ENGINEERING EDUCATION AND REQUIRMENTS OF INDUSTRY

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1.0 INTRODUCTION

The engineering education in Sri Lanka is now more than fifty years old. The first faculty of engineering celebrated is golden jubilee last year. Three other faculties of engineering have come into existence since then. As such it is a very apt time to be examining our success or otherwise of providing the types of engineering education that is best suited for our country.

In this respect we must recognize the wide ranging changes that have taken place in the country, socially, economically, politically and environmentally. We will certainly be considered failures if we cannot change our ways at least now to keep up with these changes

It is my intention to briefly look at the circumstances under which the engineering educational system evolved fifty or more years ago and to discuss the current status. It is questionable if the changes that have been made in our education system by design or by force of circumstances are indeed the type of changes we desire or are those needed for the country at large.

It is important to examine diligently the real needs of the industry under the changed circumstances and question the match we have attained between the quality of engineers we produce and the engineers needed by the industry and thereby the country.

The very fact that a seminar such as this is being held is a very healthy sign that the universities have realized the need for such self criticism. I would like to venture some comments on the quality of the match mentioned above and offer some suggestions for your consideration.

Some of these views I have already expressed at various workshops and seminars held over the past year or two at the faculties of engineering. Since their validity have not diminished I have taken the liberty of repeating them today. Also I believe that most of these ideas have equal relevance to all streams of engineering not limited to Mechanical Engineering.

2.0 PRESENT EDUCATION SYSTEM

The present secondary education system which revolves around the fierce competition to enter the universities is to be blamed for many of the deficiencies we find with the engineers passing out from our faculties. The all pervading tuition shop culture has crept in to the universities too. As such the concept of " Learning to Learn" which should be the basic philosophy of university education seems to be forgotten. Thus the very

attributes that a student should gain to be a successful engineer are not developed.

Obviously, there is a need to revamp our system, content and methods we employ in engineering education. Let us discuss this in detail later on. In addition many of the students who join the faculties of engineering neither have any liking for engineering nor have any idea what engineering is about.

3.0 UNIVERSITY CURRICULUM

The practice of engineering and the engineering education in the era when the first faculty of engineering and its predecessor Ceylon Technical College were established were naturally influenced by the needs of the plantation industries and the priorities f the colonial rulers at the time. But since then has there been a cautious examination and a revamping of both the syllabi and the methods of teaching to meet our own national priorities ?

The need to revise the curriculum is already recognized and moves are underway already at Peradeniya and Katubedda. The new faculty of engineering at Ruhuna has the excellent opportunity to take a fresh look at the needs of today and thus commence work with a well balanced curriculum.

Those engaged in this process of revision, should study the requirements for change from the point of view of the needs of the country and the development of the graduates, who venture out to fulfill such needs. They should have the courage, if necessary, to entirely overhaul the existing system, recognizing the fact that, there has been no major revision of the curriculum for a long time.

The Gross Domestic Product (GDP) of the country increased from **Rs. 62,246 Million** to **Rs 695,934 Million** over the past two decades (1980 to 1996) . The output of engineers increased only from about **300 per year** to **600 per year.** But, the country still has a problem of unemployment or under employment of engineers. This, in spite of the fact at least 20-30% of the engineers may have emigrated.

Isn't this a clear indication that the curriculum or perhaps also the way it is taught, does not produce the type of engineers that the country needs? The 11 fold increase in the GDP should have created such a dearth of engineers so that the need to commence the Faculty of Engineering at Ruhuna would have arisen ten years ago. This certainly was the case in places like Malaysia and Singapore.

This may be a good time to ask the question " Who is and Engineer? And what is the contribution expected from him in Industry or any other place of work ?" Whilst there are many definitions and answers to this question I would like to quote the following definition.

The Engineer

The Engineer in contrast to a Scientist deals primarily in the application of the scientific knowledge. He also discovers facts about the artificial world created by man. Engineers design and plan projects, processes, products, procedures etc. They strive to achieve efficient use of resources, evaluate and forecast the behaviour of systems and planned programs.

The Technician

In contrast the Technologist or Technician works in all phases of construction, production and applications in producing the end result f a given plan or design. Through their knowledge of Mathematics. Science and Engineering Principles the see that the design is transformed in to as et of working plans. They provide assistance in organizing the work force , materials , equipment to construct, operate, complete and maintain an engineering project or production facility.

They are involved in the improvement of existing products and processes devices and procedures. They may specialize in sub fields such as drafting of design plans, quantity surveying, and costing, monitoring of production or construction processes. They oversee or conduct tests and measurements to verify that the plans and designs are implemented correctly.

A technician through experience and study would elevate his position to that of a Technologist or Engineer when he will involve himself in the design phase as well. ...

Aren't our engineers particularly the Mechanical Engineers doing the job of the technician most of the time and perhaps that too poorly, as they have not got the training a technician should get? Also how many of our employers and Industrialists really do appreciate the true value of an Engineer capable of perfuming the role as defined as above.

4.0 THE REQUIREMENTS OF THE INDUSTRIES AND COUNTRY

Successive governments since 1977 have clearly opted for rapid industrialization of the country as the path to development. Since there has been no change of this policy with the change of the government in 1994, Sri Lankan engineers need to be competent to accept the challenges that come with industrialization. The mechanical engineers have a major role to play in ushering in this process of industrialization. Naturally, the education system has to be streamlined to produce the engineers who have the make up to take over this important task.

What are the skills and attributes our graduating engineers should gather in this context? This question is better answered by a rhetorical question. What are the demands on the engineers who enter the job market and what opportunities are there for them to exploit?

The response from The Confederation of British Industry to the British Government's Green Paper on **" Development of Higher Education in**

the 1990s" states that **"The industry's prime requirement of the higher education system is good, rounded graduates possessing those basic skills and qualities appropriate to employment in industry, and on which future careers can be built."**

It is important to recognize the vastly changed state of the national economy over the past decades or more, particularly in respect of the greater contribution made by the industries as compared to the essentially agriculture based economy of yesteryears . Even in agriculture the need for more mechanization and for post harvest processing facilities is growing rapidly.

No doubt many of our graduating engineers find employment with the industrialists and consultants and contractors engaged in these economic activities. But, the all important question is, are they doing the job of an engineer or that of a technician? Are they using the valuable technical knowledge that they should have picked up to the best advantage for their place of employment as well as for themselves?

Do the industrialists and other entrepreneurs realize the contribution that can be made by a properly trained and skillful engineer to his industry or other enterprise? Would they not be able to expand their industries much more economically and with confidence, if our local engineers can provide the expertise needed, rather than rely on imported technologies, experience and equipment? How many such ventures may have been shelved, delayed or even not contemplated due to excessive costs, when relied upon imported expertise? Does not this equate to that many job opportunities not made available for our engineers?

We often hear of the myth of transfer of technology as an additional boon for the country as a result of foreign investment. I doubt if any investor will be ready to hand over their hard won advantages of knowledge to a third party except for a very large financial consideration which will certainly not be within our resources. However the amount of information that a clever engineer can pick up is enormous. But do we have the type of engineers who have the capacity and the inner drive for such accumulation of knowledge?

We have to accept the fact that, the availability of engineering materials and processed goods, that ultimately go into the assembly of a factory, manufacturing plant or even a garment industry is practically nil locally. As such, all costs of such imported goods have to be calculated in Dollars or Pounds, which when converted to Sri Lanka Rupees would naturally give the prospective entrepreneur a rude shock. But, need we also pay for the engineering designs that would be needed to put together the industrial plant in Dollars or Pounds? What guarantee do we have that a foreign engineer who may not have even visited Sri Lanka would provide a design optimized to meet the Sri Lankan circumstances? Wouldn't he naturally specify using his experience in his own country, most likely a developed country, and recommend the import of even simple components that could be designed and fabricated locally for a fraction of the cost?

What degree of automation and sophistication would he incorporate in his design without proper understanding of the availability of facilities needed for maintaining such items. Isn't this approach tailor made to add unnecessary costs to discourage all except the most lucrative of industrial ventures?

5.0 THE QUALITY OF THE MATCH BETWEEN THE NEED AND THE PRODUCT

It is regrettable that, this situation has come about due to our inability to establish the credibility of our engineering capabilities. Naturally, the interface the industrialists and other entrepreneur will have with the engineering profession is through our own graduates that they interview and hopefully employ. If they are unable to exhibit their true value, then we enter the long downward slide of loss of confidence from which it is difficult to extricate ourselves. So the industrialists are driven to seek equipment and expertise from abroad.

It is common knowledge that "Foreign Expertise" often comes in a "Package" best suited to the "Giver" than the " Recipient" be it so called aid or paid for in hard cash. .

However, there are also several examples to the contrary which gives us hope. I can point out in detail only my own experiences with Haycarb Limited where I have been working over the last ten years. Haycarb Limited which pioneered the manufacture of Activated Carbon in Sri Lanka twenty five years ago, now has a production capacity of 17,000 tons per year in two factories in Sri Lanka and one factory in Thailand. Of these all the processes and equipment at the main factory with 10,000 ton capacity were all engineered and built by Sri Lankan Engineers. The equipment in the second factory in Sri Lanka which was bought over was built by foreigners but we had to practically rebuild the processes and equipment to make them at least as efficient as our own designs. The factory in Thailand had to be refurbished entirely by us to make it a viable venture..

There are several institutions in Sri Lanka that make good and profitable use of the capabilities of our own engineers. Unfortunately the number of such institutions is very limited. It is the responsibility of the Faculties of Engineering to change this picture drastically by turning out engineers with the correct make up.

6.0 THE OPPORTUNITIES OF TODAY FOR MECHANICAL ENGINEERS

The shortage of foreign exchange in the decades of 1960 and 1970 and the restrictions on imports of even the basic engineering raw materials should have been a great impetus to the development of engineering in Sri Lanka, by innovative use of local resources of men and materials.

We did not gain from this valuable opportunity, as the training we had given our engineers did not provide them the attributes required to meet such challenges. Of the several attempts to commence manufacturing industries such as the two-wheel tractor very few if any were successful. At the same time even the old existing engineering firms from the Colonial Era were in a rapid decline due to lack of innovation.

The removal of the import restrictions with the advent of open economic policies in 1977 thus found us totally unprepared. Such relaxation should have sparked off an exponential growth of local engineering activities. Instead what we saw was an influx of manufactured equipment and engineering goods as well as foreign engineers and technicians to handle even the most simple engineering works. Our engineers were working under carpenters and welders who called themselves engineers.

Today after more than two decades of free economy, we are in the same situation with local entrepreneurs looking for foreign engineers to design even the types of buildings we designed and built several decades ago. The lack of support from the government to local engineering companies including the state owned corporations has compounded this situation.

We are presented with a third opportunity , perhaps a mix of the two previous situations and may never be repeated. In this light we must look very positively at several circumstances that are thrust upon us. These are the FAFTA agreement and the lapsing of the Multifibre agreement and the end of the era of Quotas for the garment industry. While these are viewed in fear as road blocks to development they could also be the harnessed as valuable opportunities by entrepreneurs with vision provided that the local engineers could lend them the necessary support with confidence.

Our engineers should be able to make their presence felt and their value recognized by the industrialists, entrepreneurs and the government officials.

This can be possible only by giving them the tools and the training necessary. This would need to be done as part of the University Engineering Education as the employment opportunities as well as the investments would be mainly from the private sector. These would include many companies who do not even currently have any engineers, thus we cannot expect them to be providing training of fresh engineers even if they were willing to do so. However difficult it may be the faculties of Engineering will have to take up this burden at least to some extent.

7.0 THE CHANGES NEEDED

I have presented a very bleak picture so far, which unfortunately is the true situation. However, as in every black cloud, there is a silver lining of hope. There are still some entrepreneurs who are willing to entrust some of our engineers with challenging projects and to develop indigenous engineering solutions. The continually deteriorating parity rate of the

rupee against the major currencies could encourage more industrialists and businessmen to join this small group.

However, their courage in doing so can be vindicated if we at the Universities could inculcate the young engineers with the necessary attributes to take up the challenge successfully.

In addition the Government through the Ministry of Industrial Development has prepared a Master Plan for Industrialization over the next decade covering seven sectors of industry. The objective of this Master Plan is

" To change the local industries from the current Resource Based and Labour Intensive nature to a Knowledge Based and Technology Intensive culture"

If this Master Plan is to be successfully implemented it would require the dedicated and hard work of hundreds of capable engineers, mechanical engineers in particular.

However such engineers should definitely be capable of undertaking the work of an Engineer as defined above and not that of a technician.

8.0 ATTRIBUTES DESIRED IN A GRADUATE ENGINEER

The qualities which would launch a young engineers to a rewarding and exciting career, on this path while helping our country in its development efforts should include.

1. Through understanding of the engineering science relevant to the chosen field of engineering

2. Ability to relate such knowledge to practical situations

3. Ability to formulate practical problems for theoretical analysis

4. Ability to recognize the key areas or parameters which need in depth analysis Vs less significant parameters which can be analyzed with simplifications without danger or undue compromise of performance of the project

5. Ability to co-ordinate the skills of colleagues or other engineers of different field which has contributory influences on the project in hand

6. Adequate understanding of related fields of engineering to be able to do such co-ordination with confidence

7. Ability to recognize and relate the engineering aspects of the project to Commercial, Financial, Environmental, Social and perhaps Political aspects adequately

8. Ability to communicate with colleagues, superiors related professionals so that the value of the engineering inputs receive due recognition. This would naturally require the confidence generated through thorough evaluation and understanding of the project in hand as well as oral and written communication skills.

9. Unstinting commitment to the job and perseverance and will to succeed. This would also include the ability to look for alternative solutions when the common or obvious route does not provide the necessary results.

10. Willingness to stretch himself to perform the detailed work needed or to assimilate the new areas of knowledge needed to ensure success of the project.

Our challenge is to ensure that we help all our graduate engineers gain most if not all of the above qualities.

9.0 RECOMMENDED CHANGES AT UNIVERSITIES

I would like to repeat some suggestions made in earlier occasions which would help us develop engineers with the above mentioned qualities.

- A programme to ensure that all new recruits to the faculty are required to gain minimum of 2 year industry experience prior to or not later than two years of their recruitment.

- Improve the present industrial training programmes for students, by making it

  a) compulsory
  b) of minimum duration of 6-month continuously,
  c) evaluated with co-operations from the training institute
  d) be a component of the overall course credit system of the student.

- Modifying the present project assignment, by making it compulsory and relevant. This, too should be an essential part of the students' final academic evaluation. It is essential that the projects be of some substance and value so that, the students would undertake the assignment with enthusiasm. After all, this would be the first test of their ability to fit the eventual working environment.

- Lastly, I suggest that we take a very close look at our practice of trying to teach all students, the entirety of the syllabus as presently constituted. Should we not ensure that all students are given the best foundation for learning the science of engineering so that, what is taught to all students are the essential that would be needed and used in their day to day career of this 90% of the graduates. I suggest we have an optional stream for those who choose to undertake an

- additional year of further study, even with a possibility of awarding an MSc. I believe that this system if in vogue in many countries now including UK

- Provide avenues for further study not necessarily qualifications for the passed out graduates so that they can fill in the gaps in their knowledge and skills to fit the profile described above

- There is a suggestion that future subjects for A-level and university entrance be selected from three groups of subjects. Essential, Related and Free Choice. I suggest that, we should encourage the students to continue their studies in a chosen subject not directly related to the engineering science ,such as Law, History, Humanities, Social Sciences, Art, etc. They should be given the opportunity to read, write and participate in activities in their chosen field

10.0 Conclusion

No doubt there are many difficulties and pitfalls in our path, and definitely the machinations of interested parties who would like to see us remain an subservient nation for ever labeled an underdeveloped . Also many deficiencies in the engineering infra structure could deter one unless filled with confidence and perseverance. But our challenge is to develop the type of engineers who would consider such difficulties themselves as part of the challenge and thrive. The fun is not in the money or the position but in winning in the face of such adversity.

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