the program.

## COMMUNITY OUTREACH

1. **Expand services to the community to increase awareness of Mathematics and Science in the Niagara Region and beyond**
  - a. Each year many international scholars from other universities work and/or train at Brock in the Faculty of Mathematics and Science. We will encourage **international collaborations**, faculty visits to other universities and graduate student exchanges with researchers at universities abroad. The recent announcement of an articulation agreement with SUNY at Buffalo encourages us to explore the possibility of offering joint courses in strategic areas where research collaborations already exist.
  - b. The Cool Climate Oenology and Viticulture Institute (CCOVI) is dedicated to the **advancement of the Canadian grape and wine industry**, as well as other cool climate grape and wine producing regions of the world. We will work with the Office of Research Services to secure two senior scientists to help CCOVI to respond to local and regional industrial needs for directed research and liaison. Brock will also collaborate with the Vineland Research and Innovation Centre, Niagara College and the University of Guelph to establish a wine cluster that will promote research in oenology and viticulture nationally and internationally.
  - c. Development of **high-quality communication** is essential for the well being of Brock. Our visibility in Ontario, Canada, and the world will ensure recruitment of high-calibre people at all levels, from students to senior administrators. We will work to improve exposure of Brock experts to the media. Brock people must have media awareness and training so that their presence will enhance the visibility of Brock University. We will also encourage faculty members to publish papers in the most visible high-profile journals, which will provide Communications with talking points for media attention.
  - d. In 2006/07, the Faculty of Mathematics and Science established a Dean's Network **lecture series** to bring faculty members together with representatives of local businesses and local and regional governments. The lectures deal with the impact of science on society and serve as a focal point for encouraging collaborations between academics and industry, technology transfer and innovative business ventures. The series will be continued and, hopefully, expanded.
  - e. We will encourage faculty members to participate in local committees where their expertise can provide added value to these committees by their presence.