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Rural Water Supply in Developing Countries

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held in Zomba, Malawi,
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Rural Water Supply in Developing Countries

Proceedings of a workshop on training held in Zomba, Malawi, 5–12 August 1980

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Training of Civil Engineers in Kenya

J. Gecaga[1]

The Department of Civil Engineering is one of the oldest departments within the University of Nairobi, with records dating back to 1956, when it was then part of the Royal Technical College of Nairobi. The 3 year Bachelor of Science (B.Sc.) program that is offered forms part of the professional engineer's education (which consists of a university course plus 3 years or more of apprenticeship and training). A B.Sc. is the basic acceptable academic qualification required for registering as a graduate engineer with the Kenya Engineers Registration Board. The industrial training of graduate engineers is carried out by industry. The primary employers of civil engineering graduates include the Ministry of Works; the Ministry of Water Development; municipalities; and consulting and contracting firms. Since the establishment of the degree course, the department has produced over 600 graduates up to 1979; over half of them Kenyans. The current average annual output is between 50 and 60 graduates.

Due to an acute shortage of specialists in the fields of water supply and sewage disposal, the department has embarked upon the following postgraduate programs: a Master of Science (M.Sc.) program in environmental health engineering and a postgraduate diploma program in water and wastewater engineering. Postgraduate work in other areas has been carried out mainly through research and the writing of a thesis. Several postgraduate programs involving coursework, examinations, and preparation of a thesis are planned for the future in other disciplines.

This paper will examine some of the design criteria and constraints in the development of civil engineering training programs in developing countries, with particular reference to Kenya. Emphasis will be placed on the training of professionals in the fields of water supply and sewage disposal.

Undergraduate Curriculum

The design of undergraduate engineering curricula has received considerable attention within Europe but there appear to be few criteria for the design of curricula within developing countries. If curricula are designed on purely educational criteria, then little attention need be paid to any difference that may exist between industrialized and nonindustrialized countries. If, however, engineering graduates are expected to play a major role in the technological development of developing countries, then curriculum design must be subject to engineering as well as educational criteria. Thus, it is important to examine the relevant engineering industry and the directions it may take within the next 5–10 years.

It is worthwhile to examine the type of engineering education given at universities. In general, engineering curricula are modelled after those found in Europe. When the Department of Civil Engineering was

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started in Nairobi, it was, in fact, offering external degrees of the University of London. Since that time, the format has not changed significantly. In general, little attention is given to design, i.e., the creation of structures to fulfill a function. The implicit objective of university courses seems to be the production of researchers. The appointment and promotion of staff is based upon research criteria and it is almost impossible to appoint experienced engineers because they seldom have research qualifications. The objective is, naturally, to emphasize the importance of research to the role of the university. As long as this continues to be the primary objective, it will be very difficult for engineering faculties to take into account the needs of the engineering industry when designing their curricula. It is worthwhile, therefore, to examine the differences between science and technology and the application of research-oriented motivations to the needs of developing countries.

The objective of science is the furtherance of knowledge. Its methods are analytical and its central theme is research. The end product is a research paper, after which the scientist has no further responsibility. A good research paper, adding to existing knowledge, brings kudos to all concerned, even if the knowledge is of no practical value.

Technology, on the other hand, is concerned with designing, constructing, and maintaining objects that will serve the people. The methods are synthetic, in the main, and the central theme of technology is design. The technologist is also concerned with the economics, utility, and management of projects. The technologists responsibility ends when the project is completed and functioning properly.

This means that the motivation of a technologist is quite different from that of a science and engineering graduate who is given a largely analytical education and emerges with the approach of a scientist. If adequate industry does not exist to reeducate these graduates, this attitude will remain and the engineering graduates will find it difficult to execute projects. The civil engineer in a developing country covers a wider range of subject matter (because there are few specialists) but generally in less depth (because there is less sophistication) and must possess considerable knowledge about materials (because the supporting industries providing these materials are usually very poor in terms of quality control). Designers in developing countries, therefore, if they are to use locally available skills and maximize the use of local materials with poor quality control, must take this into account when designing projects. This is more difficult and time consuming than creating designs for use by highly skilled technicians using good-quality materials. It is probably for this reason that overseas consultants prefer to use international contractors and imported materials, if possible.

The analytically trained graduates currently emerging from universities cannot execute projects without sound practical training and it seems fairly certain that facilities capable of providing such training are inadequate and are decreasing in number. The long-term consequence will be poorly trained engineers, considerable wastage of money, and probably, an increasing number of unemployable graduates.

Current Method of Producing Professional Engineers

The student who is admitted to the Department of Civil Engineering at the University of Nairobi is exposed to a reasonably wide and sound analytical engineering education. During vacation periods, the student may or may not be able to obtain employment within engineering firms. In recognition of the need for practical training in engineering education, the 4th practical training term was introduced to act as a basis upon which future practical training could be developed. Due to a lack of facilities and staff, however, this objective has not been achieved.

After successful completion of the degree course, the graduate engineer joins industry

to receive practical training. In some cases the graduate undergoes well-organized and well-supervised practical training; in other cases the training may be haphazard or nonexistent. Regardless of the quality of the practical training received, the graduate's immediate goal is to pass the professional interview for registration or for corporate membership in a professional body in the shortest time possible. In many countries, including Kenya, the shortest period during which the graduate is expected to have acquired the necessary practical experience for registration is 3 years.

Because this method of producing professional engineers has been operating in Kenya for some time, it is possible to determine the degree of its success. In this method the employer is responsible for providing the necessary practical training and developing the graduate engineer according to the requirements of the industry. In some cases, however, the employer may not be equipped to provide adequate training facilities and an effective continuous assessment system to ensure proper utilization of the training period. As a result, cases of graduates who have spent 3 years in the field and cannot produce a technical drawing they can call their own are quite common.

Integrated Engineering Training

In general, integrated engineering training may be achieved by either incorporating the practical training component into the undergraduate course, thereby lengthening the duration of the degree course, or by introducing academic sessions during the postgraduate training period.

Introduction of Practical Training into the Undergraduate Course

In this system of engineering education, practical training is considered as an integral part of the undergraduate program. After a certain period of academic training, students are assigned to industries to receive practical training. Guidance and supervision are undertaken by staff from the university and industry. The practical training is assessed and considered as part of the degree course. The practical training periods are organized such that the training is related to the subjects already covered in the academic course. The length of the practical training periods allows for sufficient coverage of practical aspects of the academic subjects already covered.

The advantages of this method are: (1) undergraduates undergo a streamlined practical training program where close supervision, proper guidance, and assessment of the quality of training are ensured; (2) each undergraduate has the opportunity to get involved in a variety of schemes; and (3) the graduate is able to adjust to the requirements of industry relatively quickly due to the experience gained during the practical training period.

The disadvantages of this method are: (1) the length of time required to obtain the degree would be increased, thereby implying that the time (and hence financial) input toward producing a graduate would be high; (2) it is difficult to find industries with suitable practical training facilities and training officers; and (3) undergraduates are normally concerned with passing their examinations and, therefore, tend to view the practical training exercises for their academic value rather than how they relate to future practical applications.

Introduction of Academic Sessions into the Postgraduate Training Period

In this system, the undergraduate undergoes the usual academic training in the university and after graduating joins industry for practical training. During the practical training period, the graduate would attend courses offered by institutions either during evenings or for full-time periods, each of which may last several weeks. These courses would normally be designed to expose the graduate engineer to the latest techniques of the profession. The courses may be general or specialized in nature.

The advantages of this method are: (1) the graduate engineer is more professionally mature at this level of training and appreciates the necessity of acquiring new

techniques; and (2) the graduate is able to appreciate and discuss case studies more easily as a result of having been involved in similar projects during the practical training period.

The disadvantages of this method are: (1) not all graduates are likely to have the same experience base; (2) many industries would not be anxious to part with graduates for extended periods of time once they have started being productive; (3) organization for such courses is difficult because experts from many fields would normally be required for the courses to succeed; and (4) because examinations, based on course material, cannot be given easily, there is a likelihood of laxity developing on the part of the graduates.

Specialized Training in Water Supply and Sewerage

In 1970, the Kenyan government established a goal of bringing the benefits of a safe water supply, sufficient to meet the requirements for livestock and domestic consumption, to the entire population by the year 2000. By 1977, about 30 percent of the entire population had access to an improved water supply. The total water development expenditure in the current development plan (1978/79–1982/83) is estimated at K£200 million (U.S.$548 million). Although this target may not be achieved, it shows the government commitment to this basic infrastructure.

The ministry's total manpower requirements, excluding casuals and trainees, are projected to increase from 7800 to a staff of 14 110 over the same period. The key cadres in which there will be major increases are engineers, geologists and hydrologists, accountants and personnel staff, water inspectors, water bailiffs, surveyors, and many subordinate staff categories including, in particular, patrolmen, pump attendants, water operators, drivers, artisans, clerks, storemen, water guards, and mechanics.

Courses Offered Within the Department of Civil Engineering

Undergraduate Courses

During the undergraduate program previously described, the following basic courses are offered as components of the B.Sc. degree: hydrology and public health engineering; and public health engineering II, which includes microbial processes, chemical processes, and physical processes as related to water supply.

Postgraduate Courses

The department is currently running two courses in the field of water supply and wastewater disposal: a 2 year M.Sc. course was started in 1976 and a 1 year diploma course in water and wastewater engineering was started in 1979. There are 17 students currently registered in the two courses.

Ongoing Research

With the assistance of several donor agencies, the department is involved in the following research activities: slow-sand filtration; stabilization ponds; defluoridation; and solar distillation. Both staff and students participate in the research work.

Conclusions

In designing a curriculum for both undergraduate and postgraduate studies, it is essential to make a thorough appraisal of the country's level of technology and its specific requirements in terms of manpower. Failure to do so may result in the training of personnel who contribute very little to the technological development of the country, in spite of the relatively large financial investments required for university education. Also, efforts should be made to incorporate practical training into all levels of university education because the graduates are, in most cases, expected to become productive very soon after graduation.