

ENGINEERING RESEARCH AND DEVELOPMENT AT THE UNIVERSITY OF THE WEST INDIES (UWI): A Personal Perspective

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INTRODUCTION

The year 1998 marks the 50th Anniversary of The University of the West Indies, and notwithstanding the fact that it is only the 38th year of the Faculty of Engineering, it is appropriate to reflect on a number of issues. One of the major issues and one which is crucial to the future of the Faculty is that of the approach which it takes to its research agenda. The aim of this paper is to reflect on some of the issues and to propose relevant strategies for improving its performance in the future. In doing so, it is fully recognised that the research and development work of the Faculty must be towards assisting in regional development; this being clearly stated in its Mission Statement. In fulfilling the aim of the paper, a brief historical perspective of the work of the Faculty is initially presented as background. This is followed by an analysis of the external environment which the Faculty serves, together with relevant background in respect of recent developments within the University. This then leads to a series of proposals in respect of future strategies, together with an evaluation of the problems which the Faculty has to solve in order to move ahead.

HISTORICAL PERSPECTIVE

The Faculty of Engineering of The University of the West Indies was set up in 1960 to provide professional engineering training for the English-speaking Caribbean. In addition however the Faculty was also required to carry out research programmes relevant to social and economic development in the region. This has been done to date mainly on an ad-hoc basis through:

- Undergraduate Research Projects
- MSc/Diploma Projects
- MPhil/PhD Projects

Undergraduate research projects are carried out over a very limited time period and whereas some have provided useful data to larger research programmes their value is mainly as a training medium.

Postgraduate teaching programmes were introduced into the Faculty in the early 1970's with the Diploma in Food Technology, this being followed by the GOTT funded MSc programmes in the mid to late 1970's. The Faculty now offers a dozen of these specialist MSc postgraduate training programmes in which all students have to carry out a major project after completion of the formal teaching requirements in order to graduate. The bulk of the students on these programmes are employed as professionals so that, except in the case of Food Technology, their projects tend to be analyses of problems of a developmental nature arising from their workplace. In excess of 300 students have completed these programmes satisfactorily to date, so that whereas no attempt has been made to assess the worth of these projects, it may be assumed that many of them have helped to move their respective companies forward. In the case of Food Technology, these projects have mainly been laboratory-based projects associated with product development, food safety or process analysis.

In-depth research is carried out as MPhil or PhD projects and it is this area where the Faculty has probably not performed to its potential to date. This has meant that whereas there have been some

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significant successes particularly in the following areas:

- Alternative Energy Applications
- Construction Engineering
- Electrical Power Distribution
- Food and Agro Processing
- Petroleum Engineering

The output and the level to which the developed technology has been implemented has not been commensurate with the size of the Faculty. Some of the reasons for the lack of output may be:

- (a) Poor support facilities
- (b) Inadequate funding for both equipment and stipends for students
- (c) Lack of students interested in doing research

and some of the reasons for the low level of external implementation of the developed technology may be:

- (1) 'Publish or Perish' approach to the assessment of Academic staff. This can mean that projects are chosen for their publication potential rather than the benefits to development of the region.
- (2) Lack of a structured approach to research. It is to be noted in this respect that whereas there is a Faculty Board Sub-Committee on Research and Postgraduate Student Affairs, this committee tends to concentrate its attention on administrative matters rather than on research strategies.
- (3) Inadequate industrial ties. Projects are chosen on the basis of the staff members' perception of importance rather than after discussion with interested parties.

In addition to the above, however, the concept of working in teams has not been as well developed as it might. Such an approach has the advantage of being more attractive to external funding agencies. There have however been successes, some examples being:

- Enhanced Oil Recovery (Funded by GOTT)
- Hurricane Resistant Structures (Funded by CIDA)
- Real Time Systems Group (Funded by various sources)

These projects have also had some success in the transfer of the developed technologies.

EXTERNAL RELATIONSHIPS

In devising a strategy to maximise the benefits of research in the Faculty towards development in the region, it is necessary to examine the external environment into which said research is to be utilised. Thus, the most important relevant industrial sectors are:

- Extractive and Mining Industries (Hydrocarbons, Minerals and Construction Materials)
- Process Industries
- Food and Agro Industries
- General Manufacturing
- Services (Electricity and Water)
- Information Technology including Telecommunications
- Construction
- Transportation

In the move towards a more structured approach, it is also important to recognise the ownership structure, as well as trading patterns and regulations, in so far as they affect the approach to the acquisition of technology and the pattern of industrial production respectively. Thus, whereas in the 1960's, all major industrial production was foreign-owned and controlled, all services were effectively government bodies. Medium and small-scale manufacturing was of the assembly type serving local markets with tariff or import ban protection. There have however been significant developments since that time with even the services sector tending to move away from government ownership or control. The large manufacturing sector has seen the enormous growth in some areas, e.g., in the processing of natural gas in Trinidad where the

ownership has passed through state control back to a largely foreign ownership situation. In the medium to small manufacturing sector, the introduction of trade liberalisation has meant that the smaller screwdriver industries cannot survive and only those who have quality products, with the capability to export a significant proportion of their production, will thrive. It is these companies which need to understand that they must invest in Research and Development in order to survive in what has now become the global environment to them. The intervening period has also seen the initiation of the Information Technology Age, a sector where there is significant potential for the low-cost but modern societies of the English-speaking Caribbean.

In attempting to mesh into the development needs of the industrial sector, it must be recognised that there are research institutions set up by governments as service supports to industry, but also to act as catalysts to industrial development. Thus, there are industry specific research institutes in Jamaica, i.e., Jamaica Bauxite Institute and Sugar Industry Research Institute, but there are also non-industry specific research institutes in Guyana, Jamaica and in Trinidad and Tobago. In Trinidad and Tobago for instance, CARIRI (The Caribbean Industrial Research Institute) is a consulting industrial research facility which offers its services to most types and sizes of industry. It is a multidisciplinary laboratory based organisation offering services in diverse fields ranging from Food and Petroleum through to Materials technologies. It is clear that the work of the Faculty must wherever possible compliment and not compete with the work of these institutes.

Another external factor which must be factored into any strategy must be the recognition that governments have control of economic development and also with potential access to some research funds. Thus, close contact must be maintained with all government departments who have a say in industrial development and also with the relevant planning agencies who are basically concerned with matters of a planning, feasibility and funding nature. Whereas they would not be directly involved in research and development programmes, they can act as an instigator or catalyst, more particularly when industrial

development is government-inspired. The potential importance of such agencies has been previously projected by reference to the following triangular scheme, as shown in **Figure 1**, for inter-institutional interactions between all the interested parties which shows the National Planning and Development Agencies (NPA) as the focal point [1].

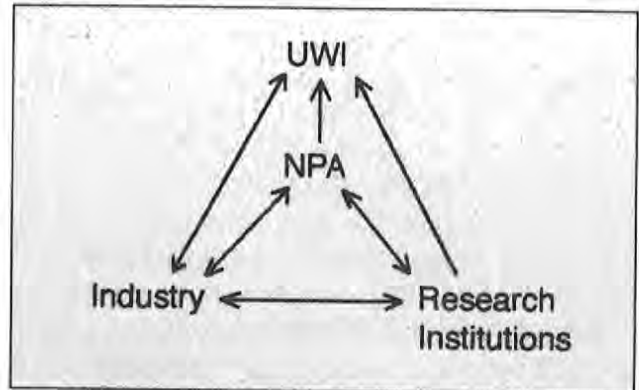


Figure 1: Inter-Institutional Interactions in Research

In the detailing and implementation of a particular research and development programme, the agency may be excluded and the possible interactions reduced to the triangular form pointed by the industry, the research institution and the University.

It is convenient to classify development-oriented research topics in two ways as follows:

- (a) Topics associated with the operation or development of existing systems; such topics being identified by industry. They may be investigated internally if resources are available; or alternatively they may be referred to a research institution. Topics requiring more fundamental analysis would be referred to the University.
- (b) Topics associated with the development of new systems, processes or industries. These topics may be generated from all three points of the triangle as a result of the identification of a particular need. Two specific examples of collaboration between the University and a research institution [2] have demonstrated that

topics can be generated at either of these points, and proceed by collaborative research and development programmes to the creation of new industries.

Overall policy for development must be spearheaded by government and clearly enunciated in a White Paper, e.g., [3]. However, in the interaction between the institutions, the most important factor is the development and maintenance of efficient communications, if collaborative programmes are to succeed.

INTERNAL ENVIRONMENT

Just as important as the external environment is the internal environment within which the Faculty has to carry out its research programmes, and this is an appropriate time in the development of the University in which to re-evaluate the Faculty's approach. This is because the recommendations of the Chancellor's Commission on Governance of 1994 are now being implemented, one of the major recommendations being the establishment of a School of Graduate Studies and Research. Thus, the Dean's Office of Graduate Studies was established at the Mona Campus in September 1996 and the Office of the Pro-Vice Chancellor (Research) at the St. Augustine Campus in March 1997. The Commission on Governance believed that the University had a unique position in the region to provide research leadership and advanced training to meet the development needs of the countries of the region. The responsibilities of the Office of Research have been summarised by the Pro-Vice Chancellor (Research) in his first presentation to the University Strategy Committee as follows [4]:

- (a) To increase the level of research activity on all of the Campuses.
- (b) To assist researchers in obtaining financial support for their research and
- (c) To stimulate the development of multi-disciplinary research and inter-campus cooperation focused on the development needs and priorities of the countries in the region.

The presentation also identified his perception of the critical areas for research some of which involved Engineering, e.g., Environment; Renewable Energy; Biotechnology; Food Technology.

In another important step, the University has, after some years of procrastination, developed its policy on the protection of its Intellectual Property; this having been approved by the University Finance and General Purposes Committee in February 1998 [5]. It has yet however to develop the means of administering this policy.

THE WAY AHEAD

The Faculty of Engineering has eighty (80) of the best-qualified professionals in the Caribbean, covering most Engineering disciplines, with the expectation that this number will increase with the projected expansion of the Faculty. The Faculty, therefore, has the potential to be an important force in regional development if its research capabilities are properly harnessed and directed. If this is to be achieved, however, there has to be a change from the traditional University approach to academic research, as well as a significant expansion in activity.

Having regard to the external environment, as well as the changing internal environment previously described in Section 4, it is proposed that there should be a strong move towards a team approach in the development of focused research programmes within clearly identified areas for regional development. The most appropriate starting place is with the Departments of the Faculty. It is proposed that the following stages may be appropriate:

- (1) Discussion at departmental level to identify priority areas for research associated with the disciplines covered within the department; and to assign staff (Academic and Non-Academic) and facilities to those teams.
- (2) Formation of appropriate advisory teams, these to include representatives from Industry, Research Institutions and the relevant government Ministry.
- (3) Identification of potential research and development projects.

- (4) Obtaining of necessary funding for the chosen projects.
- (5) Acquisition of equipment and hiring of personnel.
- (6) Project execution.
- (7) Monitoring of the project which could involve relevant personnel from industry with specific expertise who are not necessarily part of the Advisory Team.
- (8) Making appropriate protection of the intellectual property.
- (9) Communication of results and transfer of the developed technologies.

The depth of the work could be fitted into an appropriate academic level, e.g., MSc, MPhil or PhD or could be simply not tied to any academic programme.

The operation of the Advisory Team is seen to be one of the most important factors contributing to the success of such ventures. Not only can the industrial advisors ensure relevance to the work but also assist in its execution possibly through funding items of equipment and/or manpower, but also through the provision of services, e.g., fabrication. **Figure 1** essentially captures the spirit of the collaboration between all of the interested parties in national and regional development.

In general, all of this activity can take place at the departmental level. There is, of course, a role for the Faculty which could include the following:

- The encouragement and coordination of interdisciplinary teams across departmental and Faculty boundaries.
- Identification of and assistance with funding for specific projects.
- Provision of services.
- Academic administration.

- University liaison, e.g., with the Office of the Pro-Vice Chancellor (Research).

It may be argued that the basis for this approach has already been put in place with the initiation of the Engineering Institute in 1994. General background to the Engineering Institute was described by McGaw [6] at the time of its inception, special reference being made to the basic concepts being applied. An update describing experiences over the first year and a half of operations, was presented to the UNESCO World Congress of Engineering Educators and Industry Leaders [7] in 1996. In essence, the Institute is the commercial arm of the Faculty but in structuring its organisation, specific areas of particular importance to regional development were highlighted by creating a series of Centres in order to focus the work in these areas. The current Centres appropriate to Research and Development are:

- ◆ Centre for Environmental Studies
- ◆ Centre for Food Processing
- ◆ Advanced Manufacturing and Engineering Centre
- ◆ Centre for Hydrocarbon Studies
- ◆ Computer-Aided Engineering and Design Centre
- ◆ Centre for Energy Studies

To date, the emphasis in each Centre has been the procurement of income generating work which could be consulting, testing or contract research and, with exception, it may be stated that the performance to date has been less than satisfactory. There has however been good research work carried out within the specific disciplines which has not come under the appropriate Centre because it is not income-generating. For example, whereas the Centre for Hydrocarbon Studies has concentrated on getting the PVT Laboratory in operation for testing commercial samples, there have been a number of research projects completed both in Petroleum Engineering and also in Petrochemical studies which do not come under the ambit of the Centre because they are not income-generating. There is also an ongoing collaborative project being carried out with a major oil company which also does not come under the ambit of the Centre because there is no special funding arrangement. Clearly, it is better for all staff

working in a particular area to work together as a team irrespective of whether there is external funding involved. A similar type of situation exists with the Centre for Food Processing.

It is therefore proposed that the Centres take responsibility for all work in their specific areas irrespective of if there is external funding involved. The inputs from the industrial members on the Advisory Board will be important to the total work of the Centre irrespective of whether or not the work is specially funded.

The above relates to existing Centres. Each Department should decide on its specific research areas which may or may not relate to existing Centres. If not, the relevant teams should be initiated and a work programme devised and executed. At some stage, the Faculty may decide that a new Centre of the Engineering Institute is appropriate. It is also possible that existing Centres may be deleted because they have not developed or are not likely to develop to the required extent.

The concept of developing research teams does not preclude individual research outside the areas specified. It is anticipated that staff may wish to be involved with curiosity driven research and they should be encouraged accordingly. In addition, there is no reason why individual work could not be directly associated with industry. The author is involved with two such projects at MPhil level at this time, where the projects are tied into the two companies' development programmes. The clear advantages to this approach are the assistance that the companies can give to assisting the research in terms of fabrication, equipment, testing, etc., thereby alleviating the Faculty budget. Problems can arise, and in fact have already arisen, however, in respect of balancing the company's development needs with the academic standards associated with the award of the higher degree.

In fulfilling the above proposal, there are a number of problems which will have to be addressed which may be summarised as follows:

- There has to be commitment at the Departmental level, this to include all staff, Academic and Non-Academic alike.

- The approach has to be sold to all of the relevant external organisations whether they be industry, research institution or government-based.
- The Departmental administration has to be improved to allow for increased external activity and to release academic staff to concentrate on technical issues.
- There must be an imaginative and concerted effort towards identifying funding sources for the work.
- Faculty services in terms of workshop, maintenance and computing services must be significantly improved. The Faculty workshop, for example, has little capacity to deal with any research needs at this time, and the time lag even when they do respond is far too long.
- Campus security both in terms of physical and human resources must be improved. Research is not a '9 to 5' activity.
- There must be an adequate supply of research assistants to carry out the work. It is suggested that if the work is carried out directly with industry, and can be seen to be part of their career path, then this could be an important incentive to attracting the right calibre of people.
- The University's approach to assessment and promotion for academic staff must be modified to recognise that performance may not be demonstrated by publication alone.

One of the key success factors in assessing the performance of the above approach would be in the implementation of the work carried out in any project. In working directly with a particular company, the implementation strategy would be developed with that company directly. In the development of new industrial areas however, entrepreneurs need to be attracted to take the technology to the commercial stage. It is for such projects that a Business Incubator should be set

up to provide facilities for starting and nurturing new businesses based on technology developed in the Faculty. It has been proposed that this could be incorporated into the Engineering Institute [6]. It has also been proposed that it may only be necessary to provide limited space and personnel for business services with the technical operations being located within the laboratories of the Faculty. Money has in fact been donated for this purpose.

CONCLUSIONS AND RECOMMENDATIONS

With the largest concentration of professional engineers in the English-speaking Caribbean and widest spread of disciplines, it is important that the Faculty of Engineering of The University of the West Indies coordinates its research in order to maximise its effect on regional development. It is proposed that this is best effected by identifying the most appropriate research areas through discussion at departmental level followed by the formation of appropriate research teams. A key factor in the success of the work carried out by such teams would be the guidance given by Advisory groups comprising professionals from industry, the research institutions and the relevant government agency. Reference is made to Figure 1 which encompasses the spirit of collaboration towards national and regional development. Such advisory groups would ensure relevance, assist in project execution as well as in the implementation of the final developed technologies. It is also proposed that the implementation of some of the work may be facilitated through a Business Incubator.

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