

The Evolution of Systems Management of Engineering Education

N. IDRUS†

Department of Mechanical Engineering, University of Technology, PNG, Private Mail Bag LAE Papua New Guinea

This paper describes the problems facing engineering education in Australia in general and how one regional tertiary institution has managed to accommodate these changes. It is shown that a shift from collegial to commercial management of the faculty is mandatory in order to survive. However, a systems approach involving both academic as well as university administrative sectors would ensure synergy towards overall excellence.

INTRODUCTION

UNTIL the recent reform brought about by the Minister of Employment, Education and Training (DEET), Mr John Dawkins in 1988, tertiary studies in Australia could be done in either a university or a college of advanced education (CAE) for the award of similar sounding degrees, e.g. BA, BEc, BE or BEng, BSc, even Msc, MEng. The Dawkins Reform as it came to be known, abolished this binary system in Australian tertiary education. CAEs are either merged with an established university or merged with each other to form a viable 'university' (specifically defined in terms of students enrolments), or for well argued reasons will be left alone except for a name change incorporating the title 'university' but having an established university as a supervisor or 'sponsor' until such time that the new university is deemed to have satisfied the full definition of university both in terms of student enrolment and research standing. Capricornia Institute for example fell into the last category and as from 1 January 1990 became known as the University College of Central Queensland with a three year sponsorship by the University of Queensland in Brisbane. The Victoria University of Technology in Melbourne, on the other hand, is an example where three CAEs have merged to form one of the largest universities in Australia. The latter was only possible because one of the constituents, the Royal Melbourne Institute of Technology (RMIT) indeed has been operating virtually as a university, both in terms of student numbers and research profile.

* Paper accepted 21 November 1990.

† Dr Idrus is Professor and Head of Department of Mechanical Engineering at the PNG University of Technology, Lae, Papua New Guinea. He was formerly Head of Mechanical Engineering and Dean of Engineering at the University College of Central Queensland, Rockhampton, Australia. Professor Idrus is also a member of the Board of Accreditation (Mechanical Engineering discipline) of the Institution of Engineers, Australia.

The debilitating effects of the binary system on engineering were shortlived, by virtue of the accreditation system of the Institution of Engineers, Australia (IEAust), whereby courses and not institutions are accredited. Hence a Bachelor of Engineering will be assessed in similar ways whether being taught in a university or a CAE. Indeed there have been cases where an engineering course in an established university temporarily lost its accredited status and was required to undergo a re-assessment some 12 months later. Engineering courses in CAEs appear to have had no such experience. It is perhaps due to similar reasons that the faculty profiles of engineering schools in universities and CAEs do not show much difference. Many CAEs exceed the percentage minimum of faculty staff with PhDs required to satisfy the definition of a university.

However, with the Dawkins Reform and the privilege of a university title, research and publications, areas outside the charter of the IEAust's accreditation function, became increasingly emphasised. Not funded for research, CAEs in general lack the important infrastructure for research endeavour. Only the bigger and more established CAEs have been able to compete successfully for external research grants. This has therefore posed a new challenge to 'managers' of engineering schools in ex-CAEs. Although some funds have been set aside by the Federal Government for the purposes of infrastructure development in ex-CAEs, the amount (about Aus\$10 million) is nowhere near enough when it has to be divided among some 40 recipients at a time when costs of equipment and tools have soared. The situation is somewhat exacerbated by the fact that many of the smaller engineering schools in ex-CAEs have had to require their staff to take higher contact loads than those in universities or bigger CAEs.

Against this backdrop, the engineering school at the UCCQ has been able to sustain growth in its

Bachelor of Engineering (BEng) enrolment and has embarked on a Masters Program as well as other entrepreneurial activities. However, this could only be achieved through a shift in the management of the school. This paper describes a number of initiatives of the school of engineering at UCCQ which have resulted in turning around budget deficits to surpluses as well as keeping a high morale amongst all staff of the school. The latter is a necessary condition for a successful deployment to respond to required changes.

THE PROBLEMS FACING ENGINEERING

Although the community in general recognizes the products of engineering, such as bridges, household electronics consumables, aircraft and the like, they are taken for granted. Engineers in the English speaking countries generally enjoy less status than other professionals such as lawyers and physicians, unlike the case in continental Europe or Asia. The professional engineers in English speaking countries do not have a recognizable title or pre-nominals, such as Ing. or Ir. in continental Europe. The word 'engineer' has also been used for people doing sub-professional work, such as 'plant engineer' when meaning a mechanic or 'aircraft or licensed aircraft maintenance engineer' when a qualified aircraft tradesperson is actually meant. In the United States the train driver is also known as the engineer.

In a nation, such as Australia, where professionals have only recently begun to enjoy some respect from the community, engineering education must extend to educating the community at large as well. The task is therefore formidable. It is indeed worse for an engineering school in a regional centre which developed by virtue of the kindness of the land. It is only by 'educating' the parents that one is able to entice the children into engineering. In the extreme, there is some anti-technology feeling, because most of the news about engineering and technology in the media are usually about disasters, bombs, falling bridges, i.e. about engineering failures. There is therefore much more effort needed to attract the same number of students into engineering than into the Arts or Business studies. Much of this effort will have to be expended by the teaching staff of the engineering school, as very few of the secondary school teachers and career-guidance officers are science oriented and very few indeed if any with engineering qualifications.

Governments, universities and parents are expressing grave concern about the dearth of science teachers in secondary and primary schools around Australia. To some extent the revolution towards the soft-options in the late 1960s and early 1970s can be blamed for this. That revolution did not end then, because we are still seeing the 'free-choice' syllabus in secondary schools around the country. Such a syllabus allows the pupils to choose

for themselves whatever they wish to do during school time. Only the state of New South Wales has taken some action to return to the "3R's" in the primary and secondary schools. The state of Victoria had decided to abandon any real assessment of the six years of its secondary school, prompting universities there to invoke an Entrance Examination for which the private schools say they will prepare their students. In short, there is a lot more 'softening' in the secondary school scene, a situation which disadvantages engineering schools even more.

The engineering schools themselves, even after spending time and effort on peripheral activities, are further disadvantaged by the university system which funds academic sectors of the university according to the number of students enrolled. University administrators cannot really be blamed for perpetuating this system, because this is obviously the fairest system, given the ever tighter funding from the Federal government, increasing salaries and increasing costs. Already engineering schools constitute the university sector that consumes one of if not the highest dollars per student by virtue of the equipment and experimental requirements. As CAEs do not have medical faculties in their midst, engineering in general is indeed the school that costs the highest per student enrolled. Given that the community perception prevents a lot of potential students from selecting engineering and those who may want to do engineering are not qualified because they had not taken the right subjects at secondary school, the number of students enrolled in the engineering schools is small compared to the other schools on campus, while the inflexibility of courses controlled by the accreditation guidelines makes the teaching of small classes inevitable. The vicious cycle then starts again.

Insofar as the country is concerned, engineering schools are blamed for not producing enough engineers of the quality and expertise needed by and in industry. Porter *et. al.* (1986) proved that manufacturing is the sector with the highest multiplier factor, stating basically that if manufacturing is down the economy of the whole country will be down as well. As modern manufacturing needs engineers of all types, the importance of manufacturing must necessarily point to the importance of engineering and engineers in the economic well-being of the country. Engineering Deans hoped for a special assistance from the Minister of Employment, Education and Training, given the other difficulties and disadvantages mentioned above. This unfortunately was not and is not likely to be forthcoming. This does not seem to be logical, because it could mean further degrading of manufacturing and hence economy of the country.

USING REAL INITIATIVES

The various 'solutions' discussed here were those carried out at the UCCQ (and formerly

Capricornia Institute) while the author was Dean of Engineering there. UCCQ is a small ex-CAE with six academic schools namely Business, Education, Engineering, Health Science, Humanities & Social Science and Applied Science, having about 4000 students and four branch campuses radiating up to 350 kms from Rockhampton. The town of Rockhampton is a regional centre serving many coal and gold mines to its west. There is little manufacturing in the area. The nearest metropolitan centre is Brisbane, some 700 kms to the south. Although connected daily with jet service to Brisbane, and modern telecommunication systems (fax, bitnet computer network) available, many academic staff still feel isolated academically.

In the past, academic schools are generally run on the collegial system with little if any business-like management control. Budgets are not usually taken all that seriously because deficits can be covered from the succeeding year's budget. The important thing is that subjects are taught, research done and students graduated. The needed equipment usually, and almost certainly in the established universities, is taken for granted, as is the case with staff requirement and the continuation of research grants from the various research councils and foundations. The changing economy had gradually robbed these institutions of such 'luxury'. Researchers are no longer required to do research only but also must look for the financial resources that will fund their research. Although ostensibly competitive and external (to the teaching institutions), the research grants received by university-based researchers were in the main public money coming from the same source that pays those researchers in the first place, namely the government. To be fair, there were research projects funded by private companies, but the ratio between government funded and privately funded research at universities is so large that it is not worth quantifying. With the increasing number of 'research' institutions by virtue of the Dawkins Reform and given the reduced funding for education in real terms, real research can only be carried out now with substantial support from the private sector. For an institution like UCCQ, its good name earned by graduating excellent engineers readily acceptable by industries, must also be maintained, while the acceptance of less able but nevertheless enthusiastic students is inevitable to maintain the level of financial cake. This job was made harder when the effects of reduced university budget was passed on to academic schools across the board. The engineering schools in particular have to look elsewhere to maintain their financial resources and to expand.

Attracting resources

This is not traumatic for universities in metropolitan areas or areas with a good industry base. But for the school of engineering at the UCCQ given the description of Rockhampton above, this endeavour proved much more difficult. However,

persistence and tenacity in the part of faculties led by the author, resulted in contributions in kind by industries around Central Queensland. It is believed that universities in both geographical locations will need to nurture a working and sometimes personal relationship with the 'right' people in the particular company or industry before any contribution can be made by that company or industry. The following table is a sample collection of contribution that the UCCQ School of Engineering received over the two years the author was Dean there:

Company/Industry	Items Donated
Automotive wreckers	complete rear axle with differential; gear box; drum and disc brake assemblies; diesel motor; car batteries
Gold mining company	crusher, grinder, pulverizer
Telecom	dial and push button telephone sets
Cement manufacturer	bucket elevator
Garage door manufacturer	a roll-a-door
Water tap manufacturer	a novel ceramic-valved kitchen tap
Transmission service centre	an automatic gear box assembly
An electronic manufacturer	a PDP-11 mini-computer
Gas service station supplier	a petrol bowser nozzle
Miscellaneous	a gear pump; car air-conditioning compressor; other smaller items

Although the total amount of donation in dollars of above was not earth-shattering, it nevertheless allows the School to spend the money which otherwise would have to be spent on the above, on other items that will help develop the school's equipment even further.

Other methods of attracting resources include the offering of the school's expertise in the various fields on a consulting basis to help solve some of the industry's problems around Central Queensland. These consultancies ranged from actual solving of existing problems faced by an industry to providing specialist training courses such as in Quality Assurance and Productivity Improvement. Proceeds from these consultancies are distributed to staff involved as well as to the university's central consulting funds and to the department's consulting fund according to some agreed formula. The amount that is apportioned to the central consulting fund together with such other amounts from

other consulting activities become part of the source of funding of the internal Research Committee to disburse to research applicants on competitive basis. The amount received by the department's consulting fund may be spent at the discretion of the Head of Department. Usually, this fund is used partly to complement equipment grants allocated by the university and partly for staff development, either by bringing experts onto campus or sending staff to conferences or symposia.

School of Engineering staff have also been active seeking research and other grants from outside the university, some of which are joint government and private sector grants. Examples of the latter that the School of Engineering had won, were the National Teaching Company Scheme grant where the federal government and a local company contribute equal amount of money to pay for a recently graduated engineer to carry out an agreed project for the company; the Australian Production and Inventory Control Society (APICS) Inaugural Research Grant funded by APICS and the New South Wales government. As is the case with many research grants, through the above grants the

Department of Mechanical Engineering at the UCCQ has been able to acquire a number of expensive computer software packages and at the same time helped various industry in their quest for improved productivity, quality and overall systems control. In these examples, it is clear that contacts with industries around the geographical area are important, as the grants mentioned could only have been won because the applications submitted clearly indicated the support of the industry which would find the results of the research useful.

Attracting students

As mentioned earlier, funding to the schools on campus is commensurate with the number of enrolled students in the particular schools. It is therefore important that the student enrolment is as high as practicable. However, the problems discussed previously showed that the pool of students wishing to do engineering is extremely limited, unless a change in attitude of the public in general is quickly achieved.

The Table below shows the various activities that have been carried out by the School of Engineering at UCCQ during the last two years:

Activity	In conjunction with	Target Audience
Schools liaison Faculty and sometimes students go to secondary schools to explain engineering careers, prospects and courses.	all public and private schools in the area	years 10, 11 and 12 students, as well as their teachers and career guidance officers
Engineering Open Day where all the laboratories in the Engineering school are open to the public and counselling provided by senior staff of the engineering school	industries around Central Queensland as well as government instrumentalities, who supplied personnel for the day to man their booths	secondary school students and parents as well as teachers, career guidance officers as well as industries
Careers Markets where displays and counselling are provided by various institutions at an education bazaar around the state	Careers development unit of the State Education Department and the IEAust	years 9 to 11 secondary school students
Letters and copies of articles about engineering career, to parents	all public and private secondary schools in Central Queensland	years 10 and 11 secondary school students
Extended Learning Program (ELP) where selected secondary school students spend a week in the laboratories of the engineering school carrying-out special assignments using various new technology	Regional Officer of the State Education Department	advanced year 11 students from secondary schools throughout Central Queensland
Public Relations Program directly or indirectly through concerted effort in publicising the many and diverse activities of the school of engineering	local newspapers, radio and television stations, as well as professional and social clubs, e.g. Rotary	students as well as general public
*Engineering Scholarship Fund to pay selected students' Higher Education Charges (HECs) introduced in conjunction with the Dawkins Reform, thereby attracting students who may not originally think of an engineering career	industries who will provide the funding; the Taxation Department which determines deductibility status of donating companies	year 12 secondary school students, especially those with very good grades at their final secondary school examinations

Activity	In conjunction with	Target Audience
Delivering First Class Engineering Education thereby gaining recognition by current students who will act as the School of Engineering Ambassadors to the public in general and to potential students in particular	current students and all engineering alumni	all secondary school students
Developing courses of interest to the public within the expertise of the faculty, for example a combined BE and BBusiness degree	other schools, industries for feedback on what is required	secondary school students, industries as well as government

* At the time the author left the UCCQ, arrangements with the Taxation Department and the UCCQ Finance Section were already in an advanced stage, with letters to various industries prepared.

SYSTEMS MANAGEMENT

The last section and its two subsections illustrate the range of activities an engineering school management is now involved in. It must also be recognised that the above activities cannot be done without the co-operation and pro-active attitude of the engineering school staff. That is, to a large extent, no external activity can be successfully achieved without having the internal parts in order first. Furthermore, the faculty must be made aware of their changing roles. A systems management approach is therefore inevitable, if overall optimisation of the situation is to be achieved.

As is usually the case in industry, appropriate direction must firstly be agreed upon. To do so, a five-year and a more focussed three-year plans were drawn up with a rolling 12 months action plan prepared in time for the commencement of a new calendar year. Every staff member in the School of Engineering was involved in discussing the five- and three-year plans, resulting in an almost unanimous strategy. Those who still had reservations were invited to discuss their concerns with the Dean of the School of Engineering individually, to allow more expanded explanation. In time every staff member of the School of Engineering accepted the direction set-out in the five- and three-year plans. The five-year plan gave a more visionary and less specific action requirements than the three-year plan. The 12-month rolling action plan is a detailed statement of what is to be done, when and by whom. The 12-month action plan is reviewed monthly so that delayed items may be further looked at to allow catch-up or modifications so that the overall plan at the end of the year is achieved. Agreement on the 12-month action plan was only made between the three Heads of Departments with the Senior Administra-

tion Officer together with the Dean being charged with the implementation of the action plans. The Dean, however, maintains a Managing Director role of overseeing the overall strategy as well as the action plans and in particular ensuring the proper human resource management personally. The latter ranged from location of a washroom to policy on equipment borrowing as well as to policy on staff development and consulting.

One policy that did take some time for staff to come to grips, was the introduction of the Quality Assurance (QA) concept into the management of the School of Engineering. The accomplished lecturers felt that their excellence was not recognized, while the less accomplished ones were concerned they may be found out. In short, it took quite some time to convince everyone that QA can only do good for each individual in the School as well as for the School itself. The major contribution of the QA concept in fact is in ensuring that the 'customers' are always properly served. This then set everyone thinking as to *who* are the customers of an engineering school and *how* to properly serve them, with *what* and *when*. This exercise resulted in the restructuring of the administrative support area, a policy on immediate service over the counter at the general office, the number of telephone rings allowed, the commissioning of a facsimile machine in the School, telephone redirection, a policy on continuous telephone answering between opening and closing time of the office, and on the academic scene, the appointment of Director of First Year Engineering Studies and the general division of the entrepreneurial and the academic areas of the school of engineering management as shown in Fig. 1. The Table below summarises other achievements following the change in management style of the school of engineering at UCCQ:

Area	Savings	Comments
Photocopying	50% reduction	previously photocopied materials were now bound and sold at the university bookshop, thus allowing students to have complete subject material for the whole semester, at beginning of the semester

Area	Savings	Comments
Telephone	20% reduction in charges	better control of the telephone accounts assured staff that school management is serious in reducing telephone costs; the use of facsimile communication proved to be cheaper than verbal communication, especially since most calls are either to Brisbane (700 kms away) or interstate.
Stationery	20% reduction in charges	although staff initially felt the control on this was intrusive, it is generally accepted now that a more efficient use of stationery is exercised
Approach in Teaching	up to 70% in time for marking of assignments	working smarter and not necessarily harder is now the motto, without reducing effectiveness of student learning
Approach in Resources	unquantifiable	everyone is aware of the possibility of obtaining items and equipment as donation; all try to reduce any type of wastages in the operation of the school of engineering
Budget	eliminated deficit in the first 8 months at the rate of \$10K/mth with the succeeding 12 months incurring a surplus	allowing proper planning of the school of engineering income and expenditures, staff development and lately a purchase of upgraded PCs to double the facility for computer-aided-drafting and design of the school's centre for computer-aided-engineering with no costs charged to the university's central account; increased support staff therefore relieving academic staff from doing routine tasks such as photocopying when required, responding to enquiries and other administrative work
Contracts Mgmt	enormous overall	encouraged by successes in the budget management of the School, a similar approach was taken with respect to the management of contracts, such as computer software/hardware maintenance and licence; as some maintenance contracts were initially negotiated on ad-indefinitum basis, the savings accruing from deleting this requirement after paying the licence fully cannot be enumerated - simply huge; renegotiation of quotes allows further reduction in purchase costs (was never done before)

The better control of the budget was facilitated by the development by the Senior Administration Officer of the School of Engineering, of simpler prints-out and more efficient reduction of data supplied by the Finance Section of the university. Such facility allows the Dean and the other Heads of Departments of the School of Engineering to quickly scan and compare budget data on a monthly basis accurately. Such is the usefulness of this program that even the Finance Section themselves advocated its use by the other Schools on campus. Needless to say that the close working relationship between the Dean and the Senior Administration Officer is essential to ensure that no surprises occur in the financial management of the School, and that financial and budget plans are on target.

The above simply shows that without the practice of systems management all the seemingly unrelated attacks on costs and wastages would not have been possible. More importantly, as also shown by the comments in the Table, the attitudinal changes in the staff of the engineering school were quite marked, even if the staff concerned were not fully conscious of them.

CONCLUSION

With the changing climate in engineering education and the rather passive community perception of engineering in Australia, engineering schools in the country's universities must look at other means of attracting both students and resources.

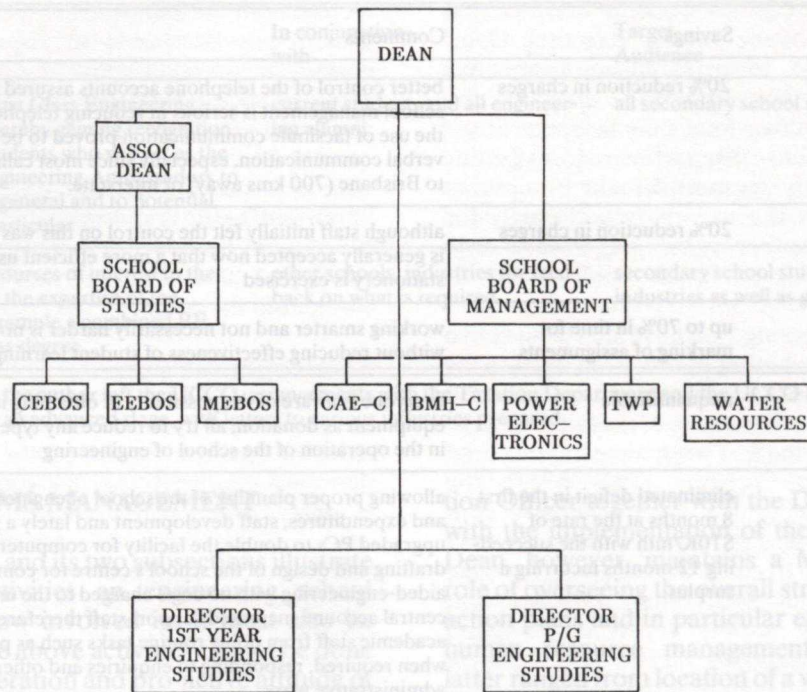
In one of Australia's regional tertiary institutions, the UCCQ, the introduction and practice of business-like systems management by the engineering school has proved highly beneficial and relevant. Having attained the required cohesiveness amongst the staff of the school and their acceptance of the changing direction in the management of the school, the heretofore deficit of the operating budget was turned to surplus within eight months and various savings shown previously were achieved.

Future endeavours of the School of Engineering would not be possible without continuing to manage the school in the same manner, as introduction of new courses, reduction in staff teaching loads to allow them to carry out research which increasingly underwrites the very existence of a university and others, can only mean more cash requirement. Unfortunately, cash is no longer forthcoming either from central university administration or the government. This is further exacer-

* Paper accepted 14 September 1990.

† Naren Vinnik Associate Professor

‡ Lewis Thygesen is Professor and Chairman

**Notes:**

1. Chairman of School Board of Studies (ex officio): Dean
Executive Officer of School Board of Studies: Assoc. Dean
Members: Heads of Departments, Chairmen of Departmental Boards of Studies, Director of 1st Year Engineering Studies
2. Chairman of School Board of Management: Dean
Members: Heads of Departments, Associate Dean

Legend:

- CEBOS = Civil Engineering and Building Board of Studies
 EEBOS = Electrical Engineering Board of Studies
 MEBOS = Mechanical Engineering Board of Studies
 CAE-C = Computer Aided Engineering Centre
 BMH-C = Bulk Materials Handling Centre
 TWP = Timber and Wood Products Research Centre

Fig. 1. Structure of the James Goldston School of Engineering.

bated by the fact that Schools of Engineering will need more of the cash because of the need to increase the elusive student numbers, educating the community and the employers of the engineering graduates and the local (i.e. Australian) manufac-

turing companies as a whole. The latter are an imperative for the survival of the country's economy and without engineers their fate is sealed. Schools of Engineering must help to provide the vision.

REFERENCES

1. L.H. Cook and M. G. Porter *The Minerals Sector and the Australian Economy*, Allen & Unwin (1984).
 J.S. Dawkins *Higher Education - a policy statement*, Aust. Govt. Publishing Service, Canberra (1988).