

THE FACULTY OF ENGINEERING – MEETING THE CHALLENGES OF THE 21st CENTURY

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The following is an essay written by Mr. Christian Welsh who was then a Level 2 Chemical Engineering student in the Faculty of Engineering at The University of the West Indies (UWI), St. Augustine Campus, Trinidad during the Academic Year 2003/2004. Mr. Welsh was placed First in the EOG Resources Technical Essay Writing Competition held earlier this year.

1. Introduction

The Faculty of Engineering, one of the foremost Faculties in The University of the West Indies, can boast of having a proud tradition of producing world-class graduates possessing internationally-accredited degrees. Operations commenced with 28 students during the Academic Year 1961/1962 and have continued unabated to the present, producing approximately 5,000 graduates in the fields of Civil, Chemical, Electrical and Computer, Mechanical, Industrial, Agricultural, Biosystems, Petroleum, and Land Surveying. The Faculty's Staff has maintained high academic standards in their research activities as evidenced by their numerous publications in reputable journals. Both graduates and staff continue to make invaluable contributions to public life, many serving on national boards and task forces.

If the Engineering Faculty, however, is to survive and continue to be relevant to the region, it must itself evolve as engineering education evolves, to keep pace with the mighty changes occurring today in business, industry and society. It must not only address issues related to the education of engineers but also research, funding, administration, competition - both national and international, partnerships with government and industry, as well as the diverse, regional needs.

The challenges may seem daunting because there are so many and varied. However, if support is harnessed from all stakeholders and a strategic plan is developed and to address them, I am confident the Faculty of Engineering would continue to fulfill its mandate of “... *the development of the region through the training of its human resources, conducting research, delivering advisory services to governments as well as to the private sector and forging links with other institutions in the wider region and the rest of the world.*”

2. The 21st Century Engineer

The new millennium has seen a shift toward knowledge societies and at the center of gravity of the workforce in these societies are the knowledge workers, who are being paid, not for using their muscles, but for applying competencies learnt in the classroom. Of these knowledge workers, the engineer is the most valuable. Engineers comprise only a tiny percentage of the Caribbean workforce, yet their contributions to our society's quality of life is disproportionate to their small number. Our entire infrastructure i.e., roads, bridges, telecommunications and industrial plants is derived from their work. Projects previously inconceivable in the Caribbean, such as the Point Lisas development, have been proudly built and maintained by local engineers.

Now, new demands are being made on skills and competencies of the 21st Century engineer. In addition to having a sound knowledge of the essential technical engineering principles that draw upon the application of Mathematics and Science, he or she must learn new skills.

Engineers are increasingly occupying leadership roles in various industries and as such require management and communication skills' training. The future engineer cannot just be a design technician, but must be able to see the big picture and be always guided by his professional and ethical responsibilities. Computer advances have given engineers the tools to free themselves from the time-consuming calculations of the past and new engineering specialties have appeared to cater to modern concerns, e.g., environmental engineering. Engineers must also function in an interdisciplinary environment where the distinctions between science and engineering are becoming blurred. This is especially true of technological breakthroughs where teams of engineers and scientists work together to explore and develop new discoveries.

It is essential that the engineer of the future be taught some of these “*soft*”, survival skills, such as emotional competence. Personal and social skills including the ability to resolve conflict, create, maintain and enhance working relations, as well as entrepreneurship skills must be developed.

3. Critical Goals

To educate this “*new*” engineer, the Faculty of Engineering must aggressively address the following aims:

- Maintaining a favourable staff-student ratio to accommodate adequate levels of student-faculty interaction, student advising and counseling, university service activities, professional development and interactions with industrial and professional practitioners as well as employers of students.
- Allowing engineering students access to a programme of studies which will enable them to launch a career, or to continue their studies in any part of the

globe. This can only be achieved by raising standards, maintaining accreditation for existing courses and seeking accreditation for new ones.

- Offering students more creative options to pursue postgraduate studies. One such option can be to encourage capable students to begin their graduate programme while still registered as an undergraduate student.
- Developing a complementary studies component to make students aware of the function and responsibilities of the professional engineer in society and the impact that engineering in all its forms has on the environmental, economic, social and cultural aspects of the regional societies.
- Proactively forging links with industry, not only for funding but to ensure students gain the practical experience that is critical in engineering.

4. Major Challenges of the Engineering Faculty

With 42 years of experience, the Faculty is well into its “*middle age*” and since as they say, “*life begins at forty*”, maybe the Faculty like its human creators, is being called upon to renew its vision and restore its vigour. The Faculty must move quickly to surmount obstacles that could hamper its further development, or risk being sidelined.

1) The Need to Maintain Accreditation for Existing programmes offered at the Faculty

Accreditation serves to notify:

- (a) Prospective students that a programme has met minimum standards
- (b) The Faculty of a programme’s strengths and weaknesses and improvement methods
- (c) Employers that graduates are prepared to begin professional practice.
- (d) Taxpayers that their funds are being spent well

Most Engineering degrees in the Faculty are accredited. For example, the Land Surveying degree is accredited by the Royal Institute of Chartered Surveyors (UK) and the Chemical and Process Engineering Degree by the IChemE (UK). To maintain accreditation of existing programmes, attention needs to be given to quality issues such as:

- Outdated laboratory equipment;
- Instruction by part-time lecturers, most notably in the newly established Petroleum Geosciences programme as well as,
- Limited time for interaction with experienced teachers and mentors. The tutor system at the Faculty of Engineering should be enhanced by fashioning it into a more formal programme. Timetabling of meeting rooms, as well as detailed agendas would be helpful in this regard.
- Increased class sizes in most Departments of engineering;

The problem of overcrowding is especially acute with the size of the student population gradually overwhelming the existing static stock of resources, including lecturers and classrooms. During my first year of engineering, I felt little incentive to attend lectures for cross-faculty courses, since it was quite likely that I might have to sit on the floor, if I did not arrive early. Demand for undergraduate places in the University is very high, with 3,000 more applications this year than there were places and at the same time, student population jumping from 6,900 in 2000 to 11,300 today.

One practical short-term solution could involve connecting separate lecture rooms via video links, to allow a lecturer to teach the same course to two classes simultaneously. Assisting the lecturer could be several teaching assistants who would complement the professor's lecture by giving on the spot explanations of ambiguous points at regular time intervals or whenever a question is asked.

Focus on improvement of teaching quality in the Faculty must be intensified. Obtaining a doctorate does not make someone a good teacher. Students' assessments of lecturers must be surveyed and action taken. More workshops in topics, such as pedagogy and classroom management for academic staff should be organised. A performance management system must be implemented which measures not only technical but also behavioral skills. The 360⁰ feedback system should be implemented to solicit feedback of peers, as well as students. The Faculty must not only attract the best staff, but also must continue to train and motivate them by offering rewards and ensure accountability by measuring performance.

2) New Sources of Revenue

Building classrooms, modernising labs and hiring qualified, full-time lecturers require more funding than that which presently exists. Where is this new revenue going to come

from? The majority of the recurrent costs of the university (teaching and administration) are met by the contributing Governments, with funding for research and special projects coming mainly from international donor agencies like the Ford Foundation and UNESCO, as well as foreign governments. In order to better serve our expanding student population, a more systematic and assertive approach to soliciting non-traditional and independent sources of funding needs implementing. The traditional 'British' reserve in hunting out such funding must be replaced by a more aggressive, American-type programme for fund raising. Some important initiatives which can be implemented soon are:

- a) The lobbying of the government of Trinidad and Tobago to ensure that all future, production-sharing contracts contain clauses relating to the funding of Faculty of Engineering. In this way, an energy company, which is successful in its oil and gas-drilling operations, will be required to make annual contributions to the Faculty of Engineering. This measure should also be extended to include the large bauxite companies like Kaiser and Alcoa in Jamaica, which benefit from the training that Jamaican engineers receive here. A task force should be set up to define the proposal to be taken to the Jamaican government, which would then make a decision for implementation with respect to refinery expansion and opening of new mines. The fact that the Faculty of Engineering is located in Trinidad must not prevent this plan from coming to fruition since this institution plays a role in the development of the entire Caribbean.
- b) Better utilization of the physical plant of the Engineering Faculty during the vacation period. The systems and departmental computer laboratories could possibly offer courses on PC maintenance and upgrading of Network+ Certification, or enter into partnership with interested entrepreneurs.
- c) Introduction of specialised courses, which rely on some Faculty members' experience in Caribbean industry, can also be offered here to foreign students. For example, a Civil Engineering course on road-building in Caribbean soils could have the positive outcome of providing the Faculty with much needed, hard currency.
- d) Paying more attention to market segmentation, as there is a more valuable market among the mature, working population than school-leavers. It should work more closely with The University of the West Indies Distance Education Centre (UWEDEC) to plan, prepare and implement distance education programmes.

3) Competition

The Engineering Faculty's main competition is not international, but internal. The Trinidad and Tobago Institute of Technology (TTIT), the University of Technology, Jamaica and the soon-to-be established University of Trinidad and Tobago (UTT) with its proposed, Repsol-sponsored Energy Education Centre intended to train "*energy professionals and develop a strong R&D capability...*" are its main competitors.

The relatively new TTIT, at present, offers Certificate, Diploma and Applied Degree Programmes in partnership with UWI, the Southern Alberta Institute and the University of Houston. It has pioneered a new kind of technology-training which directly and substantially involves the private sector, especially engineering firms, in its funding, planning and management. At the University of Technology in Jamaica, Diplomas in Chemical, Mechanical and Electrical Engineering are available, in addition to post diploma Bachelor of Engineering Degrees.

In view of this build up of tertiary-level, engineering offerings in the University/catchments area it is important to stress the importance of linking with such institutions. This will share not only responsibilities, but also the cost of higher education. It can be easily seen that funding which might have gone solely to the University and the Faculty, will now have to be divided among the University and the local institutions in each Caribbean territory. It is imperative that the Faculty finds new ways of maximising the effectiveness of collaboration with such institutions. Initiatives may include the sharing of some facilities of the Faculty, such as laboratories, library and qualified lecturers, in order to optimise the investment made by the Caribbean governments in tertiary education. UWI Engineering Degrees can be offered at these institutions as long as they achieve the required standards. Wastage caused by unnecessary duplication of facilities must be avoided.

The Faculty will also gain from this competition if it is wise enough to benefit from the learnings of these new institutions. An excellent example is the TTIT programme which allows engineering student to receive one semester of work experience for every two semester of theory, before graduation. Will this not leave these graduates better prepared for the world of work than the average UWI engineering graduate?

Fortunately, a Cooperative Training Programme is also available to the UWI Engineering undergraduate if the student wants practical experience to complement his or her field of study. The programme involves attachments to various companies and organisations for a one-year period without attending classes. The programme facilitates the linkage between classroom theory and the realities of the workplace. At present, the programme is voluntary and only a handful of students in Engineering Faculty avail themselves of the opportunity. Why not make it compulsory requirement of an Engineering degree? As profit-centered, technology-driven enterprises are not in the business of being training grounds for students, this may pose a challenge for some companies. A strong marketing plan emphasising the mutual benefits of the training programme would help. The existing programme can be better promoted, e.g., by having a lecturer devote time to

discussing the maturity and experience the student can gain by participating. The Students' Advisory Services in conjunction with the Faculty should encourage students by visiting classrooms to promote this valuable programme.

4) Research, Development and the Needs of the Caribbean Region

Universities exist for a variety of different reasons, but they are expected primarily to provide excellent teaching, as well as research. This Engineering Faculty, like any other in the world must seek to make contributions to the advancement of science and technology through regular and systematic research, development and sharing of knowledge with the wider professional community and the general public.

In order to make the Faculty's research agenda more effective, there need to be some identification of regional needs and the selection of priorities that would determine the Faculty's research focus. A few areas of research interest already undertaken here are:

- The phytoremediation of petroleum contaminated soils.
- The monitoring of heavy metal and organic pollutants in the environment and the development of effective methods of immobilisation of heavy metal wastes.
- The study of transition metals for use in diagnostic medicine, electronic devices and industrial processes.

Despite these efforts, research is still deficient in quantity and quality, due in part to the competing requirement of a heavy undergraduate teaching load and the inadequacies of the current research infrastructure. The Faculty can become more research active by:

1) Establishing a center for engineering research studies. Research institutes for many of the other Faculties of the University have been long established. For example, the Institute of Social and Economic Research (ISER), the research arm of the Faculty of Social Sciences, has been involved in research training, publications, technical assistance, evaluation and documentation in the fields of economics and social sciences since 1968. I envision an Institute of Engineering Research to better coordinate the research activities of the Faculty and to increase the visibility and role of this Faculty in finding engineering solutions to satisfy the region's growing needs. One potential application of the Institute's resources could be providing consultancy to the governments of the region on the feasibility of future engineering projects. Currently, this is done at great expense to taxpayers, mostly by foreign firms. With regular proceeds from consultancies, the institute could in time be self-sustaining. The prestige and funding that a project such as this could attract, if well-marketed to government and multi-nationals, would augur well for establishing the Faculty as a "*center of excellence*" in research and development.

2) Regular assessment of staff on research performance, with built-in rewards for the more dedicated professors. Lecturers are aware of their main roles of teaching, research and outreach to the community, but it is time to give tangible rewards, monetary or otherwise, to the more prolific researchers as a means of encouragement. This step is aimed at seeing to it that the volume of published research papers and projects increase. After a five-year period, the efficacy of this measure should be re-evaluated.

The Engineering Faculty is in the business of training professionals for the world of industry, so it is easy for these same industries to see themselves only as customers whose sole recourse is to complain about the quality of the product received. But, it is important for industry to recognise that there are effective means of partnering with the same institution that they berate, in order to get the kind of graduate they need. What may discourage this crucial interaction is the bureaucracy of the University system. The Faculty must re-engineer its administrative policies to be more efficient so that it can quickly achieve the goals that it has set and not get bogged down in bureaucratic “*red tape*”. Only when it is shown that University can alter itself to better collaborate with industry and society, will the knowledge that is gained here be a means for human development in the region.

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