



**Internal Academic Review 2007-2008**  
**Department of Mechanical and Materials Engineering**  
**Internal Academic Review Committee Report to Senate**

The Internal Academic Review (IAR) of the Department of Mechanical and Materials Engineering (MME) is now complete. The Internal Academic Review Committee (IARC) has taken into consideration all of the IAR submissions related to the Department and respectfully submits the following report. The IARC Report to Senate is intended to supplement the findings of the attached Review Team Report and to provide a mechanism for the Head of the Department and the Dean of the Faculty of Applied Science to report jointly on the progress in addressing the Review Team recommendations.

**Summary of the Internal Academic Review of the Department of Mechanical and Materials Engineering (MME)**

The Internal Academic Review Committee (IARC) acknowledges the Department of MME's positive reputation and commends the Department for its excellence in teaching, research and service to industry.

The IARC acknowledges the Department's achievements in offering a stimulating academic program in both undergraduate and graduate studies. The IARC agrees with the reviewers' recommendation that the Department formulate a strategic plan to determine academic priorities for the future. The IARC supports the idea of the Department engaging in an analysis of the relationships between areas of traditional discipline strength in manufacturing design and systems and other areas of innovation within the Department to identify synergies that can be integrated into the curriculum.

The strength of the undergraduate program in the Department of MME is noted in the reviewers' reports. The IARC joins reviewers in their recommendation that the Department continue to enhance the quality of existing undergraduate programs and avoid expanding programs at this time. The IARC also agrees with the recommendation that the Department of MME continue to provide graduate students with a stimulating learning environment, develop a strategy to increase PhD enrolment, and introduce mechanisms for student retention that will contribute to the overall vitality of the graduate program.

The IARC noted the reviewers' recommendation that the Department remain aware of the declining proportion of female students and seek ways to foster a greater diversity in student enrolment in the undergraduate program.

The IARC agrees with the reviewers' recognition that the Department of Mechanical and Materials Engineering is strong in the fundamentals of teaching and research. The IARC

supports the recommendation that the Department use the development of a strategic plan to explore new ways to address the challenges related to space and sustainability, and seek opportunities to work with the Faculty of Applied Science to address future challenges and opportunities.

**Outcomes of the Internal Academic Review  
for the Department of Mechanical and Materials Engineering**

*submitted jointly by the  
Dean of the Faculty of Applied Science  
and the  
Head of the Department of Mechanical and Materials Engineering*

The Dean of the Faculty of Applied Science and the Head of the Department of Mechanical and Materials Engineering welcome the positive review of the department's activities by the IARC. We have set several processes in motion to address the specific recommendations of the committee.

1. Strategic Plan:

The Faculty of Applied Science undertook the development of a strategic plan in 2007/08 at the same time as the internal academic review of the department was being conducted. Our plan, which was approved by the Applied Science Faculty Board in January 2009, will guide the development of the Faculty in the coming years and serve as an overarching roadmap within which departments can align their distinctive program requirements. The strategic plan of the Department of Mechanical and Materials Engineering is in preparation with an expected completion date in early 2010.

2. Space

The Department is currently scattered over eight buildings (McLaughlin Hall, Nicol Hall, Jackson Hall, Walter Light Hall, Beamish Munro Hall, Hotel Dieu Hospital, Kingston General Hospital and the City's Industrial Park on Grant Timmins Drive). Much of this space is inadequate for our needs in that it is old, poorly configured and lacking essential laboratory services. The dispersed nature of department activities has limited significantly the interaction between students and professors. Existing resources are duplicated and used inefficiently. A new Applied Science building will be constructed in the near future providing an opportunity to consolidate many of our activities. This is a priority in our strategic plan.

3. Undergraduate Curriculum

The Department currently offers three options – ME1 Mechanical Engineering and ME2 Materials Engineering and, new in 2009, a third option, ME3 Biomechanical Engineering. The addition of a third option runs counter to the recommendation of the IARC. However, this new option is a strategic response by the department to the

growing demand from students for studies in the field of biomechanical engineering. It capitalizes on an area of strength within the department. It is also consistent with our diversity goal to promote programs that are attractive to women with a view to increasing the number of women choosing engineering as a career. This objective is very much in keeping with another recommendation by the IARC.

The ME2 option was created with the closure of the department of Metallurgical Engineering. In creating such an option the Faculty acknowledged that there was not sufficient demand to mount a program in Metallurgical Engineering but believed that there was a core of students in a Mechanical Engineering program who would benefit from a grounding in the fundamentals of the metallurgical engineering discipline. The student experience is not uniform over the three options. The majority of students still take the traditional mechanical engineering option ME1 which has seen a reduction in faculty over the last few years. This continues to be a challenge. Getting the right mix of course offerings will occupy a prominent place in our strategic planning. A major review of curriculum, led by the Associate Dean (Academic), is taking place for all programs in the Faculty of Applied Science.

#### 4. Graduate Program

Achieving a more Ph.D.-intensive graduate student population continues to be a challenge given our close ties with the external engineering profession. While we are actively recruiting graduate students and are cognizant of the pressure to increase the proportion of our graduate population that is registered in Ph.D. programs, many of our faculty do applied research for industrial clients. In such cases students in master's programs are better equipped to satisfy the educational requirements of the degree together with the shorter period of time of turnaround time that is an expectation of our clients. For that reason master's students will continue to be an integral part of our educational programming objectives.

#### 5. Sustainability

It is difficult to continue to sustain programs where the cost of program delivery outpaces program revenues. Budgets are being cut and positions closed at a time when enrolment is growing. The largest class in the department's history will be welcomed in September 2009. Inevitably, there will be some erosion in our ability to accommodate such numbers without affecting the quality of the student's learning environment. The Dean and department in partnership are actively seeking support from our alumni to raise the funding required to sustain our programs of engineering education and research. A new building will provide badly needed facilities to cope with our growing enrolment

#### **Attachment:**

Review Team Report

## Report to IARC by Internal Academic Review Team for Mechanical and Materials Engineering, Winter 2008

### 1. Team Membership

The IAR team membership was as follows:

Keith Banting, Tiago Falk, Martin Guay, Hoi Lam, Betsy MacDonald, Ian Moore (Chair), Hilary Sirman

### 2. Documents provided for consideration

#### 2.1 *Report from MME: Self-study*

In general the self-study followed the Senate guidelines (at <http://www.queensu.ca/secretariat/senate/policies/iarrev/index.html>). However, the committee was concerned that the self-study did not provide all of the needed information, and identified several specific limitations:

- a. The first section of the document does not explicitly provide

‘Standards, including definition of indicators that provide evidence of quality of faculty, student demand (applications and registrations), student quality, the outcomes of the program (graduation rate, length of studies, etc.) and achievement of its learning objectives, against which the program or unit wishes to be judged together with the justification for these standards. Examples of national and international programs in same field which provide useful reference points for comparison together with the rationale for the choice’.

- b. The document does provide a general discussion regarding QU equity policies, but does not explicitly provide

‘information on how the program has addressed the equity goals of the University including the mechanisms by which the program addresses equity issues, including any identified inequities; the most recent equity audit; relevant questions from USAT and from the exit poll’.

- c. The document does not provide a ‘Summary table of numbers of completed research publications by category’

In addition, the review team requested answers to the following in an email dated November 15th but did not receive answers:

- The department’s perspective on exit polls of student satisfaction (including decreases in performance relative to the ‘research skills’ question)

- Information on median times to completion for masters and doctoral degrees
- Information regarding the status of the three new courses that were to be offered in 2007 (impacting whether the 'breadth' of the program, identified as a strength, is being maintained)
- Information on how the department responded to the previous IAR request to further develop specific areas of research focus and strength. This is implicitly covered in the documents, but some explicit statements would have been valuable.

The committee asked and received answers to the following questions (not formally, but during the site visit by consultants)

- Information on plans for unspent funds from Alumni donations relative to equipment or facilities development
- The reason for students obtaining noticeably higher grades in their fourth year
- Which professors or research areas are being adversely influenced by space constraints? Which aspects of the undergraduate program are being adversely affected? The provision of specifics would have facilitated an objective assessment of this issue.

## **2.2 Report from External Consultants**

The external consultants have prepared a thorough, constructively critical but generally sympathetic assessment of the department. Though this report does not require repeating here, a summary of some specific general observations is worthwhile:

- The consultants confirm that the department offers one of the leading Undergraduate programs in MME in Canada (its national reputation is 'very high')
- The department is encouraged to embrace the institutional vision, including a more international focus
- The consultants indicate that student-staff ratios are poor, though the data supporting this was not provided (this is true of some other departments in Applied Science at Queen's so their conclusion is believed to be accurate)
- Improvements in curriculum efficiency are possible, leading to reduced workloads (workload is currently assessed as 'unsustainable')
- Concerns were expressed regarding the number of withdrawals from the MSc and PhD programs
- The consultants imply that the current space per faculty member is adequate by national standards. Space was not seen as a problem for junior faculty (Asst Profs) whereas mid-career and senior faculty expressed concern; this may be because the junior faculty members are given priority, or because they have not been caught up in the department's focus on the need for more space.

- Funding for equipment maintenance and reinvestment was judged to be poor relative to Ontario averages (this is also a problem in other Applied Science departments)
- The esprit de corps is generally strong, with good rapport between staff, faculty and students

The consultants provided 23 specific recommendations.

### **2.3 Reports from Dean of Applied Science and Head of Department**

Both Dean and Acting Head support the facts expressed in the report from the consultants. In addition, the Dean indicates her intention to support the department, identifying space issues as 'critical', and stating that 'top priority will be given by the Faculty of Applied Science to increase faculty and staff complement' in MME. Neither of these commitments is seen to arise from key recommendations from the consultants. Instead, it reflects the department's self-assessment. Interestingly, MME is not understood by the IAR Team to be the department in Applied Science with the worst student to faculty ratios, so the Dean's commitment to the department regarding personnel indicates that the former and current (acting) department Heads have succeeded in articulating the department's needs admirably.

## **3. Review team assessment**

### **3.1 Undergraduate and Graduate Academic Programs**

The undergraduate program in Mechanical and Materials Engineering is clearly one of the strengths of the Department. In the judgment of the external reviewers report, the undergraduate program "is one of the most highly regarded in Canada and has been the subject of considerable staff investment for a number of decades," (p.4). The reviewers encourage the department to maintain its strong focus on design and manufacture, including the exposure of students to machine-shop related activities.

The external reviewers do underscore the extent to which the undergraduate program is negatively affected by the overall resource pressures on the department, especially the constraints on faculty resources, space, facilities and equipment. Similar concerns were raised by the Canadian Engineering Accreditation Board (CEAB). As noted earlier, the external reviewers are concerned about the challenge of delivering quality undergraduate and graduate programming with "a relatively poor student-Faculty ratio compared to other Canadian ME departments" (p. 3). They also comment on the lack of sustainable funding for the workshop and equipment generally, noting that the "allocation from operating funds for equipment is one-fifth the Ontario average" (p. 9).

We are concerned that the pressures on the undergraduate program are likely to grow as the department seeks to enhance its graduate program and its research profile. Balancing these priorities will require careful management. In this context, the Team supports the suggestion from the external reviewers that the department develop a more strategic

approach to the deployment of faculty, reviewing the delivery of modules with low student numbers and making the selection of courses to be offered “option (stream) rather than Faculty driven.”

### **3.2 *Scholarship and Research***

The department of mechanical engineering has experienced significant growth of its research portfolio in the last seven years. Based on the evidence provided, it would appear that this growth is the result of a concerted effort to hire high quality faculty members, to support the existing faculty, and to build strategic research groups and centres.

The department is involved in nationally or internationally recognized research studies in

- a. Biomedical engineering through the Human mobility research centre (HMRC)
- b. Materials engineering including the Centre for Manufacturing of Advanced Ceramics and Nanomaterials (CMACN)
- c. Energy and fluids research including the Fuel Cell Research Centre (FCRC)
- d. Manufacturing, Dynamic Systems and Design

The department has three centres that are developing strong external identity (those mentioned in a. to c. above). Furthermore, the department has spearheaded the development of the Collaborative Graduate Program in Computational Engineering and Science at Queen’s (an initiative to build expertise and identity across a large number of disciplines in Kingston). These initiatives are the means to develop strong national and international profile for the department’s research and graduate training activities.

The junior faculty members, and the recently tenured faculty members, have performed well in terms of external funding, which would explain the recent increase. This also reflects positively on the research output of the department. It remains difficult to assess the performance of the department in comparison to other mechanical engineering departments in Canada and abroad. As highlighted by the external reviewers, the department does not appear to have clear metrics to evaluate its own impact both nationally and internationally. The department needs to define clearer research objectives.

The manufacturing researchers are strongly encouraged to further develop their collective identity. This will involve obtaining team research grants from NSERC and other agencies, building group infrastructure through NSERC RTI and CFI grants, and creating joint websites and other promotional material.

We believe the Department can use its website to communicate its research strengths much more effectively. The website is limited to the following statement regarding research:

“Current information about projects, innovations and research in this department, research centres, and activities listed by faculty”. While the individual faculty profiles are listed in topic areas, the department is encouraged to present its research studies in a much more cohesive fashion.

The ‘graduates’ section of the website is similarly limited. It simply instructs viewers to “Please explore the site and discover all of the resources available” by which the total website is meant, not the subset pertaining to graduate studies which simply has links to the Online pre-application form, the New Collaborative Program in Computational Science and Engineering, and encouragement for website visitors to “Read through the Research by Faculty for Mechanical and Materials Engineering to identify potential areas of interest and supervisors”. Graduate research activity is not presented in theme areas and visitors to the website are again asked to put the pieces together themselves to interpret whether the department offers graduate research with a “critical mass” in fields of interest to potential applicants. In a period of vigorous competition for graduate students, this could be presented better.

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

The consultants confirm that the learning environment in MME at Queen’s has some unique or uncommon attributes, including the continued availability of the machine shop where students obtain excellent experiential learning. The consultants clearly value the department’s ‘rich and stimulating environment’ and they encourage continued emphasis on ‘design and manufacture’.

The Internal Academic Review team supports the recommendations from the External Consultants with regard to teaching and learning. Specifically,

- The Department should focus on the existing curriculum rather than expansion, streamlining what they teach to use resources more efficiently.
- The Department should focus on its excellent reputation in design and manufacture as this is an important and unique contribution to the teaching and learning environment at Queen’s.
- The Department is encouraged to fund raise for student teaching resources (e.g., T.A. support, lab equipment, etc.) rather than exclusively on a new physical building.
- The Department is encouraged to have more presence in the Integrated Learning Centre, allowing them more participation in institutional activity and providing more resources for labs.
- The Department should also place emphasis on learning of faculty, especially providing training for effective leadership and governance for the future.



In relation to equity, the proportion of female participants in the undergraduate program has declined from over 20 percent at the turn of the century to less than 15 percent in 2006 (Appendix J). Unfortunately, as stated earlier, the Department does not address this question effectively in its own IAR report. The section on equity is limited to a description of the university-wide procedures and a very brief and general paragraph on possible innovations; and the Department's final self-evaluation of the strengths and weaknesses does not raise the issue.

We encourage the Department to address this issue more directly. The external reviewers recommend that the department "implement policies that will encourage female UG enrolment within the discipline and provide best practice in the area." However, they are silent on what these policies and practices might be. In this context, the department might find guidance in the report of its own Advisory Council (Appendix A). Feedback from students emphasized the importance of "more female mentors and professors," while feedback from faculty pointed to the "existing frosh week culture" and the need for involving female graduates during the Department's own orientation activities. A recommendation was made by the department's Advisory Council in 2006 to continue recruiting more females into engineering and the Mechanical & Materials stream, in particular. The Council recommended that consideration be given to expanding the department's orientation sessions to include a broader perspective on women in mechanical engineering. From a community and societal perspective, further engagement of the department with Queen's Applied Science initiatives such as the annual Women in Engineering Conference may further help in promoting to prospective students how a mechanical engineering degree can fit with their career expectations and personal goals.

A review of the curriculum vitae of the department's current faculty demonstrates a highly qualified and proficient team of nationally and internationally recognized academic staff. Their level of expertise and experience in the field fosters a positive impact on the professional and social development of students as evinced by the Exit Poll survey data of the last 7 years. From 2004-2006, student respondents to the annual Exit Poll show an increase from 39% to 55% when asked if their experience in the department strongly contributed to their sensitivity to ethical issues. It is worth noting that this percentage is higher than results for the same question asked of the entire Faculty of Applied Science (42% in 2006) and just under that of Queen's University as a whole (62% in 2006). When asked in 2006 if the department strongly contributed to their development in the following areas, the percentage of MME students who responded in favour was as follows: awareness of political and social issues (39%); rights and responsibilities of citizenship (25%); and appreciation of other races, cultures and religions (36%). In these areas the department is somewhat behind the favourable responses provided by University community as a whole (political and social issues – 53%; citizenship responsibilities – 43%; and appreciation of other races, cultures and religions – 53%). However, given these same responses for Applied Science (27%, 22% and 30% in each respective question area), the MME Department is rated slightly higher than that of responses for the entire student body within the Faculty across all disciplines in 2006.

One other concern regards the department's perspective regarding USAT scores for undergraduate teaching. The Department's average USAT scores on the four key questions fell below the averages for the Faculty of Applied Science and for the University as a whole in every term of every year between 2002 and 2006 (Appendix L). To be sure, there are more positive indicators as well. The Department scores comparatively well in the Exit Polls, suggesting perhaps student assessments have improved by the end of their programs (Appendix K); and the external reviewers report considerable enthusiasm among undergraduate students they met (p. 11). Nevertheless, we suggest that the department carefully consider its USAT results in a comparative context, and take any necessary steps to ensure that the reputation of the undergraduate remain strong.

### *3.4 Service to the University, the profession and the community*

Although the external review suggests briefly that educating students is the major service that the MME Department provides, it is important to note the other areas in which the department currently does, and could in future, contribute in a service function.

In their internal review materials, the department itself notes that "Our purpose is to educate engineers who will be leaders and practitioners in our society, primarily in industry and business, but also in engineering research and development, and in education and public service". They further indicate an increased demand among students for a Mechanical & Materials Engineering degree in recent years (enrolment rising approximately 30% in last five years).

The appointment of a new Head and increasing the profile of current faculty members within the university community - and externally - will also be critical for alumni and philanthropic engagement as the department looks to launch major fundraising initiatives, including support for faculty resources and increased physical space.

Work has already begun by the newly appointed Head in engaging alumni in Western Canada and this should be continued throughout key areas across Canada and the United States where active alumni populations exist. Active efforts in externally promoting the excellence of the department and opportunities for growth and expansion will help leverage the alumni community's support and increase the profile of the department with key internal and external stakeholders.

### *3.5 Other issues*

The only other issue of concern to the review team regards space. In the department's IAR documentation they make it abundantly clear that they see a serious problem with research and teaching space available to them. The review team is concerned that the department is placing most or all of its developmental effort into the goal of securing a new building. A new building to consolidate more of the department in one location would obviously be nice, but it is a major task. The University already has substantial fund-raising challenges related to its current construction activities, and putting emphasis

on a new building may only be realized in the very long-term. The team therefore believes that the department should also be devoting attention to alternative strategies in case a new building does not materialize in the near-term. In effect, we recommend a two-track strategy. Track A would be a new building which consolidates more of the department in one location; Track B, which would be the multi-location strategy, would represent a fallback if Track A is not feasible. For far less funds than a new building, the manufacturing group could, for example, have an elevator installed and build excellent facilities in Jackson Hall. This would provide graduate students involved in that field an excellent sense of identity and it would be a clearly identifiable 'home' for this area of research and graduate education.

#### **4. Recommendations**

In conclusion, the IAR review team commends the department for its excellent contributions to undergraduate and graduate education and research. These include an undergraduate program acknowledged to be one of the best in Canada, attracting high calibre students and producing engineers with particular strengths in manufacturing and design. Graduate education is also of high quality, and research teams have developed and are emerging that will provide nationally and internationally recognized leadership in a number of areas.

In addition to recommendations provided by the consultants, the IAR review team suggests that:

- i. Efforts are needed to improve the MME web pages to better present research teams and fields of graduate study
- ii. Continued attention is needed regarding the recruitment of a diverse student body, including female students.
- iii. Consider an alternative long term strategy for addressing space issues that does not focus on a single building to become home for the department, but where work continues on developing excellent facilities group-by-group (including upgrades to Jackson Hall so it becomes home to the Manufacturing researchers and graduate students)
- iv. The Department is encouraged to fund raise for student teaching resources (e.g., T.A. support, lab equipment, etc.) rather than exclusively on new space.
- v. Evaluate the USAT results and consider strategies to raise outcomes and ensure the undergraduate program remains strong
- vi. Make every effort to sustain the undergraduate program as efforts continue to build the graduate programs and research profile of the department
- vii. The Department should focus on the existing curriculum rather than expansion, streamlining what they teach to use resources more efficiently.
- viii. The Department should ensure it maintains its excellent reputation in design and manufacture as this is an important and unique contribution to the teaching and learning environment at Queen's.

- ix. The Department is encouraged to have more presence in the Integrated Learning Centre, allowing them more participation in institutional activity and providing more resources for labs.
- x. The Department should also place emphasis on learning of faculty, especially providing training for effective leadership and governance for the future.