

86062

# Improving the Quality of Engineering Education and Training in Africa

## Africa's Need for Engineering

Sub-Saharan Africa seriously lacks engineering capacity and relies heavily on imported expertise for two reasons—insufficient output from training institutions, and poor quality education and lack of practical experience among graduates. Yet Africa also has pressing development needs that require engineers. First, infrastructure needs to be built in step with the region's economic growth trajectory, including roads, bridges, buildings, airports, and harbors. Second, industrial development should be accelerated, especially in manufacturing, so that the region becomes a net exporter rather than importer of manufactured goods. Third, Africa's ever-increasing energy requirements should be met to overcome acute power shortages. Fourth, the region should take control over mining its rich natural resources—especially minerals, oil and gas—and these resources should be refined before export. Finally, it is estimated that a staggering 2.5 million new engineers and technicians will be needed just to achieve a single Millennium Development Goal; that of improved access to clean water and sanitation.

This brief is based on a forthcoming study commissioned by the World Bank to inform a proposed Partnership for Skills in Applied Sciences, Engineering

and Technology (PASET) in Africa to build capacity in technical, vocational, and higher education with the help of partner countries in Asia and Latin America. The study (i) assesses the current state of engineering education and training, including technical and vocational education and training (TVET), in Africa; (ii) surveys existing regional initiatives in terms of objectives, coverage, approaches, and potential; and (iii) examines accreditation of engineering programs.

## KEY MESSAGES

- Engineering can help Africa unlock its huge potential for economic growth and development and make faster progress toward the Millennium Development Goals.
- However, there is a serious lack of engineering capacity in Africa and heavy reliance on imported expertise in engineering.
- Higher education institutions need to change their approach to teaching engineering so that graduates are creative problem-solvers. Engineering courses also need to be oriented towards market and development needs.
- Women are under-represented in engineering education, constituting less than 10 percent of the student population in Ghana, Nigeria, and Zimbabwe in 2010.
- Few African countries have established a robust accreditation system. In addition to improving national accreditation, regional accreditation of engineering professionals should be encouraged so that engineers have greater mobility within Africa.
- A proposed World Bank initiative, the Partnership for Skills in Applied Sciences, Engineering and Technology (PASET) will build capacity for technical, vocational and higher education in African countries.

## The State of Africa's Engineering Education

Three important reports offer a clear view of the state of engineering and engineering education in Africa. In 2012, the Royal Academy of Engineering published a comprehensive report entitled *Engineers for Africa: Identifying Engineering Capacity Needs in Sub-Saharan Africa*. The report is based on a literature review, an electronic survey of professional engineers and decision-makers from 18 African countries, and interviews with



engineering stakeholders with experience of leading projects in various (largely Anglophone) African countries. In 2010, UNESCO published a landmark report entitled *Engineering: Issues, Challenges & Opportunities for Development*, with contributions from global experts. Another study, undertaken on behalf of the African Technology Policy Studies Network in 2005, evaluated the capacity of engineering education in Ghana, Nigeria and Zimbabwe to prepare engineering graduates for their role in industrial development.

From the three reports, the broad state of engineering education and training in Africa can be summarised as follows:

- A shortage of engineers, yet engineering graduates remain unemployed. For example, Nigeria produces 3,500 engineers a year, a modest number relative to its population, but there is significant unemployment among them.
- Lack of funds to procure laboratory equipment and to support other facilities, and outdated curricula and methods of teaching.
- Lack of academic staff with industrial experience; difficulty in recruiting and retaining staff because of poor salaries and employment conditions.
- Weak university-industry partnership and lack of opportunities for industrial experience for engineering students.
- Graduates tend to have weak management, entrepreneurial, and communication skills.
- Women are under-represented in engineering institutions, forming less than 10 percent of the student population in Ghana, Nigeria and Zimbabwe in 2005.

***“Lack of capacity at every level of the (engineering) profession is a substantive obstacle to achieving almost all development goals, from the provision of basic sanitation to the reduction of rural poverty.”***

– Engineers for Africa: Identifying Engineering Capacity Needs in Sub-Saharan Africa, 2012

- Weak availability of statistics and indicators on engineering at the national level.
- Need for public awareness about the role engineering can play as a driver of social and economic development and innovation.

There has also been increasing awareness in African countries that technical and vocational education and training (TVET) plays an important role in national development. It is identified as an area of focus in the African Union’s Plan of Action for the Second Decade of Education for Africa (2006-2015). The African Union Commission developed a strategy to revitalize TVET in Africa, adopted by AU education ministers in 2007. The following issues were identified:

- Poor perception of TVET, considered an option only for the academically less endowed, and gender stereotyping (for example, dressmaking for girls).
- Lack of instructor training; need to link TVET both to general education and to the labor market.
- Harmonization of programs and qualifications to facilitate mobility within Africa.

## **What will it take to Develop Excellent Engineering Education?**

### **ASSESSMENT AND PLANNING**

Several African countries such as Ethiopia, Mozambique, Rwanda, and Senegal, have assessed their skills needs, as revealed in PASET consultations held in 2013. Some have also developed specific human resources plans. Successful implementation of such plans requires better and more regular national data on employment and institutional output. It also requires institutional mechanisms across several ministries to assess industry demand.

### **GREATER QUALITY AND RELEVANCE**

The paradox in Africa is that although there is a shortage of engineers, engineering graduates remain unemployed or are under-employed. A key reason for this is the poor quality of engineering education. Existing institutions need to urgently upgrade their infrastructure and laboratories. Publicly funded African tertiary education institutions have for

#### **Box 1. The skill-mix ratio in engineering**

For the engineering industry to operate effectively, there needs to be a skill-mix ratio between three categories of personnel—professional engineers, technicians, and craftspeople. The International Labour Organisation recommends a ratio of 1:5:25 between the three. There is a serious lack of data on the skill mix in African countries; available data from South Africa show disproportionately few technicians.

several decades suffered from lack of investment and their infrastructure has deteriorated. Laboratory equipment is out of date or non-functional; libraries do not have the appropriate books and journals; and availability of ICT and computers is still limited.

The curricula of engineering courses also need to be revised. Most of them are outdated, lack originality and are not necessarily relevant to the African context. Very few African universities involve industry and other stakeholders to help revise their engineering curricula. Teaching methodology also needs to be improved. It would be advisable to adopt the Problem-Based Learning approach in engineering education, because it could result in a noticeable improvement in students' ability to solve problems and their acquisition of 'soft' skills such as good communication, team spirit, creativity and adaptability.

Lecturers need to be trained to teach well. For many, getting a good Master's degree in the appropriate field, acquiring some industrial experience, and undergoing pedagogical training would better equip them for their jobs.

### **ENABLING GOVERNMENT POLICIES**

Industrial policies are required that create jobs, promote enterprise development and improve skills training. Specifically, a statutory requirement for the professional registration of engineers should be created and enforced; investments made in higher education institutions to improve engineering education; and the 'brain drain' of engineers mitigated.

Engineering is often classified under Science and Technology; making it difficult to address it precisely. It is important for African countries to set up a national database of both output from engineering institutions as well as personnel employed in engineering at various levels.

### **LINKAGES WITH INDUSTRY**

All studies on improving engineering education highlight the importance of strong university-industry linkages. A recent study undertaken by the Association of African Universities and the Association of Universities and Colleges of Canada found that while several higher education institutions in Africa are taking steps to link with industry (taken in its broad sense to include public bodies and other stakeholders), others have limited experience, expertise and resources to do so.

Representatives from industry should be invited to serve on engineering boards or even on higher administrative bodies of institutions. Also, professionals from business and industry can be used as adjunct professors. Not only would this make up for the acute shortage of academic staff in most higher education institutions but it would also give students valuable practical exposure and provide direct contact with industry.

Industry's most important contribution is to provide practical training to students at two stages: during their course of study in the form of industrial attachment which exposes them to the world of work and subsequently facilitates their employment; and, on completing the course, to meet the necessary professional registration requirements.

### **REGIONAL ACCREDITATION AND MOBILITY**

Initiatives that foster regional mobility of professional engineers within Africa should be encouraged. Currently, most accreditation bodies have only national jurisdiction. However, there are examples of regional cooperation in engineering regulation. Recently, the Engineering Regulation Boards (ERBs) of Kenya, Tanzania and Uganda signed a Mutual Recognition Agreement by which programs accredited in one country would be recognised in the other two. In Francophone Africa, the African and Malagasy Council for Higher Education (CAMES), which groups some 18 countries, has a program for the recognition and equivalence of diplomas (PRED) awarded in all the countries.

Africa could well aim to establish a regional body for the accreditation of engineering qualifications by building up from sub-regional initiatives. For instance, the engineering accreditation bodies of the other East African countries, Rwanda and Burundi, could be brought on board. In Southern Africa, the very well-established Engineering Council of South Africa (ECSA), which already works with accreditation bodies in Botswana and Namibia, could take the lead and establish a Mutual Recognition Agreement by inviting other countries in the subregion to join in. A similar approach could be adopted in West Africa, potentially led by the Council for the Regulation of Engineering in Nigeria (COREN).

These initiatives should be supported by the respective Regional Economic Community.

## REGIONAL ENGINEERING EDUCATION AND TRAINING

Several recent regional initiatives are underway to address some of Africa's engineering challenges. These initiatives need to be supported, nurtured and extended. Two important common considerations are the harmonisation of approaches and collaboration among African institutions. Here, the PASET partner countries can play a supportive and catalytic role. In engineering, just as in medicine, education and training go hand in hand. Improving university education in engineering must be accompanied

by appropriate training to enable a graduate to practice as a professional engineer. Regional initiatives in engineering therefore cover both education and training.

As Table 1 shows, most initiatives are fairly recent and their activities have yet to develop fully. Most faculty development activities relate to upgrading of academic qualifications, usually to the doctoral level. What is lacking is means by which young engineering faculty can spend some time in industry to gain industrial experience. Also, although there are initiatives for curricula reform, they are not accompanied

by pedagogical training of faculty. Similarly, except at the International Institute for Water and Environmental Engineering (2iE) in Burkina Faso, there is no regional initiative to help place engineering students for industrial training. This is especially important because institutions find it difficult to place students locally for training in industry. Given the importance and significant activities in, for example, the extractive industries, construction and ICTs in several African countries, such placement could greatly help students to gain meaningful experience and subsequent jobs.

**Table 1. Summary of regional initiatives**

	Initiative	Year Established	Broad Actual or Proposed Activities
<b>Higher Education Initiatives</b>			
1	African Network of Scientific & Technological Institutions (ANSTI)	1980	Institutional collaboration; publication of research; faculty development
2	UNESCO Engineering Initiative (UEI)	2011	Faculty development; curricula reform; QA & accreditation
3	Pan African University (PAU)	2011	Institutional networking for graduate training and research
4	Tuning Africa Project	2011	Curricula reform; improving quality
5	International Institute for Water and Environmental Engineering (2iE)	2007	Training and research at all levels; linkages with industry
6	African Engineering Education Association (AEEA)	2006	Networking conferences for improving engineering education; advocacy; involvement of diaspora; student exchanges
7	University Science, Humanities and Engineering Partnerships in Africa (USHEPiA)	1996	Regional research collaboration; faculty development
8	Regional Initiative in Science & Education (RISE)	2008	Institutional networking for research; faculty development
9	Africa Engineers Forum (AEF)	1995	Networking among engineering organisations
10	Federation of African Engineering Organisations (FAEO)	2012	Networking among engineering organisations
11	Africa-UK Engineering for Development Partnership	2010	Collaboration among engineers; curricula reform
<b>TVET Initiatives</b>			
12	Commonwealth Association of Polytechnics in Africa (CAPA)	1977	Networking among TVET institutions; policy advocacy; staff development
13	African Union-India Cooperation on TVET	2008	Setting up of TVET institutions
14	Vocational Training Pilot Programme in Post-Conflict Countries	2008	Capacity building of unemployed youth
15	Innovation in Vocational Education & Skills Training (INVEST)	2010	Increasing access to TVET through open & distance learning

## MORE ON THE TOPIC

- *Engineers for Africa: Identifying Engineering Capacity Needs in Sub-Saharan Africa*. Royal Academy of Engineering, 2012
- *Engineering: Issues, Challenges & Opportunities for Development*, UNESCO 2010
- Forthcoming, Mohamedbhai, Goolam. *Improving the Quality of Engineering Education in Sub-Saharan Africa*, World Bank, 2014.

