

Personal View: Engineering Education in Eritrea— Proposals for a College of Engineering*

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This paper describes a framework for engineering education at Asmara University, Eritrea. A brief description of Eritrea and Asmara University is given, prior to making a proposal for a College of Engineering. Curriculum design, staff development, research, and a development and action plan are presented. The paper proposes a shift from the conventional engineering education in Africa to project- and system-oriented approaches. The main objective is to set a tone, mode or agenda for the discussion of engineering education in Eritrea in particular and Africa in general.

INTRODUCTION

ASMARA University in Eritrea has recently decided to establish a College of Engineering [1]. The idea must be fully justified in the light of the present and probably future socio-economic development of Eritrea. Notwithstanding the political goals of technological self-reliance, it is a well-known fact that engineers and other professional technical personnel play a vital role in national development. Through the continual extension of the physical infrastructure, production facilities, plants and machinery, which are necessary for development, the need for qualified professional engineers steadily mounts.

Ever since 1890, when Italy officially colonized Eritrea, Eritreans have considered themselves an independent nation. The Eritreans never accepted their forcible annexation by Ethiopia in 1962. For example, during the period of British administration (1941-52), Eritrea had better educational facilities than Ethiopia. The former government of Ethiopia began to undermine all Eritrean institutions, especially the educational system, during the period of the federation (1952-62). Eritreans began fighting for independence in 1961. After 30 years of war, Eritreans had won control of most of Eritrea and finally defeated the Ethiopian army in May 1991.

Eritrea had been a *de facto* independent state from May 1991 until May 1993. Independence was therefore only a matter of time. A referendum was held on 22-23 April 1993, and there was little doubt about its outcome. Independence was announced on 24 May 1993. Eritrea is now a member of the UN, the OAU and financial and international organizations. Despite comprising

nine nationalities with eight languages and two religions (Islam and Christianity), Eritrea had been united on the need for independence.

Nevertheless, the problems that Eritrea has inherited in the education field include, among others [2], an illiteracy rate of over 80%; an acute shortage of technicians, technical students and technical know-hows and a very low academic level amongst students, and also amongst many teachers.

The education problems can be summarized in the words of the Africa Watch 1993 report [3]:

During the period of Ethiopian rule in Eritrea (1962-91), a systematic policy of denying educational freedoms to Eritreans was followed. This ranged beyond stifling freedom of thought to a sustained attempt to dismantle the educational system and block the emergence of a university serving Eritreans.

ASMARA UNIVERSITY

Higher education in Eritrea began with the founding of the 'Holy Family' University Institute, officially established on 20 December 1958 by the Missionary Congregation Pei Madri della Nigrizia of Verona, Italy. The medium of instruction was offered in Italian according to the established plan of the Italian university with a view to preparing students for the final year of study in an Italian university to earn the 'Laurea'. In 1959 the university was recognized by the then Eritrean Government. In 1964 it adopted English as a medium of instruction alongside Italian. By the year 1965 it was recognized by the then imperial Ethiopian government and changed its name from the 'Holy Family University Institute' to the University of Asmara. On 17 July 1968 it was granted

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a charter. The first degree was awarded in 1969 and six years later the university came under the Ethiopian Commission for Higher Education. In 1990 the university was disbanded by the Ethiopian government, with its staff and movable property taken away to Ethiopia. The provisional government of Eritrea has re-established Asmara University as an autonomous institution in 1991 with an all-out effort to rehabilitate, restructure and revitalize it as a centre of higher learning and development-oriented research.

Asmara University resumed its academic work in October 1991 and now has five faculties: natural sciences, social sciences, agriculture, law and languages. The university plans to establish new colleges such as engineering, including architecture; medicine and public health, including pharmacy; marine resources; and education.

ENGINEERING EDUCATION PHILOSOPHY

Engineering education in most Western countries can be briefly characterized: it is based on refined analytical methods with a strong bias to conceptual and theoretical understanding. An engineer working as perhaps the only professional in a government office, municipal authority or industrial plant in Eritrea, seeking to implement local components of a national plan for energy and water resources, or production management for a town, region or industry—subject to all the violent changes in strategy, finance and institutional organization from above and faced with policies and proposals rapidly overtaken by migration and resource starvation from below—has to operate with a different set of personnel resources and concepts than a counterpart in a developed country.

Engineers in Eritrea are unlikely to find a curriculum heavily based on theory of great value; instead they need to be equipped with inappropriate knowledge, operational values and skills. They need less an understanding of reactive roles, but a clear understanding of a range of proactive roles in initiating development, and in guiding and managing implementation process.

The guiding philosophy is not only to train and to optimize the use of scarce manpower in Eritrea, but more to ensure that essential continuity between problem formulation and development implementation—critical to the role of engineers as initiators and managers of development processes.

OBJECTIVES

Engineering education in Eritrea should fulfil the following:

- Provide education and advance training for engineers.
- Conduct research in the interest of a suitable exploitation of natural resources. Research

needs to contribute to solving national problems and to the restoration of ecology through applied technology research based on sustainable development.

- Provide expertise in the form of consultancy to industry, government institutions and private organizations.

The first two functions, namely teaching and research, constitute the traditional roles of any university, the objectives of which are to train the high-level manpower needed to perform specific national tasks, to transmit knowledge from one generation to another and to advance knowledge. The third function characterizes the professional nature of a college of engineering.

EDUCATIONAL CONCEPTS AND APPROACHES

Undergraduate programme

The undergraduate curriculum of the College of Engineering should cover five engineering disciplines, including civil engineering, mechanical engineering, electrical engineering, chemical engineering and agricultural engineering. All students should follow a common project- and workshop-oriented course in the first year, after which they opt for a professional specialization in one of the engineering disciplines in accordance with their indicated preferences.

Issue-based approach

Project work should be considered as an important feature of the curricula in all disciplines. In other words, engineering programmes should be structured to place a greater emphasis on 'engineering project work' with a much stronger problem-orientation yet without sacrificing broader conceptual understanding. In contrast to more orthodox structured courses, this approach could help to ensure that: (i) the various components (lectures/seminars, technical programmes and project work) are effectively integrated; (ii) live project work becomes a central focus which clearly interacts with support from more formal communications of technical, procedural and conceptual knowledge; and (iii) vocational industrial training, design classes and laboratory work assume much more importance in engineering education.

The use of project work, particularly on engineering programmes, should be extensive so that students may acquire understanding, as well as analytical and practical abilities through 'doing' rather than listening. A student who has to organize his/her own way of solving problems should achieve far greater motivation, interest and initiative.

Duration of degree

The implications of this are closely linked to the duration of an engineering degree. Eritrea, like

other developing countries, cannot afford to have manpower tied up in education for a period of up to five years, in addition to the period of professional experience. It is inevitable, therefore, that engineering education in Eritrea must accommodate generally shorter (four years) and perhaps more closely focused curricula. There is a greater need for retraining or at least a progressive build-up of modules of higher professional or academic skills, which may in time replace completely one five-year block of initial education.

Practical training

This should form as an integral part of the undergraduate programme in order to equip students with basic practical skills so as to facilitate their integration in professional practice. Engineering education should consist of manual workshop training at on-site workshops where students spend about half of their time during the first year followed by practical training in industry and government institutions during summer vacations.

Breadth versus depth

The programme of engineering education at undergraduate level should emphasize breadth of knowledge in order to facilitate interdisciplinarity. Thus the first year should be common for all students. It is obvious that the necessity for breadth of education of engineers may lead to perceptions of (or in some cases real problems of) inadequate depth and rigour. Engineering education in Eritrea must involve a continuous compromise in the tension between the interdisciplinarity breadth and the depth of disciplinary knowledge demanded for understanding and solution of engineering problems.

Sustainability

Provision should be made in the first two years of study for students to gain an understanding of sustainable development for environmental management and technology assessment. In the third and fourth years students also should study industrial and production management, and strategic project planning courses, which should explicitly include ecological concepts and sustainability in design, construction and product development. During the third and fourth years of study there should be opportunities for students to broaden and deepen their knowledge in their chosen specializations by way of optional courses and choice of project topics.

CURRICULUM DESIGN

Details of curricula in the various disciplines will not be given in this paper. Nevertheless, the design of an engineering curriculum is not an easy exercise. Many have argued that there is a straightforward methodology of curriculum design. The methodology has three stages: (i) problem identi-

fication; (ii) structuring the curriculum; and (iii) implementation and evaluation [4]. The first stage is the definition of the goal that the curriculum is supposed to achieve. Hence it might be thought that a curriculum in a developing country like Eritrea would point towards a goal which is the result of the consideration of inputs from government, industry, indigenous engineers and associations of engineers, and twinning engineering schools. It should be designed to use scarce resources based on ecological considerations as efficiently as possible, and to meet the needs of Eritrea's national development in the future. System orientation of the curriculum should also be emphasized. As Professor Parker puts it:

we begin to create a culture of 'systems-think' among our students, where they would think automatically of the total picture, and appreciate the need to consider total life-cycle performance and costs not only of the physical object of immediate concern. . . . How many times have you encountered a structural engineer who has just completed building design, because the quantity surveyor has not yet looked at the drawings?

STUDENTS

Students who enrol at the faculty should have completed General Certificate Examinations or equivalent with requisite passes in mathematics, physics and chemistry, while a few technicians holding the Full Technicians' Certificate from a polytechnic or technical school could be admitted (a re-entry examination must be conducted for the technicians).

STAFF DEVELOPMENT

It should be realized from the very start that staff recruitment should be as international as possible. An agreement could be made with twinning engineering schools which will assist in exchange and recruitment of international staff. However, plans for localizing the teaching staff should also start as early as possible. The programme could entail recruitment and extensive training of Eritrean engineers in order to acquire higher qualifications. Arrangements for practical training could also be provided for young Eritrean graduates who will join the teaching business. In the initial stage, i.e. the first and second year of the engineering college, it is anticipated that approximately 10–20 academic staff would be needed.

RESEARCH

Research productivity is perhaps the most important measure of judging the scholastic standing of a university. This fact should be recognized

by the college, though at the initial stage of development the college will have to limit research activities. Emphasis should be placed on applied research dealing with problems of immediate importance in national development. Postgraduate education and Ph.D training for Eritrean lecturers should be combined with research activities that focus on national priorities. However, I wish to highlight two particularly debilitating traditions in African universities, and in particular in engineering schools: departmentalism and excessive egalitarianism contingent on the Ph.D. degree. These two attitudes have promoted a broad, diversified research effort centred on individual faculty members. With such dissipation of effort, often over ill-defined goals, it is not surprising that science and engineering research in African universities has made little impact. In Eritrea, engineering research needs to be organized and funded in a way that ensures a pooling of effort within a department and across disciplines, and concentration of effort on a few carefully selected problems. Well-conceived and well-articulated engineering research programmes of national importance in the country could always attract international support.

RELATION WITH INDUSTRY

As already mentioned, industrial training would be a major component of the professional training for engineers and the college should devote a lot of time and effort to this. The main purpose of relations and close contacts with industry, government and private consultant firms will be to organize and coordinate the practical training of students and to analyse the quantitative and qualitative engineering manpower requirements of government and industry as an essential feedback to the educational programmes of the faculty.

CO-OPERATION

Asmara university has already established regional and international contacts and co-operation with a number of universities in the Sudan, Tanzania, Denmark, Norway, Germany, Australia and the USA. The College of Engineering should also establish close collaborations with engineering schools in the South and the North. Such co-operation can take the form of exchange of students, staff, collaborative research, sharing of facilities and networking. Bilateral and multilateral organizations, engineering associations and schools should be informed about the university and the college's initiative.

DEVELOPMENT PLAN

The development of the college should be accomplished in three phases extending over a period of 10–12 years:

1. Preparatory phase (1993–94) involving curriculum design, construction of buildings, installation of equipment and appointment of the initial core staff.
2. Beginning of operations (1995–97) involving an enrolment of students, acquisition of additional equipment and staff.
3. Completion of establishment (1998–2002) involving consolidation of the undergraduate curricula and establishment of postgraduate courses. It is also envisaged that localization of teaching staff would be accomplished during this phase.

ACTION PLAN

In order to implement the proposed development plan, Asmara University should take an immediate action plan. The following are suggested to hasten the process:

- A workshop on engineering education in Eritrea should be held at Asmara University. Bilateral and multilateral organizations should be asked to support the workshop.
- A steering committee composed of engineers from government, industry, municipalities, the Association of Eritrean Engineers, Asmara University and twinning engineering schools should be formed. The main work of the committee should be, among others, to prepare a strategic plan for the college, design detailed curricula, and to mobilize internal and external manpower and financial resources.
- The committee could start preparing a detailed site plan and cost estimate for the college's physical facilities such as lecture halls, offices, laboratories, workshops, design classes and computer rooms.
- Plans for the requirement for engineers must be projected. This would guide the annual intake of students per engineering department.

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