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How best to sustain engineering and technology education in the West African sub-region

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ABSTRACT: Funding has proven to be a great obstacle against sustainable engineering and technology education in the West African sub-region. The structural functionality of the education itself is an even greater problem. It is envisaged that the *application-integral* approach will position the *horse* in front of the *cart*, which hitherto had not been so! The systems approach should replace the present outdated standalone departmentalisation format. Project-oriented engineering education imparts practical abilities and will encourage the interest of industry, governments, public enterprises and individuals to sponsor the education sustainably by using serious endowments and education tax funds, as well as campus-based revenue generation.

INTRODUCTION

In a sustainable education system, the standard of education and training, and the resources available per student or staff in the future, should be equal to, or greater than, those available per student or staff today! In the West African sub-region, for example, the falling levels of all of the education variables makes it obvious that sustainability has been the clearest missing attribute in engineering and technology education.

In many Western countries, technological development came not by way of analytic engineering theories, but rather by way of practical industrial work. The principal *fuel* of the Industrial Revolution, the steam engine, was not a development from analytic theories. The steam engine was first invented before knowledge of the theories of engineering thermodynamics, fluid flow and mechanics were applied in order to refine and develop the equipment. Therefore, education in engineering becomes functional and productive after practical equipment and systems have been invented – often by persons who are less versed in the various engineering theories and sciences [1].

In West Africa, when colonialists finally recognised the move towards independence, they left within decades, in a hurry, as it were, without establishing the practical (industrial) foundations for functional, productive, and hence sustainable engineering and technology education, systems. The local political leadership in West Africa was pre-occupied with establishing the political foundations for democracy or autocracy, as the case may be, immediately after independence. In order to score political points, many universities and polytechnics were established in a hurry – without proper practical foundations!

The engineering and technology products (graduates) of these theoretical universities and polytechnics are generally unable to seize the abundant market opportunities in order to establish industries because they lack the requisite skills and sound practical knowledge in engineering and technology entrepreneurship.

To date, West African countries are still putting the proverbial *cart* before the *horse* in engineering and technology education. Therefore, as the trainee later becomes the trainer, and existing facilities and resources depreciate, the standard of engineering and technology education continues to decline. As student populations continue to escalate and the resources available per student dwindle rapidly, the concept of sustainability had almost been forgotten in this region!

SUSTAINABLE ENGINEERING AND TECHNOLOGY EDUCATION

Sustainability in engineering and technology education can be seen from the following perspectives:

- The identification of fail-proof source of basic funds, which are required for the maintenance and replacement of existing facilities, as well as the payment of minimum salaries and wages for basic manning levels.
- The removal of wastage (through increasing productivity) in education and training activities.
- The activation of financial and other productivity means from student practical/laboratory activities.
- Sustainable administration of repayable students bursary awards, even through legislation.
- The establishment of education tax funds from corporate profits.
- Intensive institutional involvement in internal revenue generation ventures linked with some of the other perspectives.

- Increases in the functionality of education by including skill training through campus-based apprenticeships.
- The stimulation of employment through extensions of campus-developed products and services to later self-employment supported from campus.
- Industrial and corporate endowments.
- Sustained national budgetary provisions.
- Linkages and exchange programmes with global and international schools.
- A rethinking of the national value system for productivity purposes.

PROBLEMS IN FUNDING ENGINEERING AND TECHNOLOGY EDUCATION

Governments in the West African sub-region bear the brunt of educating engineers and technologists as the average citizen can hardly afford it. Furthermore, few industries in the sub-region show very little interest in contributing funds to educate these future professionals while they are in the academic institutions. Industries feel that they will still invest many funds in re-training them upon first entry into a job.

There are hardly any significant endowment funds for financing the engineering and technology schools, as their products have made no real impact in large-scale industrialisation in West Africa. Furthermore, most of the major industries and rich public organisations are foreign-owned and so do not feel obliged to establish endowments for *chairs* in engineering and technology education in institutions in the sub-region.

Although countries in this sub-region are signatories to various UNESCO agreements and recommendations, the governments fail to implement these recommendations at home! The budgets for education in the sub-region hardly exceed 5%, which is contrary to the 26% recommended by UNESCO. In fact, in the Nigerian 2002/2003 budget, the *democratic* government's allocation to education was 1.8%, despite strong protests from the nation's virile academic staff unions.

If the budget attention recommended by UNESCO for education were to be heeded, sustainability in funding would have been partially guaranteed in the West African sub-region for engineering and technology education. Presently, the falling standards are also partially attributable to non-existent or dilapidated infrastructure, laboratory equipment and badly needed technology-enhanced education.

The reasons advanced by governments for their inability to heed UNESCO recommendations on funding education in the sub-region involve the exacerbating foreign debts and other contending and *equally important* sectors of national development and service. UNESCO should therefore use its good offices to persuade the creditor nations to not only cancel debts for the sub-region, but also agree to a special UNESCO fund for engineering and technology education in the sub-region.

The funding problem should ultimately be addressed through industrial, governmental, individual and organisational endowments for sustainable financing.

Other areas to be considered for sustaining the financing of education may be found through the education taxes that are paid by profitable corporate organisations; fund-raising by campus-based ventures, research consultancies and funds that are fed back from profitable alumni business initiated from campus.

THE PROBLEM OF VALUES AND BRAIN DRAIN

The salary and service benefits that are paid to teachers in the engineering and technology areas in the West African sub-region is about the lowest worldwide! Therefore, although great brains abound in this sub-region, they often migrate to other countries, especially the USA, or else to local industries for better pay. The exchange rate power of currencies in the sub-region is low and so do not particularly help matters. Nigeria, for example, harbours about the lowest pay rate for labour – even for tertiary education sectors in the world. As such, this situation forces the highest level of migration of engineering education teachers.

Traditionally, the teaching profession has never been associated with prosperity in this sub-region and governments are indoctrinated accordingly. The value system in Nigeria, for example, does not encourage excellence at present. Politics offer the best option for prosperity and popularity followed by the *middlemanning* of foreign goods and services for quick wealth, as enunciated by these values [2]. The value system in the sub-region does not encourage research and development. This basically explains why so many academics opt for politics after attaining the rank of *professor* when they are instead expected to lead functional research and development. Research and development itself gets less than 0.15% of the Gross National Product (GNP) in the sub-region.

In the West African sub-region, the first choice for a job is in an industry – if available. Teachers in engineering and technology education would prefer to work full-time in a bank if a job is offered there because the pay and the prospects in the value environment are better there! Therefore, the poor pay and counter-development value system in the sub-region are militating against sustainable engineering and technology education through low productivity and brain drain! Therefore, the political leaders in the sub-region should now address the value system and teachers' wages in these countries.

OVERHAULING THE ENGINEERING AND TECHNOLOGY EDUCATION SYSTEM

The expectations of industry and people in the West African sub-region are for graduates of engineering and technology who are almost *finished* with industrial skills upon first entry into a job. However, graduates who are equipped with skills that are adequate for engineering and technology entrepreneurship are even better for the West African sub-region. The present education structure should be pressed into producing such graduates. Without cultivating such graduates now, there will be no sustainability in the engineering and technology education in this sub-region.

The remedy now is to adopt the *applications-integral* approach, together with the *application-first* procedure in the engineering and technology education process [3]. The *application-integral* approach adopts the projects-oriented procedure in educating engineers and technologists [4]. An industrial development centre is very useful for the integration of practice with theories in the teaching and learning environment. Students' practical work, laboratory and workshop assignments should be focused

on marketable products and services as much as possible, even from the first semester of the first year! Every department or school should appoint an industrial and marketing liaison for the purposes of converting campus products and services to funds and entrepreneurship training for students. An industrial development centre, when established, will help to facilitate the projects-oriented practical and laboratory activities.

Such an industrial centre would ameliorate the lack of industrial background that would otherwise place a handicap on the learning of the theories in engineering and technology. Such an industrial centre would be multidisciplinary in nature in order to achieve the needs of most engineering disciplines in the area. Nigeria has presently set up 21 such industrial centres in different parts of the country.

In the absence of these centres, teachers need new orientations in order to adopt the applications-integral approach through in-service courses. Industrial complements can be provided by way of functioning or broken-down equipment components that qualify as *engineering building blocks* [4].

The present engineering and technology education curricula should be overhauled in order to remove alien structures. The curriculum should be redesigned to be in line with the needs of local industry at the undergraduate levels [5].

If curriculum is mainly derived from engineering activities and technology within local industry, then the Students Work Experience Scheme (SIWES) would be provide significantly more functional apprenticeships in the sub-region. The subjects of study would also be considerably more related to the industries in the countries of the sub-region. The graduates of this programme would be productive upon first entry into a job and the interest of industry in fund endowments should then rise, as the impact of these graduates would force a re-thinking in industry.

A SYSTEMS APPROACH TO ENGINEERING AND TECHNOLOGY EDUCATION

The systems (functional) approach is considered to be state of the art in the academic and practical management of engineering and technology education. Departments of civil, mechanical, electrical, etc, engineering should now give way to functional disciplines, such as: design engineering systems or control engineering systems, manufacturing engineering systems, environmental engineering systems, plantation engineering systems, etc [6].

The interactions between the functional disciplines in a projects-oriented education approach will create another set of marketable products and services. Some of these products and services will form the basis for the business employment of some of the present students upon their graduation; this would be often after formalising some technical relationship with the school. The author has been pursuing these objectives through the course, Industrial Studies, which includes entrepreneurship, and which he coordinates for all students studying engineering and engineering technology at the Federal University of Technology, Owerri, Nigeria, since 1984/1985.

The systems approach takes technical and economic advantage of their interdisciplinary nature in order to produce functional engineers at the lowest possible cost. Institutions teaching engineering and technology education in the sub-region should take advantage of the systems structure of management in order to remain relevant in the future.

CONCLUSIONS

Sustainability is now the most important concept in development at all levels. With regard to engineering and technology, education and practice have mutual sustainability as their umbilical cord. Sustaining engineering education is just as important as sustaining the practice after the campus.

Structural adjustments in the physical and academic set-up of engineering and technology education institutions are necessary now. Curricula have to be modelled on the needs of local industries, while also giving ample room for all future developments in engineering and technology.

A projects-oriented teaching and learning environment should be the norm. Centres for industrial studies should be involved in these environments. Physical and academic readjustments should be aimed at evolving the systems approach to replace the present stand-alone academic departments. Every opportunity should be taken with regard to developments in information and communications technology in order to acquire technology-enhanced teaching and learning, eg the virtual classroom system to reduce the cost of investment in physical classrooms for large classes [7].

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