- Professor R.H. Paul Memorial Lecture 1987 -

ELECTRICAL ENGINEERING EDUCATION IN SRI LANKA

by

Prof. S. Karunaratne

The history of electrical engineering education in Sri Lanka is naturally a part of the history of engineering education in the country. Formal engineering education in Sri Lanka commenced with the establishment of the Technical School in Colombo in 1893 which was renamed Technical College in 1906. This was established with the intention of providing facilities for general technical education in Civil, Electrical and Mechanical Engineering in addition to providing skilled manpower to the various technical government departments. In 1908, however, a Commission of Enquiry decided that there was no sufficient demand for electrical and mechanical engineers in the immediate future to justify the maintenance of advanced courses in these subjects. The Commission, further, suggested that one scholarship in civil engineering be offered by the government through open competition for studies in England. Even with the establishment of the University College in 1921, engineering was not included as an academic discipline. However, it is on record that from 1923 this college had a system of awarding university engineering scholarships for science graduates to proceed to the United Kingdom to study for the engineering degree.

On the list of University scholars, a notable name is that of Professor R.H. Paul, who won the scholarship in 1924. Professor Paul, later held the post of Director, Ceylon Technical College (CTC) and subsequently was appointed the first professor of electrical engineering of the University of Ceylon. He is presently regarded as the father of electrical engineering education in Sri Lanka.

In 1933, with the reorganisation of the Ceylon Technical College and the appointment of Mr. E.R. Bartlam as Principal, it was made possible for local candidates to prepare for the B.Sc. Engineering (external) degree of the University of London. The first candidate from the Technical College completed his degree in 1935. However, regular courses for the degree commenced only in 1942 with the reorganisation of the Ceylon Technical College which became a Government department separated from the Department of Education. Among the reorganisation proposals for the College at that time were :

1. The College was to be developed to become the centre for technological instruction in the island;

   and

2. The College was to offer courses leading up to the London University degree in Engineering and to Associate Membership of the Chartered Institution of Engineers.

Professor R.H. Paul, making an appropriate comment had this to say about engineering education in Sri Lanka.

Prof. S. Karunaratne, BSc(Eng), Dip.EE, MSc(Eng), CEng, FIEE, FIE(SL), MCS(SL) is presently the Head of Department of Electrical Engineering, University of Moratuwa. He graduated from the University of Ceylon in 1960 and did his Post Graduate work at University of Glasgow, University of California, Berkly and UMIST.

"Prior to 1942, engineering education in Sri Lanka had been a Cinderalla among the learned professions. Whereas long standing regular schemes existed for a number of years for turning out lawyers and doctors, no training facilities existed for turning out professional engineers. If one wanted to be an engineer one had to proceed abroad to study at one of the Universities or Technical Colleges".

The year 1942 could be recorded as an important eventful year from which there had been a regular output of engineering graduates with a Bachelors degree in Engineering of the University of London.

It has been recorded that up to 1952, the total number of engineering graduates who passed from the CTC totalled 104. Of this it is estimated that about 20-25 were in the field of electrical engineering.

From the table with shows the number of students who sat and passed the B.Sc. Engineering degree it can be concluded that the courses have been firmly established and the intake had been substantial, in the period 1942 - 1950.

Year	Number sat	Number passed (both Parts I & II)
1942	6	3
1943	16	15
1944	20	12
1945	24	17
1946	50	28
1947	74	45
1948	84	49
1949	99	09
1950	142	80

With the establishment of the Faculty of Engineering of the University of Ceylon in 1950, the courses leading to the B.Sc. Engineering, London were discontinued. Courses leading to the B.Sc. Engineering, Ceylon were started and facilities at the University of Ceylon, Thurstan Road and at the Ceylon Technical College were used initially till the facilities were developed at Peradeniya.

The faculty was headed by the Dean of Engineering, Professor E.O.E. Pereira and the Department of Electrical Engineering was under the able guidance of Professor R.H. Paul, the first Professor of Electrical Engineering in Sri Lanka who had shown academic excellence from the 1920's.

The admission to the faculty has been rather modest with an intake of only 25 students to follow courses in the three branches of specialisation viz. Civil Engineering, Electrical Engineering and Mechanical Engineering. Of these only about a quarter were reading for the Electrical Engineering degree.

Around 1956, the faculty of engineering was assisted by the United States to upgrade its facilities. Under this aid package, some equipment and some academic staff were provided by the U.S. The electrical engineering department had the services of Professor M.C. Hughes of the Texas A & M University, College Station to supplement the electrical engineering staff comprising of one professor and four lecturers.

In 1957, the faculty doubled its intake from around 25 to 50 and it steadily increased thereafter. In 1964, the faculty of engineering shifted to Peradeniya thus concluding the long association of the faculty with the Ceylon Technical College at Maradana, Colombo and the University premises at Thurstan Road. In 1986 certain important events took place which are of interest to electrical engineering education. The retirement

of Professor R.H. Paul, the appointment of Professor W.P. Jayasekera at the University of Peradeniya and the establishment of degree level engineering courses at the newly formed Ceylon College of Technology at Katubedda, Moratuwa, headed by Dr. L.B. Sumanadasa, an eminent engineer and educator were significant events.

The inauguration of the Ceylon College of Technology at Katubedda, Moratuwa and the establishment of engineering degree level courses there, have their origin in a report of the Commission of Inquiry on Technical Education published as a sessional paper in 1963. This commission was chaired by a well known engineer, T.P. de S. Munasinghe and one of the other members being Dr. S. Gnanalingam, a former lecturer in electrical engineering of the University of Ceylon. It is this report that recommended among others :

- The establishment of a College of Technology and the conduct of engineering courses of the sandwich type and of five years' duration.
- The award be named Dip.Tech(Eng) and that this be recognized as equivalent to the Engineering Degree.
- Commencement of such courses in Civil, Mechanical, Chemical and Electrical Engineering with provision for specialisation in Electric Power, Communication and Electronics.
- The first year course followed, by the engineering students in the Faculty of Science be taken over by the Faculty of Engineering and be integrated with the engineering degree course.
- Introduction of a compulsory "General Paper" at the final examination based on a course of lecturers in such subjects as Principles of Economics, Industrial Management and Psychology and Labour Relations.

The commission in arriving at their recommendations studied the manpower requirements at the level of engineer in the country by reference to the previous data available on the subject and also by a comprehensive survey. The relevant extracts for electrical engineering are reproduced below.

Dr. Saks' (ILO Manpower Expert) Survey (1951)

	Employed in Oct. 1951	Vacancies in Oct. 1951	Expansion needs 51-57
Electrical Engineers	129	29	40

Planning Secretariat Survey of Engineers (1958)

	Employed in 1958	Vacancies in 1958	Additional No. required by '82
Electrical Engineers	206	46	62

Munasinghe Commission Survey (1961)

	Employed in 1961	Vacancies in 1961	Additional requirements 1962-1970
Electrical Engineers	204	75	96*

* Estimated as the original survey has certain omissions.

With the establishment of the College of Technology (with some assistance from the UNESCO) and the creation of three professorships in electrical power, electronics, telecommunication and the significant changes made to the syllabi in the field of electrical engineering at University of Peradeniya at about the same time, the diversification of electrical engineering education had begun. The number of students reading for the electrical engineering specialisation more than doubled. With the students of the College of Technology been subjected to a training of one year in industry, the diversification

of the electrical engineering education had been as expected in the Munasinghe report.

With the appointment of Professor S. Karunaratne as the Professor of Electrical Engineering and Professor K.K.Y.W. Perera as Professor of Electronic Engineering in 1969 at the College of Technology, there were 3 chairs filled in this field, which could be considered as a rare event.

The change in the University Act in 1972 and the establishment of the University of Ceylon (which became later the University of Sri Lanka) incorporating the existing Universities and the College of Technology, the degree of B.Sc. Engineering was conferred on those who successfully completed the 5 year course at the College of Technology. From this year onwards there was a steady increase in the output of electrical engineering graduates in the country.

Up to 1971 the total number of B.Sc. Electrical Engineering graduates who passed out from Sri Lanka amounted to 169. From then onwards with the two faculties preparing students, the numbers were significantly more as shown in the table.

Year	From Katubedda, Moratuwa Electrical + Electronics & Telecommunications			From Peradeniya Electrical & Electronics	Total
				169 (up to 1970)	169*
1971	07 + 07	=	14	11	25
1972	10 + 12	=	22	13	35
1973	11 + 11	=	22	20	42
1974	17 + 13	=	30	19	49
1975	19 + 26	=	45	10	55
1976	30 + 14	=	44	10	54
1977	20 + 12	=	32	25	57
1978	25 + 12	=	37	07	44
1979	18 + 13	=	31	02	33
1980	19 + 23	=	42	12	54
1981	16 + 23	=	39	07	46
1982	22 + 25	=	47	14	61
1983	30 + 27	=	57	21	78
1984	28 + 29	=	57	17	74
1985	21 + 26	=	47	17	64
TOTAL	272 + 247	=	566	374	940

* Vide Appendix I for details.

The output of electrical engineers in the period 1942-1952 when the Ceylon Technical College was charged with this responsibility has been rather low, amounting to only 3-4 on the average per year. With the establishment of the Faculty of Engineering of the University of Ceylon, a significant increase in the number took place. In the period 1952-1970 the university produced on the average 8-10 electrical engineers per year. With the establishment of the Ceylon College of Technology which later became the University of Sri Lanka, Katubedda Campus and the University of Moratuwa, Sri Lanka, the number of electrical engineers passing out almost quadrupled. In the period 1971-1984, University of Peradeniya produced on the average 13 per year whereas the University of Moratuwa on the average produced 37 making a total of 50 per year. Thus it is seen that there has been a significant increase in the number of electrical engineers passing out of the Universities.

This is considered a remarkable achievement as these results were achieved despite the shortages of lecturing staff in both faculties of engineering. Despite the creation of two more professorships in electrical engineering at the University of Peradeniya (present incumbents being Professor W.M.G. Fernando and Professor J.A. Gunawardena) and the payment of an allowance to engineering lecturers, still the terms and conditions are not yet adequate to attract suitable lecturers to the departments of electrical engineering at the Universities and the maintenance of quality of the electrical engineering degree is becoming increasingly difficult.

The present output of about 70 is unlikely to change significantly unless other degree granting institutes are established under the new Universities Act.

While the path through the Universities is the direct path to become an electrical engineer, a few students, mainly those who had completed technician courses sit the CEI (London) Exams viz. Parts I and II, qualifying to become electrical engineers, provided they have adequate laboratory and practical experience.

Unfortunately due to the CEI and IEE not being strict about laboratory and practical experience, some students have passed both parts I & II by studying for such exams privately without ever being enrolled in a Technical College or similar Institute. It is also heartening to note that EC is taking some steps now to ensure that laboratory and practical work are done by students before they are allowed to sit the Part II Examination.

The Institution of Engineers, Sri Lanka too has established a course for preparing students to become electrical engineers. This Institution insists on very stringent entry requirements, for example, the satisfactory completion of a technician level course with significant amount of laboratory and practical work or passing of the GCE Advanced Level Examination and a significant involvement in engineering for a period of 3 years duly signed by chartered engineers to seek gain entry to follow a one year part time course for Part I and a two year part time course for Part II complete with theory and practical work, the practical work being mainly done at the University of Moratuwa.

Despite the strong effort put into this course, both by the Institution and the lecturers concerned, for the last 12 years, the number passing out to gain Associate Membership has been few except for the last two years. Vide Appendix 2. The fact that all such students are employed and study only part time, and the fact that the average age

of these students being high and family responsibilities that some carry are significant factors which are reflected in the results.

As at present all electrical engineers passing out of the Universities and the Institution of Engineers, Sri Lanka find gainful employment. In fact, the demand from industry, was so great that hardly any were available for 'soft jobs' such as sales engineers or technical type managers. But the indications are clear that in the next few years, the demand for electrical engineers will be such that the output will be more than the demand. The demand as such vary with the various policy decisions taken by the government as the bulk of the engineers are employed in the state sector.

Since the policies vary frequently, it is not possible to match the supply with the demand as the gestation period to educate an electrical engineer is 4-5 years and the policy changes take place much more frequently. Also from the view point of the educational system, there is naturally a resistance to any reduction of numbers. As such the present numbers will be maintained over the next few years, or may be slightly increased with the hope that a good 'pickup' in the electrical engineering services and industries will absorb the excess in due course.

So much I have said regarding the numbers of electrical engineering students over the last 30 years and permit me to say a few words regarding the developments in the content too.

With the passage of time, from the early fifties to-date, there has been a continued progress and improvement in the standard of the degree. The standard has been maintained in level with the degrees of the UK earlier but with the adoption of 3 year degrees in UK the standard of our degree had been pitched slight at a higher level than the British degree. Now that UK is going for the 4 year engineering degree, the levels would be comparable again.

The contents of the degree have undergone much change. For instance in the mid sixties matrices were introduced to the curriculum in a big way. Computer programming and use of Fortran language was initiated around 1969. Around the same time specialisation in electrical power engineering and electronics and telecommunication was made available. Electrical power systems were taught separately from electrical machines and this brought about more content in power systems. Separate courses were also made available in high voltage engineering. With such diversification, fault studies in power systems involving large number of nodes were handled. Load flow analysis, both by non-iterative and iterative techniques became common place in the final year class room. Newton-Raphson technique and its modifications and the use of sparsity techniques were introduced to the students. Power System stability was previously confined to the most elementary systems. The use of Runga-Kutta techniques, predictor corrector method etc. in the solution of higher order differential equations and in the solution of vector differential equations became common place. This made it possible to incorporate the P-f Controllers (governor system) and Q-V Controllers, (excitation controller) the time constants of turbines and generators and the reaction of the loads to frequency and voltage in the analysis of stability.

Sensitivity analysis of large power systems, the state space approach in the solution of such systems has been recognised. Reliability analysis and power system planning became a regular feature in the final year examination papers.

With the use of matrices and transforms, generalised theory for electrical machines and transformation from d-q components to phase components and vice versa were recognized as common methods. With the increase in importance of power electronics, electrical machine control and analysis using thyristors, diacs and triacs and special purpose IC's were emphasised.

With better understanding of the power system components and their behaviour at high frequency, students have been able to accurately model such components and the behaviour of the system to both switching surges and lightning surges were better analysed. With the modal transformations surge phenomena on multiconductor systems, use of Fast Fourier Transform (FFT) in their analysis were made known to undergraduate students.

All these things were made possible mainly due to the fact that electrical engineering undergraduates were expected to study digital computer programming. It was found that computer programming was best studied by themselves and not by teaching. Most students became experts in programming using Basic, Fortran, Pascal etc. and with the availability of fine algorithms to solve problems, solution of almost any problems became possible and within reach of the students. The availability of powerful microcomputers with different language compilers and large scale disc and main storage of computers greatly contributed to the computer proficiency of the electrical engineering undergraduate.

Facilities for computer based training have been enhanced in 1986 by the establishment of a degree in Computer Science and Engineering.

The introduction of the undergraduate project in a serious manner also made it possible for the student to achieve that self confidence required to prove himself of this ability to undertake and tackle serious problems.

Post-graduate education in electrical engineering has been lagging for a long time. The first master's degree candidate passed out in the early 1970's and upto now only about four candidates have been awarded the master's degree in electrical engineering. A significant change in 1986 is that about 14 have registered for a M.Eng. Course in electrical engineering and 4 have registered for the degree by research. This of course is an unusual phenomenon and is not expected to be a common feature in the subsequent years.

In conclusion, may I say that in the academic training of electrical engineers, we have come a long way and we have a long way to go. I for myself entered the university as a young student over 30 years ago. Ever since, I have been at the Universities here and abroad except for my 'flirtation' for a brief period with the State Engineering Corporation. Now I have come to the autumn of my life. On looking back for any blossoms of my life. I see very little. Achievements of one, except in rare cases, are far and few in between. I have tried to find some thing to be left behind for my students, perhaps for those yet to come. I have had little success in this search. Apart from the pleasure I have derived by teaching around 600 electrical engineers out of around a total 900 upto now, my legacy is rather insignificant. Nevertheless, I like to leave on record that legacy, insignificant it may be, in the form of the following equations which I have developed for the solution of two common problems in power systems, namely the load flow problem and the stability problem which I teach to every electrical engineering student each year. They are, with the usual notations:

$$[Q_m] = [H]\,[V]$$

for non-iterative reactive power flow, Karunaratne (1973)

where $Q_{mi} = Q_i - P_i\theta_i$

and P_i and Q_i are obtained from the already known equation

$$[P] = [H]\,[\theta]$$

and $$\Delta\delta_n = \frac{1-\lambda}{1+\lambda}\Delta\delta_{n-1} + \frac{(\Delta t)^2}{M}\frac{P_{an-1}}{1+\lambda}$$

for the point by point solution of the Swing equation in the presence of damping, Karunaratne (1986)

where $= \frac{K\Delta t}{2M}$, K being the damping factor.

This resembles the traditional equation for the solution of the swing equation without damping, namely

$$\Delta\delta_n = \Delta\delta_{n-1} + \frac{(\Delta t)^2}{M} P_{an-1}$$

formulated by Dahl in 1938.

References

1. Report of the Commission of Inquiry on Technical Education Sessional Paper X - 1963, Govt. of Ceylon, 1963.
2. Education in Ceylon. A Centenary Volume, Ministry of Education & Cultural Affairs, Ceylon 1969.
3. Seventy Fifth Jubilee Souvenir, The Institution of Engineers, Sri Lanka, 1981.
4. 'Use of dc network analyser for ac load flow studies', Transactions, IESL, 1973, S. Karunaratne.
5. 'The dc network analyser: an effective instrument for the teaching of the load flow problem'. IJEEE, Manchester, 1978, S. Karunaratne et al.
6. 'Synchronous Machine transient stability analysis by an extension to the point by point method of solution of the Swing equation'. Engineer, IESL, Sept. 1986. S. Karunaratne et al.

APPENDIX I

Output of Electrical and Electronic Engineering Graduates from the University of Peradeniya. (This includes those who graduated from University of Ceylon, Colombo before shifting of the Engineering Faculty to Peradeniya in 1964.)

Year	No. of graduates (approx.)
1953	2
1954	6
1955	4
1956	-
1957	9
1958	6
1959	6
1960	6
1961	9
1962	10
1963	8
1964	5
1965	14
1966	11
1967	20
1968	15
1969	19
1970	19
TOTAL	169

APPENDIX 2

Output of Electrical Engineering Graduates from the Institution of Engineers, Sri Lanka after passing IESL Part II Examination.

Year	No. of graduates (approx.)
1974 Dec.	1
1978 Dec.	1
1979 Dec.	3
1981 Jan.	4
1982 Jan.	5
1983 Jan.	3
1984 Jan.	4
1985 Jan.	8
1986 Jan.	14