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Establishing a Computer Science Program with Staff Shortages in a Developing Country through an Electrical Engineering Department*

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Development experts, in the wake of the IT revolution, generally see Computer Science as a pathway to advanced economic status bypassing industrialization. Many countries have therefore made IT development a high priority and universities have been charged with and pressured into rapidly developing suitable academic programs in Computer Science. In the Third World where human resources in high-tech fields like Computer Science are scarce, a successful Computer Science program can be developed through an Electrical Engineering Department. The resulting failures and challenges in developing such a program in a developing country context are described. Such successful programs can be sustainable, particularly if they are located physically close to the metropolis.

Keywords: Education; Computer Science; Electrical Engineering; Staffing; Visiting Faculty

COMPUTER SCIENCE

THE IT REVOLUTION is seen as a phenomenon on par with the industrial revolution. The UNDP, the UN's global development network, in consultation with developing country stakeholders, has urged "National ICT" for Development Strategies [1]. In the UN's words, IT is a panacea for all ills: "Information and Communications Technology (ICT) is an increasingly powerful tool for participating in global markets; promoting political accountability; improving the delivery of basic services; and enhancing local development opportunities" [1]. The places that succeeded in IT (e.g. Bangalore) are a flagship for many countries that believe that making the populace IT-savvy is far easier and less costly than the traditional route to development through industrialization [2–4]. Indeed, the physical infrastructure for a Computer Science degree program is much cheaper to establish than that for an engineering degree program with big laboratories. In the United States, NSF calls for international cooperation in Computer Science with a view to advancing development [5].

By the year 2000 the world had recognized information technology as a key in learning at all levels. In UNESCO's Dakar Declaration or "Education for All 2000" [6], the international community pledged in paragraphs 10 and 11 to include information technology as a key component in learning and teaching. Teachers were to be trained in using IT in the class. Decentralization and computerization of educational administrations were pledged. Every course had to have an IT component.

BRAIN DRAIN

However, the brain drain [7] has made staffing these new programs difficult. The brain drain is the phenomenon whereby educated persons migrate to the West, draining Third World countries of the small pool of talented persons whose presence is so critical to national development [7]. In a pernicious twist, instead of natural resources, the best brains are now transferred from the former colonies to the West. In this process the Third World effectively undertakes at its own expense the expensive training from kindergarten to first degree for the elite graduate workforce in the West, affecting university level education more than any other. A further problem accentuating the brain drain is the worsening terms of trade [7] which makes migrating to the West more attractive for professionals and staffing programs, installing infrastructure and acquiring educational tools increasingly difficult.

Large countries such as India with an industrial base of their own and universities with strong research programs have adjusted to the problem by training their staff internally [8]. Indian books have a sufficiently large market to justify local editions. Industry is sufficiently advanced and the markets reasonably large to manufacture goods

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including educational equipment in a protected market until industries have a chance to grow, stabilize and be competitive.

In smaller countries like Sri Lanka, however, such a course is not possible. Being small, training local staff would amount to inbreeding. Reinforced in part by colonial thinking, postgraduate qualifications from the West are still the main route to respectability for a university don. The first Faculty of Engineering trained local students for University of London's external degree and acquired standards that were described as lately as 1971 by Britain's Council of Engineering Institutions as high.

Today, accentuated by the brain drain subsequent to 1970 when First World salaries rapidly increased [7], and further complicated by the civil war, the Sri Lankan engineering educational establishment is badly staffed. Exemption from academic requirements based on the Sri Lankan degree for corporate membership in British professional institutions is no more—the reasons being the system's failure to modernize and the loss of fluency in English owing in part to the brain drain (with even many of the teachers who teach engineering in English unable to write or speak English properly). Such a collapse for the same reasons is a common experience in many countries after independence and the lessons of this paper apply equally to most former colonies.

Skewed specialties

The brain drain has skewed the development of Third World universities [7] and the specialties they offer. Electrical engineering moved away from power engineering around 1970 and US civil engineering classrooms collapsed in size through the 1980s. Since then, generally speaking, the best-staffed engineering departments in Sri Lanka are civil engineering and the electric power sections of electrical engineering [9]. This skew has to do with comparatively fewer jobs being available in the West to doctoral students in these fields at the end of their studies, forcing their return home.

An accentuating effect of this change of emphasis away from electric power and civil engineering in the West is that these fields offer relatively more graduate scholarships to Third World students. For, with tenured staff and few students in these departments, several scholarships are offered abroad as "Foreign Aid" by European governments to read for higher degrees from these departments. Thus even as Third World departments try hard to move their curricula away from the traditional fields, more and more Third World graduates specialize in these fields in the West and, unable to secure employment there, return to reinforce these fields in their home departments. For example, in the Faculty of Engineering at University of Peradeniya recently, although about 250 of the class of 320 asked for specialization in electrical and computer engineering, only 90 were allowed, while 150 were put in civil engineering although only about 50 asked for it. This assignment is based on staff availability and historic patterns of resource allocation from the 1970s when civil engineering enjoyed a boom through several development projects, especially in the Middle East. The electrical engineering department has some 14 Ph.D. level staff of whom only four are not power engineers. The civil engineering department has 25 or so Ph.D. holders. On the other hand, the mechanical, production and chemical engineering departments have only about two Ph.D. holders each [9].

This skew is reflected in the research output of the universities. The country as a whole in the year 2000 produced only nine ISI-indexed engineering articles. Of these only five were truly local, the other four having been based on work in a foreign laboratory during graduate studies or postdoctoral assignments [10]. The five local papers were all in civil engineering, reflecting mainly the lighter

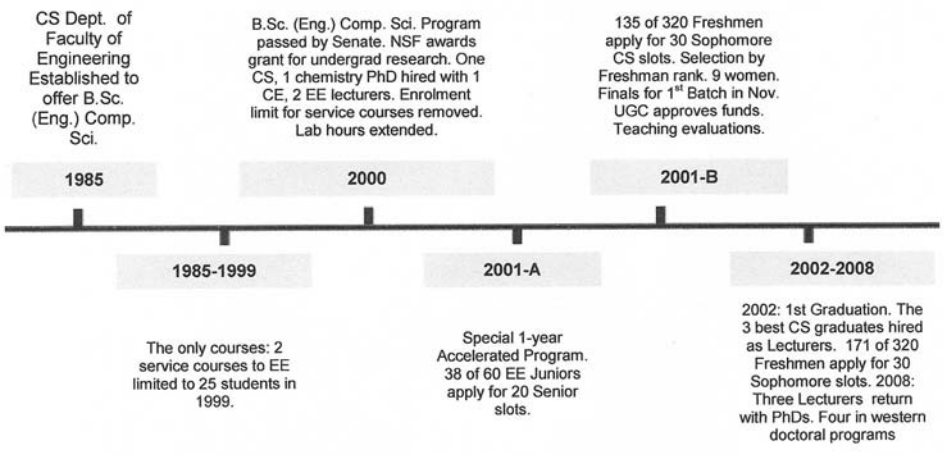

Fig. 1. Timeline and enrolment as CS Department is developed.

teaching loads in the overstaffed civil engineering departments.

Thus the engineering specialties offered by Sri Lankan and other similarly situated Third World universities are preponderantly the traditional ones and these are well taught, well staffed and well equipped [9]. The departments do little research but their graduates are well prepared.

Some early decisions—is a large high-powered staff essential?

When the author was made Head of the Department of Computer Sciences in Jan. 2000, the charge was to offer a Computer Sciences/Engineering specialty in a department offering only service courses till then and lacking a specialized degree program for 15 years since being founded in 1985 (Fig. 1). The task was daunting, especially without staff.

An early decision was not to plan immediately for the ideal Computer Science product. Instead the focus would be on producing the best possible given the circumstances, giving them a deeply theoretical training that would stand them in good stead anywhere. Bright, motivated, first-degree holding electrical engineers would do some of the teaching; there would be no waiting for the classic research-scholar teachers.

Three factors were given cognizance in going ahead with this staffing. First, in the best days of the university in the 1950s, most teachers had only a good first degree. And it was this university's first Vice Chancellor, Sir Ivor Jennings, who went on to be Master of Trinity House and Vice Chancellor of Cambridge [11]. Second, Purdue University where the first Department of Computer Sciences in the United States was established in October 1962 did so with only five teaching faculty, not all full time—the Head was a numerical analyst who had been an Associate Professor, joined by two Assistant Professors from mathematics and electrical engineering, an industrial engineering doctoral candidate and an Instructor [12]. And third and most importantly, the first collegiate institution in Asia, the Batticotta Seminary, founded in 1823 in Sri Lanka (then Ceylon) by the America Ceylon Mission from New England, at the time had usually one or at most two first-degree holders from New England on the staff, the rest having been locally trained. In the words of Sir James Emerson Tennent, Colonial Secretary, after visiting the seminary: "The knowledge exhibited by the pupils was astonishing and it is no exaggeration to say that in the course of instruction and in the success of the system for communicating it, the collegiate institution of Batticotta is entitled to rank with many an [sic.] European University" [13].

These examples suggested that motivation in staff is far more important than Ph.D. degrees and research credentials, although the latter would be ideal. The needs for the Computer Science specialty were so high and the precedents cited so comforting that the risk was well worth taking.

A recruitment drive yielded one Ph.D. holder in Computer Science (who, lucratively employed abroad, had just returned for personal family reasons), a woman B.Tech. graduate from the prestigious IIT system in India who had specialized in computer engineering, and some high-performing electrical engineering bachelor's degree holders who had always wanted to be computer engineers and were therefore well read and self-taught in the Computer Sciences (Fig. 1).

TEACHING—ELECTRICAL ENGINEERING LEADERSHIP

"Many CompSci departments at US universities were offshoots from math departments in the 1970s, and the emphasis on providing a rigorous mathematical foundation for the computing disciplines is still evident in many CompSci curricula. Computer engineering programs largely developed in engineering departments strong in electrical engineering. The practical aspects of development and use of computers, as in digital logic design and processor interfacing build on an engineering student's knowledge of electronics and circuits." (paraphrasing John Board and colleagues [14]). Therefore in the absence of Computer Science staff, electrical engineers or mathematicians could be used to begin a program.

The Papua New Guinean model provided a third possibility where the development of Computer Science and information systems came through the business school [4].

However, in most of the Third World where the introduction of computers was relatively late, the only possibility was to start with electrical engineering staff since it is mainly electrical engineers who were first exposed there to computing (as early as 1972 in Sri Lanka with the IBM 1130). Indeed, when universities were established in the 1950s and 1960s in newly free countries with enviable bank balances, good engineering faculties were also founded. The need for Computer Science came later in the 1990s at a time when the terms of trade had worsened and these countries' economies had often been run down under corrupt administrations. Generally therefore, when these staff-short countries seek to establish Computer Science, they often have a good engineering faculty to look to for leadership. As for leadership from mathematicians in the Third World, till very recently they were exposed to little or no computing—sometimes not even to word-processing. So that was not a possibility. The decision by the university to establish the new Computer Science program with electrical engineering leadership was vindicated at National University of Singapore (which pays higher emoluments than western universities and is ranked 22nd internationally [15] and can therefore get any staff profile it chooses). Singapore started a computing specialty within a new cross-faculty Department of Engin-

eering and Science around 2006. The department's two initial academic staff members were from the university's own electrical engineering department and from a mechanical engineering department in the US.

Student recruitment

Although the students had asked for the Computer Science specialty under engineering, it was by no means clear that they would opt for it at the end of their first year unless they saw that the standards were good. Admission to the university is highly competitive. The cream of the physical sciences from the national high school exam is taken into engineering and the next lot admitted to the science faculties. Therefore students felt that they had worked hard to read engineering and would now be downgraded into science if they chose Computer Science. Computer Science in Sri Lanka is relatively new and not understood as anything beyond Microsoft Word which many tutories teach privately for school-leavers and secretaries. Departmental allocation of students involves asking all first year students to mark their preferences by department and assigning in the rank order of first year aggregate marks. As an interim measure, because of student pressure, a special route was established for Junior electrical students to specialize in Computer Science in their senior year (Fig. 1). The recruitment drive for students first had some 38 applying for the 20 Computer Science slots available. It was disappointing given the wide initial expression of interest. Besides, all those in the first batch were male.

However, as students saw the curriculum being implemented under international guidelines [16, 17] and its new features as detailed here and below, demand went up to 135 of the 320 Freshmen asking for Computer Science. The previous 20 slots were increased to 30 by the Faculty Board reluctantly; reluctantly because this extra number would come from other departments as the total number in the Faculty was fixed at 320. Special teaching methods and escort services after dark were introduced to attract women students [18]. The effort paid off when there were nine women students out of 30 in the second batch of Computer Science students (compared to the Faculty's typical 11–15% female population).

Other efforts were also launched to attract students to the poorly staffed department. Teaching evaluations of departmental staff by students were introduced for the first time against resistance from other departments. The exercise conveyed the impression that the Department cared about its students. Instead of using the clerically approached allocation of students for industrial training as done by an office of the Faculty, companies where students wanted to be were directly approached by the Department with much success. To overcome the bias against the word "science," the name of the Department was successfully changed to Department of Computer Engineering by a proposal to the Faculty, Senate, Council and University Grants Commission. By the third batch the Department had 171 of the Faculty's 320 students asking for the now increased 30 slots in the Department, no doubt attracted by the special efforts and the Department's liberal ethos, and driven by the higher salaries drawn by IT professionals outside. The new and poorly staffed department had the best students in the Faculty as a result of the high demand.

CURRICULUM AND ITS DESIGN

The curriculum was designed:

1) Identifying what ought to taught using professional institution and accrediting agency guidelines [16, 17], the syllabi of established universities, and industry input
2) Optimizing what would be taught from what needs to be taught, based on the competencies of those available to teach
3) Refining this over Faculty and Senate discussions. A restriction was that the first year would be the same for all departments (a Faculty requirement).

In the interim, since Electrical Engineering and Computer Science have much in common [19], the curriculum was designed to use many electrical engineering courses to ease the burdens of the small staff. Thus, the teaching responsibility of the Department in the first two years of the curriculum was minimal. Designing in 2000 (free of the framework of 1950 when the Faculty was founded) was an opportunity to explore new subjects such as human rights [20] and communications, thereby overcoming the old criticism that the Sri Lankan engineering curriculum is weak in treating the humanities and social sciences.

The then prevailing system of academic regulations flowed from University of London. University of Peradeniya [as the legal successor to University of Ceylon (established in 1942) which in turn was the successor to University College Colombo (established in 1921) affiliated to the federally organized University of London established in 1836] had prepared students since 1921 for London degrees. These regulations required three-hour examinations at the end of every course, which had to be yearlong in duration. Although London had long since introduced course units, flexible examination styles and curricula including more than 20% humanities for engineers as reflected in the Washington Accord [17], departure from these rules was seen as whittling away at the old high standards. The conservative assertion of the status-quo was a natural reaction in a system laboring under a colonial mindset and the brain drain, very unsure of itself. The National University of Singapore with similar

antecedents had moved away from these rules only as late as 1994.

As a result, the curriculum, as presented in Table 1, had to be designed to fit not only ABET regulations in anticipation of that day when ABET accreditation would be sought, but also ancient university regulations. Two modules were put into one to fit the yearlong style. Practices in Software Engineering had all the humanities and presentation skills packed into it. The senior project was disguised as the coursework (that is laboratory component graded as pass/fail for eligibility to sit the final examination) for Practices in Software Engineering. Studying humanities being unusual to Sri Lankan engineering students, this was an opportunity to get students to engage in lengthy prose writing and use that exercise to teach grammar and writing skills at the same time. A moot court while teaching human rights was used to force the students to argue cases in English and develop their presentation skills. Getting students to argue in the moot court for "clients" of the other ethnic side advanced harmony [20, 21]. As engineers/scientists doing the teaching without formal qualifications in English or the humanities, such teaching had to be approached delicately to avoid denial of permission by the Faculty Board. Thus the brief "The Engineer in Society" in the approved syllabus disguised much of the liberal studies and communications material to be covered.

An informal survey of industry leaders through the year 2000 was disappointing. The survey was by academic staff members in the course of student/graduate placement meetings with potential employers and intern-hosts, asking them about what they wanted to see in the graduates. The result appeared to suggest that they only wanted English fluency and competency in specific packages. They seemed interested only in high IQ programmers good in English for working with their international partners and whom they would train internally. Given the traditional commitment of a university and the profession to engineers as analysts and designers, the curriculum could not be altered because of this advice. But the coursework now emphasized programming assignments, writing and familiarity with packages imparted through exposure through coursework using packages donated by industry leaders.

Many courses indicated in Table 1 were electrical courses re-designed to teach Computer Science/Engineering. For example, Electromagnetism and Lines included memory devices, optical guides, layout design and microstrip lines. The standard finite elements course taught to electrical engineers became the CAD Techniques course; but emphasis was now on pre- and post-processing, mesh generation techniques, graphical user interfaces and matrix computation with sparsity. Software engineering with development focus, besides the latest software packages, was included.

The curriculum was supplemented by improvising every opportunity to fill any gaps. CISCO (the network provider) offered certification courses off campus. The Department worked closely with CISCO in offering courses to university students and encouraging and facilitating students to get certified. Many did so, some in parallel with their degree studies. When qualified friends in the West visited, they were cajoled into giving some lectures on their own work. Unfortunately the ossified regulations required the syllabus to be approved by the Faculty and the Senate of the University, a several months long process—the matter had to be placed on the agenda of the monthly Faculty Board meetings well in time, approved, the minutes then approved at the next meeting, the Faculty recommendation then passed to the monthly meetings of the Senate where too the process had to be repeated until the minutes of the Senate were approved. So the Department with the full agreement of the enthusiastic students suspended all lectures when a person was available and let him conduct a 45-hour course—lectures every morning and hands on work through the

Table 1. Curriculum (all courses are year long)

Year 1 Course List:	**Year 3 Course List:**
The same as all other engineering streams	301 Mathematics
	332 Signals and Communications
Year 2 Course List:	335 Electromagnetism and Lines
271 Mathematics and Programming	372 Information Theory and Computer Algorithms
203 Mechanics of Machines	373 Operating Systems and Parallel Computers
205 Applied Thermodynamics and Mechanics of Fluids	374 Computer Architecture
230 Electrical Networks and Systems	
231 Applied Electricity	**Year 4 Course List:**
	401 Industrial Engineering
	471 CAD Techniques for Electrical Devices
	472 Practices in Software Engineering
	473 Communication Networks and Digital Signal Processing
	474 Computer and Data Networks
	And any 2 courses from the elective list of the CS Department with departmental approval—Artificial Intelligence, Advanced Computer Architecture, Robotics, Telecommunications Policy, Magnetic Recording, and all EE Electives

afternoons and nights. Scheduling extra classes later made up the lost time. Since these courses were not part of an approved course, the Department issued individual certificates. Although such learning was not reflected in the transcripts of the students, the principle was that actual learning is far more important than formal certificates.

Delivery of Computer Science curriculum with staff shortage

The problems to be addressed in delivery were staff, labs and texts. The one Ph.D. holder in Computer Science was assigned the task of teaching the fully Computer Science courses that usually only a Computer Science person could teach best (operating systems, compilers, etc.). He was overloaded with several other courses: Java, compilers and operating systems in particular and certain specialized topics such as Prolog as parts of courses taught by others. Thereafter Java was picked up by the younger electrical engineers who had sat through his lectures for the first batch of students. The rest of the technical courses would be handled by the author, new electrical first-degree holding junior staff and senior electrical engineering department staff volunteering their time. Enthusiastic younger electrical staff members taught Programming (C++). This was the first time engineering students in the Faculty had been taught programming beginning from the second year. The author's spouse, a chemist, joined the Department on sabbatical leave and prepared all the material and did some of the teaching for liberal studies and communications courses. She also helped with administrative issues, freeing this writer to do more teaching. To address the costs of western texts, notes were developed and web-posted.

At the beginning there were 13 PCs for a class of 20 students and the service courses. The computer labs were facilitated by initially opening the lab beyond the traditional 8 AM to 4 PM day, going on to 8 AM to midnight. Networking and Internet services were provided by a Swedish International Development Agency (SIDA) grant to the university. Junior academic staff worked enthusiastically by virtually living in the lab when the university said there was no overtime money for the non-academic staff and objections were raised over the security of equipment after hours. Later, through a generous allocation from University Grants Commission, the equipment was multiplied manifold (Fig. 1). The junior staff managed the computer labs and associated LAN voluntarily since they simply wanted to learn. A Japanese International Cooperation Agency (JICA) grant took care of the digital equipment. Agreement has been obtained with the Third World Academy of Sciences (TWAS) in Trieste, Italy, to train Sri Lankan Computer Science Departments in setting up radio-linked networks so as to increase connectivity. Some software packages were officially provided at no extra cost by vendors when PCs were bought.

The Indian computer engineer with help from the electrical department's Ph.D.-holding motor control personnel for guidance, taught Microprocessors. The author with his academic, research and industrial background in finite element field computation for electrical devices, conducted courses in Software Development and Maintenance, Graphics for Computer Aided Design, and Parallel Computing (algorithms as well as architecture). For the latter, without equipment, compiler simulators were used and experiments were structured on putting PCs together as a

Table 2. Response to departmental survey (average score of range 0–5)

Question	Departmental Score*	
	Computer Science	Other Departments**
Summary: Mine is a forward-looking Department. I am happy to have been here	5.0	4.1
1. I will leave the Faculty with happy memories	4.8	4.3
2. I am happy in my department	5.0	4.2
3. I have a reasonable mix of lectures and labs	4.8	4.0
4. My time is well occupied with lectures and coursework	4.8	3.8
5. The dept. administration is open to corrections	4.7	3.3
6. The administration listens to and respects students	4.5	3.5
7. The syllabus is modern and reflects current trends	4.8	3.2
8. My teachers are good teachers	4.8	3.9
9. My teachers help in personal problems and advise me with career decisions	4.4	2.6
10. I have a good relationship with my teachers	4.8	3.4
11. I am not scared/afraid of my teachers	4.8	3.8
12. Questions during the lecture are encouraged	4.8	4.1
13. I can easily approach my teachers to ask questions	5.0	4.0
14. My teachers are punctual and reschedule any cancelled class	4.6	4.1
15. My teachers are competent and up-to-date	4.8	3.7
16. My teachers are well prepared for their lessons	4.7	3.9

* Key: Strongly Agree—5, Agree—4, Neutral—3, Disagree—2, Strongly Disagree—1.
** The other Departments of the Engineering Faculty: Electrical, Civil, Mechanical, Production, Chemical.

distributed system with message passing. He taught the subjects of artificial intelligence and neural networks with electrical staff members who had used AI techniques in power systems and machine design. Optimization, a subject that power engineers know well, was introduced as an elective in the context of layout design and electromagnetic interference.

A senior staff member keen to move out of power systems first taught himself computer networks and then taught it with other self-taught younger staff members. The digital hardware and instrumentation person in the electrical department taught architecture, interfacing and so on, in addition to digital electronics. One who had done economics for billing as part of power distribution had used his expertise to set up a course on Databases that had already been a service course for power students by the Computer Sciences Department before starting this degree specialty.

Senior design projects were rooted in Computer Science but drew from real problems at the university and ongoing electrical engineering design projects relevant to Computer Science. Examples are developing an Internet-accessed database in place of the card-based catalog in the library, computer network design and implementation for the campus, and AI, neural networks, magnetic recording systems, and computation for ongoing staff projects in power. The National Science Foundation through a grant funded these projects, resulting in ISI-indexed papers by undergraduates from a Faculty where staff with doctorates rarely published abroad.

Quality Assurance

Most staff members involved in teaching in the Department, though well qualified in their own fields, did not have the experience or the ethos of a computer department. With a view to quality assurance therefore all efforts were carefully coordinated with a system of "Exam Moderators" involving appropriately specialized professors in the West who went through every final year question paper and model answers prior to exams and critiqued them. Moderators hailed from such places as University of Birmingham, Rensselaer Polytechnic Institute and University of Rhodes. Given the situation, nearly all their advice was accepted so as to uphold academic integrity even if it ran counter to academic freedom. Likewise, all final year exams were re-graded by each moderator to reinforce quality assurance.

In addition to the teaching evaluations mentioned, going to class 401 Industrial Engineering, which every one of the 320 students in the final year in Faculty had to follow, a survey was done in July 2001 with the permission of the Instructor. Looking for an assessment of the Department in relation to the other departments, students were asked to identify their department as Computer or Other and then answer 16 questions and a summary question on a scale of 1 to 5. The Department did well in all questions (Table 2) and fared better than the rest of the Faculty on every issue with no average score below "Agree" on its good qualities. The Faculty reacted adversely and ordered that such surveys never be done again. In the event, however, the Department felt reassured by that one survey about being on the right track.

In a department very short of computer specialists, shifting away from an almost fully technical curriculum eased the shortage of specialized staff. But the massive changes resulted in fear. The large number of students wanting to be in the Department resulted in an inquiry into whether the high student demand was because of diminished standards and poor testing—especially after the best students coming into the department resulted in more than the usual first class degrees. The inquiry under a three-person Faculty Board committee was lengthy and vexing as students wondered if the Department would be shut down leaving them in the lurch as the first and last engineers in Computer Science. The Committee consulted 20 or so experts from abroad. Their advice and views were useful in buttressing the controversial decisions taken. For instance, the Faculty Board had not regarded hands-on programming as "practicals" and insisted that the Department have the practical classes so essential in engineering training. The advice from Birmingham (in response to a query from the inquiry) that one third of the student's time should go into practical programming obviated the criticism; as did the view of the students in answer to question 3 of the survey in Table 2. The report also helped make improvements. For example, the suggestion, again from Birmingham, that software engineering include discussion of the complete software lifecycle including requirements analysis and software testing was implemented. Ultimately the inquiry vindicated the experiment by concluding that the Department advanced high academic standards through its degree program.

Of particular pride to the author is the following passage from the university's governing Council's parallel inquiry report [22] on the formal charge (by faculty colleagues against this writer) of diminishing high technical standards by including liberal studies in an engineering exam, euphemistically titled in the charge sheet as "including extraneous material":

> "It should be noted that the role of the universities today is much wider than in the days of [the founder] Sir Ivor Jennings. The demands of society too are very different to what they were half a century ago . . . An enlightened and liberal approach is very necessary to lift the quality of those that go through the portals of our seats of higher learning, making them employable and competitive with graduates of other universities, both local and foreign. Students must cross departmental and faculty boundaries in order to get an all-round education . . . The benefits of such interaction are so multi-faceted that they need no elaboration."

SITUATION TODAY

The experiment begun early in the year 2000 reached maturity by 2008. The Department's graduates are well placed in industry and well received. All are fully employed unlike the other graduates of the Faculty and on average they draw as much as 2.5 times what the other employed graduates from the Faculty earn.

Many of the changes mooted by the Department and approached with fear by the rest of the Faculty are now in place across the Faculty. The university is pressing teacher evaluations and many staff members are voluntarily doing them. There has been a complete change over to the course unit system. Humanities courses including human rights are being taught without any disguising and even boasted about at meetings of the Institution of Engineers Sri Lanka by those who once preferred charges. The Senior Design Project is a mainstay of the curriculum throughout the Faculty. Programming taught only to computer students was seen to be so useful that it is now a requirement for all first year engineering students, allowing the Department to teach it at a deeper level. A text was required so that the majority of entrants to the Faculty who had never touched a computer may be introduced to it. Such a special text was therefore written for an orientation program for new entrants to the Faculty laying out the rudiments of IT. With cost in mind this has now been published through Cambridge University Press (India) in a way it can be also used in teacher education programs [23].

Over 75% of the Department's first graduates entered graduate programs in the West, having done exceptionally well in the GRE exams, many scoring the perfect score of 800 or close to it in the analytical, quantitative and subject sections, although the verbal section still shows a need for improvement. The best graduates, recruited as Lecturers (Probationary), went on fully paid leave in Australian, American, British and Canadian graduate programs, legally committed to returning after their doctorates. Three are back. The Department is now stable. The returning graduates pick up new specialties in the course of their graduate studies and complement the core curriculum that is now in place to enrich the curricular offerings.

DISTANCE EDUCATION/REGIONAL AND INTERNATIONAL COOPERATION

In a resource scarce situation, pooling of the scarce resources is important. The author has participated in the "SAARC Forum of Open University Vice Chancellors, Colombo 1999." (SAARC is South Asia Association for Regional Cooperation). The goal is for all SAARC counties to get together and share valuable resources though distance education. There was much agreement on addressing the problems of disparate standards within SAARC—exchanging credits (between 3-year and 4-year degrees, yearlong courses, semester courses etc.), different academic standards at schools and universities (the differences making admission to common bachelor's and master's programs difficult) and so on.

However, the effort has not delivered as much as it promised except for a joint Executive MBA/MPA program involving the Commonwealth of Learning (based in Canada) and the Open Universities of SAARC [24]. Regional rivalries have made regular meetings of the forum difficult. At the beginning in 1999 the idea was mooted to use Indian educational TV from Indira Gandhi National Open University (IGNOU) in New Delhi to broadcast lectures. Even in the short time since then technology has changed so much that the widespread connectivity of the Internet today and advances in speeds appear to make the Internet the more viable medium for delivery [25]. The new Computer Sciences program has much to offer in this area. The Department has worked on offering courses involving laboratory components through the web [26, 27].

As Chairman of the University Grants Commission's Standing Committee on Information Technology Development, the author has obtained agreement among all the Computer Science Departments in Sri Lanka to share course material, do joint teaching when possible and place such material on the web, and do accreditation-like reviews of each other. The first such review, however, has been indefinitely postponed due to the onset of hostilities in the prevailing civil war.

The author on an Indo-Lanka Cooperation visit obtained the commitment of the Chairman of the Computer Science Department at Hyderabad University to send teachers on short-assignments to do accelerated courses if the need arose. In addition, the 7-member University Grants Commission, with the participation of the author, approved a scheme in 2004 whereby academics in the SAARC region could be invited to hold Chairs in Sri Lanka for a year. The Commission would meet their salaries and expenses including travel and housing. The Fulbright Commission in Colombo also has been requested to send Computer Science professors. Every avenue has been tapped to obtain help.

Reliance on visiting faculty

University of Colombo has a successful Computer Science department because it could rely on computer scientists working in Colombo, the capital, to help as visiting faculty and it took a leisurely approach starting from 1984 out of the mathematics department when foreign aid was targeted to train their own staff abroad over some years before offering a degree in Computer Science.

Looking at the faculties outside Colombo that have ventured to start Computer Science programs but have failed, the presence of a core teaching

team in the electrical engineering department is judged as making the difference at University of Peradeniya. University of Jaffna in the very North, whose similar efforts in starting a Computer Science program were headed by their staff of the mathematics department, after several years still has its computer graduates not reaching the required breadth of specialty and a reasonable level of acceptability in industry because mathematics does not have the common specialties that electrical engineering has with Computer Science/Engineering. Likewise, South-Eastern University in Eastern Sri Lanka, struggled for long with its Computer Science program that was launched by its science faculty and now manages by moving the Department to a suburb of Colombo, far away from the university, where visiting lecturers from industry and established teachers from Computer Science departments in Colombo do the teaching. Thus in a staff short situation, if there is no electrical engineering department nearby to help, it is very important to have industries close by where professionals can be tapped to be visiting lecturers.

CONCLUSIONS

The factors that create the need for and affect the development of Computer Science in a Third World setting have been identified. A successful Computer Science program was begun with electrical engineering leadership with few staff in a department that had been founded in 1985 but had failed to take off for 15 years until then. Electrical engineering staff are uniquely positioned to start new sustainable computer programs that are usually very difficult to staff. Motivation in staff is far more important than their qualifications. The innovative ways identified of making departments student-friendly in a conservative, hierarchical developing world context, help very much to overcome the obstacles and challenges and to attract students to a poorly staffed computer department. Starting Computer Science programs early regardless of staff shortages is important provided there is an electrical engineering faculty to help or a pool of personnel close by in industry to draw from as visiting staff. Waiting for the ideal starting conditions like staff and facilities, is to wait forever as University of Peradeniya did from 1985 to 2000.

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