Improving the Quality of Engineering Education in Sub-Saharan Africa

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ACRONYMS

ABET  Accreditation Board for Engineering and Technology, Inc.
AEEA  African Engineering Education Association
AEF   Africa Engineers Forum
AMSEN African Materials Science and Engineering Network
ANSTI African Network of Scientific and Technological Institutions
ARCEE African Regional Conference on Engineering Education
ASME  American Society of Mechanical Engineers
AUC   African Union Commission
CAMES African and Malagasy Council for Higher Education
CAPA  Commonwealth Association of Polytechnics in Africa
COREN Council for the Regulation of Engineering in Nigeria
DAAD  German Academic Exchange Service
ECSA  Engineering Council of South Africa
ERB   Engineers Registration Board
FAEO  Federation of African Engineering Organisations
IEEE  Institute of Electrical and Electronic Engineers (UK)
2iE   International Institute for Water and Environmental Engineering (Burkina Faso)
INVEST Innovation in Vocational Education and Skills Training
MDG   Millennium Development Goal
PASET Partnership for Skills in Applied Sciences, Engineering and Technology
PAU   Pan African University
PBL   Problem-Based Learning
PRED  Programme for the Recognition and Equivalence of Diplomas (of CAMES)
RISE  Regional Initiative in Science and Education
SSA   Sub-Saharan Africa
SSAWRN Sub-Saharan Africa Water Resources Network
STEM  Science, Technology, Engineering and Mathematics
TVET  Technical and Vocational Education and Training
UEI   UNESCO Engineering Initiative
UNESCO United Nations Educational, Scientific and Cultural Organisation
UNDP  United Nations Development Programme
USHEPiA University Science, Humanities and Engineering Partnerships in Africa
WFEO  World Federation of Engineering Organisations
1. BACKGROUND AND OBJECTIVES

Africa, in particular Sub-Saharan Africa (SSA), has been experiencing robust economic growth in recent years. This has been accompanied by an increase in investments by new partners such as China, India, Korea, Brazil, Japan and other Asian and Latin American countries. However, the foreign investment projects are handicapped by an acute shortage of domestic skilled labour, making it necessary to import foreign skills, which impedes shared prosperity. For Africa to sustain its unprecedented economic growth and become competitive, the development of its human capital is paramount, especially in the areas of applied science, engineering and technology.

This is what led the World Bank Africa Region to propose, in 2013, an initiative entitled Partnership for Skills in Applied Sciences, Engineering and Technology (PASET) in Africa with the objective of capacity building in technical, vocational and higher education in African countries by selected partner countries in Asia and Latin America. Several of these partner countries already have engagements in human capital development in Africa, mostly through scholarships, but these engagements are not focused or adequately targeted towards the African countries’ human resources development plans.

As part of the PASET initiative, a series of structured consultations through video-conferencing was first conducted with selected African countries to assess existing engagements in Africa by the partner countries. This was then followed by a workshop organised in July 2013 in Addis Ababa by the World Bank Africa Region with the collaboration of the Ethiopian government. Over ninety participants from nine Sub-Saharan African countries and four partner countries brainstormed their priorities and possible ways of creating partnerships between them. Several recommendations were made at the workshop, one of which was for the World Bank to undertake analytical studies on the situation of applied science, engineering and technology in Africa in order to learn from them and to build on their successes.

It is in that context that the present study was commissioned by the World Bank. It has three main objectives: first, to assess the current state of engineering education and training, including technical and vocational education and training (TVET), in Africa; second, to survey existing regional initiatives to improve the quality of engineering education and TVET in Africa in order to understand their objectives, coverage and approaches, as well as evaluate their success and future promise for building on them; and third, to look at the important aspect of accreditation of engineering programmes of African universities, accreditation being a hallmark of the quality of an engineering qualification.

The methodology used for the study was almost entirely desktop research.

2. STATE OF ENGINEERING EDUCATION AND TRAINING IN AFRICA
Several reports have been published to diagnose the problems encountered in the provision of engineering education and training in African countries. This section briefly reports on the findings of some of the more recent studies.

2.1 Report on Engineering Capacity Needs in Sub-Saharan Africa


A key conclusion of the study is that there is a severe shortage of skilled and experienced engineers in SSA, and that “this lack of capacity at every level of the profession is a substantive obstacle to achieving almost all the development goals, from the provision of basic sanitation to the reduction of rural poverty”. And yet, in most countries, the study found notable levels of unemployment among engineering graduates, mainly because engineers were graduating without the necessary skills and experience to be employable, but also partly due to the local presence of foreign engineering firms who prefer to import their own skilled labour, or the reluctance of the graduates to take up poorly paid positions in rural areas.

A number of causes for the low capacity are identified in the report. These include: a low level of public investment in engineering infrastructure projects over several decades; the lack of adequate legislation to uphold engineering standards through requirements for professional registration; the lack of regulatory laws to enforce foreign companies to effect knowledge transfer to local engineers; the deficiency in resources of the engineering institutions to support engineering activities; the poor quality of engineering education, based on outdated curricula and teaching methods not relevant to local needs, and being too theoretical as the tertiary education institutions lack resources for adequate laboratory experiments; the acute shortage of opportunities for engineering students to gain pre-qualification experience through short placement in firms and adequate training once they graduate; and poor salaries for professional engineers, resulting in brain drain of engineering talent to other sectors or other countries.

The report proposes several capacity building strategies targeted at governments, industry and higher education institutions, as follows:

Governments: adopt industrial policies so as to create jobs, promote enterprise development and improve skills training; establish and enforce a statutory requirement for the professional registration of engineers; invest in higher education institutions to improve engineering education; develop policies to mitigate brain drain of engineers.

Industry: support higher education institutions by providing industrial placements for academic staff and work placements for undergraduates; provide continuous professional

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1 Summary Report accessed from
development opportunities for engineering staff; foreign companies to ensure knowledge transfer to local engineers.

Higher Education Institutions: continuously review and update engineering curricula and involve industry in the process; build stronger links with industry.

2.2 Case Studies of Engineering Education in Nigeria, Ghana and Zimbabwe

The findings of the above report are very similar to those of another study undertaken on behalf of the African Technology Policy Studies Network in 2005 to evaluate the capacity of engineering education in Nigeria, Ghana and Zimbabwe with a view to assessing the extent to which the programmes prepare engineering graduates for their role in industrial development. Data were collected from desk research, administration of questionnaires, and interviews with students, teachers, graduates, employers, university leaders and heads of parastatal bodies. The main findings from the report are as follows:

- Although there was a policy for introducing technical subjects at secondary school level, complemented by practical work, and engineering university curriculum made provision for practical work as well as industrial experience, none of the institutions had the necessary resources for implementing these.
- Due to lack of funds, most of the institutions had no modern laboratory equipment, and library facilities were below standard.
- The engineering curriculum in the three countries were deficient in management and entrepreneurship education, which did not prepare students for self-employment; also, employers complained that the graduates had inadequate exposure to practical engineering and management courses, and had poor communication skills.
- In all the three countries there was hardly any faculty-industry cooperation for curriculum development, research or consultancy. Placement of students for industrial work was also problematic, with industry unwilling to provide the necessary supervision.
- Academic staff had very little exposure to engineering practice and, although well-qualified academically, had no industrial exposure.
- Females were grossly under-represented in engineering education, constituting less than 10% of the student population.

2.3 UNESCO Report on Engineering

In 2010 UNESCO published a landmark report entitled ‘Engineering: Issues, Challenges & Opportunities for Development’, with contributions from 120 experts from around the world. Since 1998 UNESCO has published its well-known Science Reports and although science in its broad sense includes technology and therefore engineering, UNESCO responded to the call from the engineering community for a specific study on engineering, especially on the role of engineering in international development. The report emphasises the importance of engineering in achieving the Millennium Development Goals (MDGs), mentioning that in

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SSA alone it has been estimated that a staggering 2.5 million new engineers and technicians would be needed to achieve the MDG of improved access to clean water and sanitation.

The report succinctly summarises the key issues to be addressed for promoting engineering for development, and these are:

- create public awareness of engineering, affirming its role as the driver of social and economic development and innovation;
- generate statistics and indicators on engineering at national level;
- transform engineering curricula and teaching methods to emphasis relevance and a problem-solving approach; and
- encourage innovation and apply engineering and technology to global issues and challenges.

All the above are highly relevant to SSA.

The report generally has a global approach but it has a section on each region and the one on Africa focuses on four selected African countries, namely Côte d’Ivoire, Ghana, Nigeria and Uganda. The write-up on Ghana provides general information on the industrial development in the country, with nothing specific on engineering education. However, the reports from the other three countries do outline the challenges with regard to engineering education, and these are summarised below.

Côte d’Ivoire

As in most Francophone countries, engineering education in Cote d’Ivoire is provided at both universities and the Grandes Ecoles (elite professional schools). In 2005 there were three public and six private universities; four public and 108 private Grandes Ecoles; and 28 post-secondary institutions providing professional and technical training.

The steps to be taken for improving engineering education, as proposed in the report, include: investment in engineering institutions to improve teaching resources and laboratories, as well as the training and conditions of service of the engineering educators; provision of professional experience to engineering students in public and private sectors to encourage employment and innovation; creation of a better environment for women engineers; development of the research and development environment in engineering institutions; greater engagement with engineering organizations; and having regular national surveys to collect statistics on engineering.

Uganda

The challenges facing engineering training institutions in Uganda are:

- increase in enrolment in engineering without accompanying increase in resources and facilities;
- severe shortage of staff and difficulty in recruiting and retaining staff because of poor salaries and conditions of service; recruitment of part-time staff has not been satisfactory;
- the requirement for all engineering academic staff to have a PhD, which is considered unsustainable;
- outdated delivery mode of lectures and poor laboratory work experience as a result of obsolete and non-functional equipment and too many students;
• outdated curricula not relevant to the changing industrial environment; and
• poor linkages and cooperation with industry.

Nigeria

Nigeria produces about 3,500 engineers from its universities and polytechnics every year. That is a relatively small number for a country with a population of 140 million, and yet there is significant unemployment among engineering graduates. There is a general decline of the engineering profession in Nigeria as a result of the following factors:

• poor salary after graduation, coupled with decreasing employment opportunities in industries, some of which have reached their employment capacity and some have closed down or been relocated to other countries;
• a general lack of culture of maintenance of infrastructure, which reduces employment opportunities for engineers;
• lack of involvement of Nigerian engineers in major engineering projects, for example in the major gas and oil industry; and
• poor quality of engineering education, especially because of lack of properly equipped laboratories, resulting from insufficient investment by government in tertiary education.

2.4 Summary of Situational Analysis of Engineering Education in Africa

From the above reports, the situation of engineering education and training in SSA can be summarised as follows:

• Shortage of engineers, yet unemployment of engineering graduates.
• Lack of funds to procure laboratory equipment and other facilities.
• Out of date curricula and old 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.
• Lack of opportunities for industrial experience for engineering students.

3. TECHNICAL AND VOCATIONAL EDUCATION AND TRAINING (TVET)

The above reports deal almost exclusively with engineering education and training in tertiary education institutions. However, the PASET initiative of the World Bank covers the whole spectrum of education and training in engineering, from vocational to higher education. This section briefly surveys the situation of TVET in Africa.

3.1 African Union’s TVET Strategy.

There has been increasing awareness in African countries that TVET plays an important role in national development. In fact, TVET features as an item in most Poverty Reduction Strategy Papers that African governments have developed in collaboration with The World Bank. TVET is also identified as one of the seven areas of focus in the African Union’s Plan of Action for the Second Decade of Education for Africa (2006-2015). It was in that context
that the African Union Commission developed a strategy to revitalize TVET in Africa\textsuperscript{4}. This strategy was adopted by the Conference of Ministers of Education of the African Union (COMEDAF) in 2007.

TVET in Africa is delivered at different levels in different types of institutions, including public and private TVET schools, polytechnics, enterprises, apprenticeship training centres and faith-based institutions. Formal TVET programmes are school-based after primary or basic education and last 3 to 6 years. In many African countries the informal or non-formal sector plays an important role in providing technical and vocational skills.

The TVET Strategy paper identifies the following key strategic issues to be addressed:

- Poor perception of TVET, considered to be fit only for the academically less endowed.
- Gender stereotyping, for example hairdressing and dressmaking associated with girls only.
- Lack of adequate training for the instructors.
- Need for linkage between vocational and general education, as well as between formal and non-formal TVET.
- Need for linking TVET to the labour market.
- Imparting traditional skills, business management and entrepreneurial skills to the trainees to encourage self-employment because of the shrinking employment opportunities in the formal sector.
- Harmonisation of TVET programmes and qualifications to facilitate mobility and integration in Africa.

3.2 TVET in Ghana.

Ghana has one of the most developed TVET sectors in Africa. A survey was carried out to identify the challenges faced by technical institute trainees in the acquisition of skills in a specific region in Ghana\textsuperscript{5}. The survey revealed the following challenges faced by the institutes:

- Inadequate training facilities
- Large class sizes
- Shortage of instructional materials
- Weak linkages with local industries to facilitate hands-on-experience for both instructors and trainees.
- Too much emphasis placed on passing examinations.

The recommendations made were that stakeholders should complement government’s efforts in the provision of resources, students should be encouraged to purchase their own basic tools, the institutes should put in place effective industrial attachments schemes for the


trainees and that there should be appropriate pre-service and in-service training for the instructors to improve instructional quality. This situation in Ghana may not be very different from what prevails in many other African countries.

4. KEY ISSUES FOR IMPROVING QUALITY IN ENGINEERING EDUCATION AND TRAINING

4.1 Engineering Capacity Needs in SSA

Sub-Saharan Africa is in urgent need of engineering capacity for several reasons. First, for its infrastructural development to accompany its growth trajectory. Such development includes the construction of roads, bridges, buildings, airports, harbours, etc. Second, for accelerating its industrial development, especially in manufacturing, so that it becomes a net exporter rather than importer of manufactured goods. Third, for producing its ever-increasing needs in terms of energy to overcome the acute power shortages it experiences regularly. Fourth, for empowering it to take control of the mining of its rich natural resources, especially minerals, oil and gas, and of the refining of such resources before export. And finally, for achieving the MDGs, especially in rural areas.

The studies reviewed show that at present there is a severe lack of engineering capacity in SSA and it has to rely heavily on imported expertise in engineering. The lack of capacity results from two main sources. First, the insufficient output from the training institutions to meet the countries’ requirements; and second, the poor quality and lack of practical experience and skills of the graduates produced which often make them unemployable. These are the two fronts on which SSA countries have to tackle the challenge of improving engineering education and training in SSA.

Several SSA countries have assessed their skills needs, as revealed during the initial consultations held with a selected group of African countries in 2013. Ethiopia, Mozambique, Rwanda, Senegal have all developed their human resources plan recently where the skills needs are identified. Some countries have also focussed their planning on a specific area. Mozambique, for example, prepared a national higher education strategic plan which identifies science and engineering as the most critical area for development in the forthcoming years. It also conducted an assessment of its TVET capacity, from which it concluded that the extractive industry is the most critical area for development in the upcoming years. Ethiopia has also developed both its higher education and TVET development plans.

The question remains, however, whether the countries adhere to their plans. There are instances when social and political considerations have had a tendency to overrule them.

The successful implementation of a human resources or skill-needs plan that attempts to match demand and supply of human resources requires a compilation of national data on employment as well as output from institutions in each area, including engineering. It is important that this be done continually to enable adjustment to changing labour market needs. Equally important is the need to set up institutional mechanisms to assess demand, both in terms of numbers and skills, so as to enable institutions to adjust their programmes to develop the required competencies. This requires concerted efforts of several Ministries (e.g.
Education, Planning, Labour, Economic Development, Finance) as well as of the training institutions. Such mechanisms and data are rarely available in SSA countries, where usually long-term manpower planning is undertaken as a one-off exercise and the data become obsolete by the time they are published.

The use of global indicators for human resources in different areas and in different regions\textsuperscript{6} can also be useful for comparative purposes, but Engineering is often classified under Science and Technology which makes it difficult to extract the specificity of Engineering. It is important for African countries to set up a national database of both the output from engineering institutions, and the personnel employed in the engineering field at different levels.

An issue worth considering is whether there is a need for a comprehensive study on the future skill-needs in SSA in view of the important role that the region is expected to play in the global economy over the next couple of decades. Such a study was carried out in Europe in 2008 by the European Centre for the Development of Vocational Training (Cedefop), with the objective of forecasting labour market skill-needs in the medium term\textsuperscript{7}. A key finding from the study was that, in Europe, there is a continuing shift away from the primary sector (mainly agriculture) and the manufacturing industries towards services and the knowledge intensive economy. What are the implications of these trends on the labour market in Africa, which has close ties with Europe? Would there also be a shift away from agriculture and the manufacturing industries in Africa? What is the potential of employment in the extractive industries in Africa? In addition to finding answers to such questions, the study would help towards the harmonisation process among African countries that is currently under way.

\textbf{4.2 The Skill-Mix Ratio in Engineering}

There are, broadly speaking, three categories of personnel in the engineering industry. These are professional engineers, technicians and craftsmen (or skilled workers). The professional engineer usually holds a degree in engineering, has some years of experience and needs to be registered nationally in order to practice the profession. The technician has an engineering diploma (either higher or ordinary) and the craftsman has an appropriate trade certificate. The technician grade is often sub-divided into two categories: technologist (or technician engineer) and engineering technician, the former requiring a higher qualification and more experience. The nomenclature used for the different categories varies significantly from one region or country to another. And there is some degree of overlap between the various grades. The TVET area, for example, often covers both the technician and the craftsman categories.

It is usually accepted that for the effective operation of the engineering industry, there needs to be a skill-ratio between the categories. In several engineering branches the common skill-mix ratio used is two technologists and four technicians for every professional engineer, that is 1:2:4. The International Labour Organisation recommends the ratio between engineers/technicians/craftsmen to be 1:5:25. The engineer:technician ratio should therefore be of the order of 1:5 or 1:6, clearly indicating that there needs to be a far greater number of personnel.

\textsuperscript{6} For example those compiled by the UNESCO Institute for Statistics
technicians than engineers. During the PASET consultation with Ethiopia, it was pointed out that TVET is a fast expanding sector in Ethiopia and it is expected that 80% of school leavers would eventually be accommodated in the TVET sector.

As mentioned earlier, there is dearth of data on the employment situation in engineering in African countries. South Africa is the one country in SSA where the engineering profession is well organised and regulated, and it also keeps good employment records. A book on skills shortages in South Africa published in 2009\(^8\) shows that, in 2005, there were 242,018 engineers and 334,078 technicians covering a wide range of engineering disciplines, giving a ratio 1:1.4, a far cry from 1:5. This could also imply that a number of qualified engineers are underemployed and are working as technicians. This trend should not be dissimilar in other African countries. There is even a risk that the ratio will worsen as the majority of countries are upgrading their polytechnics and technical colleges to university status for offering degrees, without providing a replacement. South Africa is a typical example. In 2004, all its Technikons, which were acknowledged regionally and internationally as exemplary institutions for technical training, were converted to Universities of Technology. The latter still run some diploma/certificate courses but their primary activities are to run degree and postgraduate courses and to undertake research.

While SSA unquestionably needs an increased pool of excellent professional engineers, it equally needs an even greater number of practically-trained, versatile technicians who can not only support the professional engineers but who can equally service and initiate small- and medium-scale industries, especially in rural areas, in order to create employment, improve the quality of life and make fuller use of local resources.

**4.3 Quality of Engineering Education**

As reported earlier, the paradoxical situation in Africa is that although there is a shortage of engineers, engineering graduates remain unemployed or are under-employed. There are several reasons for this and one of them is the poor quality of engineering education.

There is, first of all, an urgent need to upgrade the infrastructure and laboratories of the existing institutions. Publicly funded African tertiary education institutions have for several decades suffered from lack of investment and this has led to a deterioration of their infrastructure. Laboratory equipment are out of date or are non-functional and have not been repaired; libraries do not have the appropriate books and journals; and availability of ICT and computers is still limited. Assisting African universities to revitalise their Faculties of Engineering is an area where PASET partner countries can assist.

The curricula of engineering courses also need to be revised. Most of them have been copied from universities in Europe or the USA, have not been updated and are not necessarily relevant to African situations. Very few African universities involve industry and other stakeholders to assist in revising their engineering curricula. This is where the Tuning

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methodology\(^9\), which is currently being introduced in several African higher education institutions, can be of enormous help.

The teaching methodology also needs to be improved. Because of large student numbers, the subjects are mostly taught by the magisterial mode with hardly any opportunity for the students to discuss and interact with the lecturer or among themselves. It would be advisable to adopt the Problem-Based Learning (PBL) approach in engineering education. Such an approach could result in noticeable improvement in the students’ ability to solving problems and, in addition, help them to acquire certain ‘soft’ skills such as good communication, team spirit, creativity and adaptability. Indeed, many employers give greater importance to soft skills than qualifications. And PBL need not be laboratory-based or require expensive equipment and materials. Students could even be assigned problems to be solved while they are on training, matching the problems with the environment of their training.

Another important reason for the poor quality of teaching is the fact that engineering lecturers have not undergone any pedagogical training. Many of them have hardly had any industrial experience, although they may have a doctorate degree in their field. They are thus ill-equipped to help students to learn using appropriate pedagogical techniques. Pedagogical training of academic staff in universities in Africa is not widespread although some institutions have made attempts to introduce it. A recent quick survey was undertaken by UNESCO to prioritise challenges facing higher education in Africa. The need to train lecturers was ranked first. Many universities are insisting that all their lecturers should have a PhD. This may not necessarily be the right approach for all engineering lecturers, and in any case may not be feasible. For many of them, having a good Master’s degree in the appropriate field, acquiring some industrial experience and undergoing pedagogical training would better equip them for their teaching.

### 4.4 Linkages with Industry

All the 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\(^{10}\) 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.

The need to involve industry in advising on curricula reform has already been mentioned. But this process needs to be formalised to make it effective. Representatives from industry should be invited to serve on the Faculty of Engineering board or even on the higher administrative bodies of the institution. Also, professionals from business and industry can be used as adjunct professors. Not only does this make up for the acute shortage of academic staff in

\(^{9}\) See section 5.5 of this report.

most higher education institutions but it also exposes students to the practical aspects of their studies and provides direct contact with industry.

Perhaps the most important role of industry is to provide practical training to the students at two different stages: during the course in the form of industrial attachments which exposes the students to the world of work and which subsequently facilitates their employment; and on completion of the course to meet the necessary professional registration requirements. There are different thoughts on the most appropriate formula to be used. Some universities prefer short industrial attachments during the vacation period of the course, with the students obtaining more substantial training once they have graduated. Others prefer a sandwich formula with almost equal periods of training in industry alternated with teaching at the university. Whichever formula is used, such industrial training is vital for engineering students and graduates.

Several universities in Africa have abandoned the in-course industrial attachments because of the difficulty in placing the ever-increasing number of students, leaving the students to acquire training after graduation. This difficulty could well be an indicator of the poor absorption capacity for engineering graduates in the country. Another reason is that industry, especially private firms, find it difficult to supervise the students and assign them meaningful tasks because of lack of staff and heavy work load. It is also true that the industrial environment in most SSA countries is not yet as developed as in other regions, and training and even employment opportunities are therefore limited. Nevertheless, this is an area where the Faculty of Engineering and the relevant stakeholders (industry, public sector and parastatal bodies employing engineers, engineering associations, etc.) need to meet to discuss the best approach to be adopted, taking into account the challenges and constraints on all sides.

Several PASET partner countries have engineering projects in Africa and, during the consultations held with the participating African countries, it was suggested that they should make a commitment to providing industrial training to local engineering students and, as far as possible, employing the engineering graduates from the local institutions. This would be the ideal approach to technology transfer and would help to empower the local engineering industry. One could also consider the possibility of mounting a programme whereby the engineering academic staff from African institutions spend a short period in the relevant industry in the PASET partner countries to get industrial experience.

Some African universities and governments require graduates to work in rural areas for about a year on completion of their studies. This is an excellent way for young engineering graduates to be exposed to indigenous practices and skills and to contribute to sustainable development. Another way of linking the university with the rural community would be to have students posted in rural areas for practical training as part of their industrial attachment. This would not only expose students to problems of rural development but would also help in bringing these problems to the university for possible solutions through projects

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5. REGIONAL INITIATIVES TO IMPROVE ENGINEERING EDUCATION AND TRAINING IN AFRICA

5.1 Introduction

This section presents the findings of a desktop research to identify regional initiatives to improve engineering education and training, including TVET, in Africa. In identifying the initiatives, two guiding principles were used. First, that the initiative should have a regional outreach that promotes collaboration among countries, not necessarily covering the whole of Africa but extending at least beyond one country. There are a number of initiatives of development assistance to a particular African institution or even a specific country, but these have been excluded. Second, the initiative should in some way be relevant to the PASET initiative and where PASET partner countries could provide an input or use it as an example for partnership.

It should be mentioned at the outset that there is a dearth of information on such initiatives in Africa and the ones presented here are by no means exhaustive. Indeed, it was in recognition of such lack of information that the World Bank commissioned a survey of regional collaborative initiatives in Africa in 2011\textsuperscript{12}. The survey identified 106 initiatives, in all areas and with emphasis on postgraduate education and research. A study of those initiatives revealed that only about three of them deal with engineering, and these have been included in this report.

In the field of 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. The regional initiatives in engineering will therefore cover both the areas of education and training.

5.2 African Network for Scientific and Technological Institutions (ANSTI)\textsuperscript{13}

ANSTI is a regional non-governmental organization (NGO) which was established in 1980 by UNESCO with funding from United Nations Development Programme (UNDP) and the German Government. Its mission is to facilitate the active collaboration among African Scientific Institutions for the purpose of training and research in science, engineering and technology. UNESCO continues to provide financial and technical assistance to ANSTI and is assigned the responsibility of coordinating its activities. ANSTI’s Secretariat is housed in the UNESCO Nairobi office.

ANSTI has a membership of nearly 200 members (Faculties/Schools of Science, Engineering and also Agriculture) in 37 countries (Anglophone, Francophone and Lusophone) of SSA. Of these, 85 are Engineering Faculties/Schools. An interesting event of ANSTI is the biennial Conference of Vice-Chancellors, Provosts, Deans of Science, Engineering and Technology (COVIDSET). The 5\textsuperscript{th} Conference was held in Botswana in 2013. ANSTI also publishes the biannual African Journal of Science and Technology.

ANSTI/DAAD Postgraduate Fellowship: The German Academic Exchange Service (DAAD) offers, through ANSTI, a number of fellowships for Masters and PhD degrees. The

\textsuperscript{13} See www.ansti.org
fellowships are awarded to staff of ANSTI member institutions for postgraduate studies at African universities.

**UNESCO/L’Oreal Fellowship:** To encourage women to undertake research in science, technology and engineering, L’Oreal offers fellowships to women undertaking PhD research projects in SSA. ANSTI, as representative of UNESCO in Africa, coordinates the fellowship activities.

ANSTI also awards grants for staff exchange purposes and for senior academic staff of its members to attend international conferences.

ANSTI is a well-established and recognised organisation and its wide membership in SSA makes it an ideal vehicle for facilitating and coordinating engineering education projects under PASET.

### 5.3 UNESCO Engineering Initiative (UEI)\(^{14}\)

Following the publication of the 2010 UNESCO Report on Engineering, in November 2011 the UNESCO Engineering Initiative (UEI) was established to address major challenges in engineering as identified in the Report. These include the shortage of engineers, decreased interest in engineering as career option for young people, the underrepresentation of women in engineering and brain drain from some countries. In line with UNESCO’s global priorities, the UEI focuses on the African region and on women.

UEI has established fruitful partnerships with a number of organisations, including ANSTI, the American Society of Mechanical Engineers (ASME), the Institute of Electrical and Electronics Engineers, UK (IEEE) and the World Federation of Engineering Organisations (WFEO) to develop projects in these major themes: engineering education, women in engineering and interdisciplinary and sustainable engineering. In 2012 UNESCO and IEEE signed a MoU for improving engineering education and, in Africa, preliminary actions identified were accreditation, faculty development, curricula development and quality assurance in pilot African universities. It was also agreed to establish a UNESCO-IEEE Chair in Innovation at an African university. UNESCO has also signed a MoU with ASME to improve the quality of engineering education, increase public awareness of the value of engineering profession and promote science, technology, engineering and mathematics (STEM) training and careers.

The UEI is a relatively new initiative and the proposed activities in Africa have yet to evolve. The fact that it is initiated and led by UNESCO gives it a special international status. This is perhaps an opportune time for PASET partner countries and African countries to liaise with UNESCO to see how they can support and participate in UEI projects.

### 5.4 Pan African University (PAU)\(^{15}\)

The PAU, launched by the African Union in December 2011, is a major initiative of continental networking for promoting graduate training and research in identified priority areas for Africa. The PAU comprises five Institutes, one in each of the five African sub-

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\(^{15}\) See [http://hrst.au.int/en/sites/default/files/PAU_CALL_FOR_STUDENTS_%20(English)_0.pdf](http://hrst.au.int/en/sites/default/files/PAU_CALL_FOR_STUDENTS_%20(English)_0.pdf)
regions and each specializing in a different field. Each Institute will then network with other institutions in its respective field, thus creating a network of networks. In addition to support from the host countries of the Institutes, the PAU has been pledged $45 million by the African Development Bank as well as Euros 20 million by the German government. Two of the Institutes run engineering programmes.

**Institute for Basic Sciences, Technology and Innovation (East Africa).** This is located at the Jomo Kenyatta University of Agriculture and Technology in Kenya. It runs MSc and PhD programmes in four areas, including Civil Engineering (Structural and Arid and Semi-Arid Land options), and Electrical Engineering (Telecommunications and Power Systems options).

**Institute for Water and Energy Sciences (North Africa).** This is located at the University of Tlemcen in Algeria. It will run two programmes: MSc in Water (Engineering and Policy options) and MSc in Energy (Engineering and Policy options).

The PAU is still in its formative stages and no cohort has graduated yet. Also, the other African institutions with which each Institute will network are not yet known, and matters related to accreditation and quality assurance of the degrees to be awarded have yet to be clarified. However, because of the paucity of postgraduate training opportunities in engineering in Africa, both these Institutes could be of immense help in staff development of the various Faculties of Engineering in Africa. They are therefore worthy of support by the PASET partner countries.

### 5.5 Tuning Africa Project\(^\text{16}\)

The Tuning Africa project forms part of the Africa-European Union Strategic partnership and aims to apply the well-established Tuning methodology, which is a collaborative, consultative process involving academics, employers and other stakeholders to improve curriculum and enhance student competencies. A pilot project on applying the Tuning process, which has been used in over 60 countries of the world, is being implemented in universities in the five regions of Africa in five selected subject areas. In each region, a university was identified to lead an identified subject area, and that university then networks with a group of other universities in other African countries to apply the Tuning process to the respective subject area. The five identified subject areas include Civil Engineering (led by Ethiopia) and Mechanical Engineering (led by Cameroon). The Civil Engineering group has ten universities, including three Francophone ones; while the Mechanical Engineering group has twelve universities, including four Francophone ones.

The Tuning process is an onerous one and requires expert guidance. But its strength lies precisely in that process of consultation of all the stakeholders by the academics, which ensures quality and relevance of the programmes and greatly improves employability of the graduates. The approach adopted in Africa of linking a group of universities in different countries to work together in a particular subject area, regardless of linguistic barrier, makes

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\(^{16}\) See [http://www.tuningjournal.org/public/site/01/7_Tuning_as_Instrument_of_Systematic_Higher_Education_Reform_and_Quality_Enhancement.pdf](http://www.tuningjournal.org/public/site/01/7_Tuning_as_Instrument_of_Systematic_Higher_Education_Reform_and_Quality_Enhancement.pdf)
it particularly attractive. The approach could also have a multiplier effect in other subject areas in the same institution.

The pilot phase started in 2011 and is about to be completed. The next phase of Tuning (2014-2020) will start in 2014 and the plan is to extend the methodology to additional universities, to undertake more in-depth work in the selected five disciplines by considering postgraduate level, and possibly to have additional disciplines included. It should be possible for PASET to partner with the sponsors of this project and help to extend the next phase beyond what is already planned.

5.6 International Institute for Water and Environmental Engineering (2iE)\textsuperscript{17}

The Institute, located in Burkina Faso, is commonly known as 2iE, the acronym derived from its French appellation. It was created in 2007 as a fusion of two existing engineering institutes which were set up in Ouagadougou, Burkina Faso, in 1968 and 1970, respectively, by the 14 countries of West and Central Africa. The new institution, under new leadership, adopted a completely different and innovative approach in its governance structure, its international outlook, its academic programmes, its funding formula and the close links it established with industry.

The 2iE runs programmes from Bachelor’s to Doctorate levels in water, environment, energy, civil engineering, mining and business administration, all directly relevant to Africa’s needs. It also places a strong emphasis on research. Its qualifications are accredited internationally, it attracts students from all over Africa and while it retains a Francophone bias, it is bilingual in its approach. It has a full-time student population of some 2,000 and about 1,500 professionals follow its various programmes by distance and online learning.

Its achievements so far have been impressive. More than 95% of its students find employment within six months of graduation; 85% of its graduates work in the private sector; and 98% remain and work in Africa.

The 2iE is a single institution and in that way it is different from the other initiatives reported in this study; but it is a regional initiative in the sense that it receives government support from the countries in the West and Central regions of Africa, and it does serve the whole of Africa. It has recently been identified as one of the African Centres of Excellence to be funded by the World Bank.

The 2iE is an example to be emulated in other parts of Africa and one that should receive the attention of the PASET initiative.

5.7 African Engineering Education Association (AEEA)\textsuperscript{18}

Since 2002 a biennial African Regional Conference on Engineering Education (ARCEE) has been organised in Africa.

A major outcome of the 3\textsuperscript{rd} ARCEE in 2006 was the setting up of the AEEA. The objectives of the AEEA include organising ARCEE to promote networking among engineering

\textsuperscript{17} See \url{www.2ie-edu.org} and accessed from \url{http://www.2ie-edu.org/assets/plaquette_institutionnelle_2iE_fr.pdf}

\textsuperscript{18} See \url{http://www.aeeaonline.org/events.html}
educators, improving engineering teaching and learning in educational institutions, advocacy for government support for engineering education, involvement of African diaspora in the development of engineering education in Africa and promoting exchange of students across the continent. The AEEA has four institutional members (three universities in Nigeria, one in Tanzania and one in Libya) and about 80 individual members from the whole African continent (not just SSA), including a few from Europe and North America. About 30% of the individual members are from Nigeria.

The 4th ARCEE was held in 2008 under the theme “Capacity Building in Engineering Education for Sustainable Development”. The Conference took a number of resolutions, including the following: AEEA should urge African governments to generously invest in and support engineering education and training; AEEA should promote and facilitate international accreditation of engineering programmes of African institutions; engineering curricula and training should be dynamic, responsive to societal needs and incorporate links with industry; and AEEA should develop a database of engineering institutions in Africa, indicating the available capacity and areas of strengths in order to identify capacity building needs of the institutions. At the same Conference the Emerald/Africa Research Fund Award was launched for encouraging research in engineering.

In November/December 2009, a 21-member delegation from AEEA attended the China-AEEA Research and Study Seminar on Engineering Education and Project Management for African Countries, hosted by the Tsinghua University Centre for Engineering Education in Beijing. A major outcome of that seminar was the signing of a MoU for cooperation between Tsinghua University Centre for Engineering Education and AEEA. The scope of the cooperation includes joint research on China-Africa engineering education, organisation of fora on engineering education, publication of research papers and exploration of potential collaboration between Chinese and African engineering education institutions.

The 5th ARCEE organised by the AEEA was held in Lagos, Nigeria in September 2013 under the theme Harnessing Scarce Resources for Advancement of Engineering Education. There was also a proposal to create an African Deans Council at that Conference, following the initiative of the creation of the Global Engineering Deans Council in 200819.

AEEA appears to be a very interesting and dynamic organisation. The fact that it is led essentially by individuals rather than institutions could be a weakness, although this should be overcome by the creation of a Deans Council. Its proposed collaboration with China is very relevant to the PASET initiative.

5.8 USHEPiA20

The University Science, Humanities and Engineering Partnerships in Africa (USHEPiA) is a partnership of eight universities (two in Kenya) in seven countries (Botswana, Kenya, Tanzania, Uganda, South Africa, Zambia and Zimbabwe). The programme was launched in 1996 under the initiative of the University of Cape Town, South Africa, which hosts the secretariat. It is funded by a number of US funding agencies, including the Rockefeller Foundation, the Carnegie Corporation and the Andrew Mellon Foundation.


20 See [http://www.ushepia.uct.ac.za/](http://www.ushepia.uct.ac.za/)
Its objective is to promote collaboration amongst African researchers in the generation and dissemination of knowledge and, in particular, to build institutional and human capacity in African universities through staff development. The programme awards fellowships to existing academic staff in the partner universities to enable them to pursue postgraduate studies (mostly PhD) within their respective institution through collaboration with the other universities.

USHEPiA has produced 10 cohorts of postgraduate students since 1996. Of these, only about 15 (roughly one a year) have graduated in the area of Engineering. This is an important programme but it illustrates the challenge that upgrading, especially to the level of PhD, of academic staff in engineering poses in African universities. One could even question the feasibility and desirability of aiming to have all academic staff in Engineering Faculties in Africa to have a PhD.

5.9 Regional Initiative in Science and Education (RISE)\(^21\)

RISE aims to strengthen higher education in SSA by increasing the population of qualified faculty teaching in African universities. It prepares PhD- and MSc-levels scientists and engineers through university based research and training in selected disciplines. A network of universities is established for each discipline and the academic staff of the network supervise postgraduate students, mentor younger and less experienced staff and facilitate access to equipment not available in the home university.

RISE is funded by the Carnegie Corporation, USA, and is administered by the Science Initiative Group (SIG) of the Institute of Advanced Study (IAS) in Princeton, USA. Of the five established networks, two are related to engineering.

**African Materials Science and Engineering Network (AMSEN).** This network focuses on developing the skills in materials science and engineering needed to develop and add value to the extensive mineral deposits in southern Africa. It is hosted by the University of Witwatersrand, South Africa and the other participating institutions are University of Nairobi, Kenya; University of Namibia; the Federal University of Technology, Akure, Nigeria; and University of Botswana.

**Sub-Saharan Africa Water Resources Network (SSAWRN).** This network focuses on the pressing water resources of SSA, including rising use, declining quality, insufficient research and teaching capacity, inadequate weather statistics and the likelihood of increased variability of water supplies associated with future climates. The SSAWRN is coordinated by Rhodes University and the other participating institutions are Eduardo Mondlane University, Mozambique; University of Botswana; and Makerere University, Uganda.

Most of the RISE networks were established in 2008 and they have to date produced several PhD and MSc graduates, almost all of whom have stayed in Africa. Both AMSEN and SSAWRN are multi-disciplinary networks and engineering is but one of the disciplines. The networks have been successful and confirm that the best approach to promoting postgraduate training and research in SSA is through networking and collaboration among African universities. It is not clear for how long the Carnegie Corporation will fund the RISE networks, which eventually should generate their own funds. The partner countries of PASET

\(^21\) See [http://sig.ias.edu/files/RISE_1_14.pdf](http://sig.ias.edu/files/RISE_1_14.pdf)
could provide support to such networks by providing expertise, assisting in the acquisition of equipment and funding seminars and workshops of the networks in Africa.

5.10 Africa Engineers Forum (AEF)\(^\text{22}\)

Established in 1995, the AEF is a network of engineering organisations that ‘subscribe to shared values in support of viable and appropriate engineering capacity in Africa’. It currently has 16 national African Engineering Institutions as signatories, mostly from the SADC countries but also from Ghana and some East African countries. Its secretariat is housed at the South African Institution of Civil Engineering. AEF collaborates in the Africa-UK Engineering Partnership for Development (see below) but apart from that it does not appear to have any significant projects. It might well be subsumed under the Federation of African Engineering Organisations (see below).

5.11 Federation of African Engineering Organisations (FAEO)\(^\text{23}\)

The FAEO brings together Engineering organisations from all over Africa and is a member of the World Federation of Engineering Organisations (WFEO). It was created in May 2012 and its ambition is to build a united umbrella body for all African engineers. Its website provides no information about its objectives but according to its President, the FAEO aims “at entrenching unity of purpose amongst all nations of the world to emancipate Africa from poverty through science and technology”. Its constitution recognizes five regional Federations of Engineering Organisations (Central, Eastern, Northern and West Africa) to operate under the FAEO. It has also created several Standing Technical Committees. The FAEO is still evolving and it would be of limited use to the PASET initiative at this stage.

5.12 Africa-UK Engineering for Development Partnership\(^\text{24}\)

This Partnership, launched in 2010, brings together the engineering community in Africa and the UK in a consortium led by the AEF, The Royal Academy of Engineering, Engineers Against Poverty and the Institution of Engineers (UK). Its purpose is to strengthen the capacity of the African engineering profession and promote mutually beneficial links between engineers in Africa and the UK.

In 2010 and 2011, the Africa-UK Partnership held a series of workshops in SSA. The one held in Zimbabwe in November 2011 was under the theme Engineering Education, where delegates discussed opportunities to improve the engineering curricula in African universities and ensure that graduate engineers are equipped with the skills and knowledge needed to promote sustainable development and fight poverty.

In 2012 and 2013 the Partnership planned to run a programme on Enriching Engineering Education in Sub-Saharan Africa, designed to bring engineering curricula in universities in line with current industrial practice and to improve teaching practices in engineering. The Partnership also planned to launch an Africa Prize to recognise and reward innovation and entrepreneurship in engineering in SSA. It has not been possible to obtain information on developments on these activities.

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\(^{22}\) See [http://www.africaengineersforum.org/index.html](http://www.africaengineersforum.org/index.html)


\(^{24}\) See [http://www.raeng.org.uk/international/activities/pdf/engdev/UK_intro_to_the_Partnership.pdf](http://www.raeng.org.uk/international/activities/pdf/engdev/UK_intro_to_the_Partnership.pdf)
There appears to have been a lull in the dynamism of this Partnership after its operation in the first two years.

5.13 Commonwealth Association of Polytechnics in Africa (CAPA)\textsuperscript{25}

CAPA is a Pan-African organisation with its secretariat located at The Technical University of Kenya which, until 2007, used to be the Kenya Polytechnic. CAPA was established in 1977, with a mandate to support professional and skills development and to promote policy advocacy in favour of TVET.

CAPA’s membership comprises 173 post-secondary educational institutions (polytechnics, technical colleges and vocational training institutes) in 18 African countries (no Francophone ones). Its main objective is the promotion of technical and vocational education and training, technology transfer and skills development in Africa. It does this through policy advocacy and dialogue with governments, development partners and educational institutions, as well as networking and information sharing among member institutions. It organises biannual international conferences and has just launched its scientific journal.

CAPA has launched a staff development fellowship programme to enable staff to spend 3-6 months in a member institution in another country, for the purpose of research and development, knowledge and skills transfer and curriculum development. The programme aims to promote partnership and networking among CAPA member institutions and assist in capacity building. The first awards are to be made in 2014.

CAPA is probably the only non-university, non-professional engineering continental association in Africa and it is well-established and recognised. Although it does not itself offer technical training, it is an important venue to go through for promoting technical and vocational training, for which there is such a great need in Africa. From that point of view, CAPA, just like ANSTI, should be of definite interest to the PASET initiative. The one disadvantage is that it does not cover Francophone countries in SSA.

5.14 African Union-India Cooperation on TVET\textsuperscript{26}

The African Union has established a cooperation agreement with India to set up ten TVET Centres in Africa, two in each of the five African regions as follows:

- Western Region: Burkina Faso and The Gambia
- Northern Region: Egypt and Libya
- Eastern Region: Rwanda and Ethiopia
- Central Region: Burundi and Gabon
- Southern Region: Mozambique and Zimbabwe

The Indian government will provide the technical support and equipment, the curricula and the main trainers for the initial three years; the respective African country will provide land, infrastructure and ensure that the Centre is fully operational.

In 2012 most of the Centres were in the initial phase of their establishment. Rwanda inaugurated the opening of its Centre at the end of 2013.

\textsuperscript{25} See \url{http://www.capa-sec.org/}

This is a most interesting initiative and one that PASET partner countries could link up with and support.

5.15 Vocational Training Pilot Programme in Post-Conflict Countries

In 2008-09, the African Union Commission (AUC) launched a pilot project in three post-conflict countries, namely Liberia, Republic of Congo and Burundi, utilizing TVET to build capacity and develop skills of unemployed young people who can participate in the reconstruction process or build their own business. The pilot project was entirely supported by the European Union Fund.

Each country identified its own areas of intervention and these included: agriculture, truck/car repair, electrical installation and electronic equipment repair, handicraft and traditional skills, tourism-related skills, hairdressing, iron construction work and tailoring. In all the three countries ICT skills, business entrepreneurship skills and attitudes, communication and dialogue skills and peace keeping attitudes were imparted. An IT centre with the necessary equipment was also established in each country.

Despite the limited resources, the project enabled an important number of beneficiaries to enter into small businesses. The project could not be fully completed because of lack of funds. Liberia and Burundi found supplementary funds to conduct the last phase of the training, while the Republic of Congo suspended the training as additional funds from AUC were not forthcoming. As of 2012, there were no funds budgeted for TVET activities at the AUC.

Assisting the post conflict African countries through provision of TVET is an excellent initiative. However, the long term sustainability of the initiative needs to be carefully assessed as the countries need eventually to own and run the project without much external assistance.

5.16 Innovation in Vocational Education and Skills Training (INVEST)

INVEST is a project with the Commonwealth of Learning (COL) and CAPA as partners. The objectives of the project are to build capacity of TVET institutions to benefit from the potential of new technologies in flexible delivery approaches and use of Open Educational Resources, and to increase access to skills development for those currently locked out of skills training, especially women and people in the informal sector. In SSA, it is believed that about 70% of the work is done in the informal sector, which in 2000 has been estimated to contribute to 42% of GDP in 23 African countries.

There are 13 TVET institutions in six African countries (Ghana, Kenya, Tanzania, The Gambia, Nigeria and Zambia) currently participating in INVEST. The achievements as at June 2012 include 3,760 learners having benefited from flexible learning, 160 girls having enrolled for a Diploma programme and student enrolment having increased in seven institutions by between 5% to 30%.

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27 Ibid.
There is a need to increase TVET training in Africa and the traditional approach of formal school education has its limitations and is not appropriate for the informal sector. So INVEST would certainly be a welcome project under the PASET initiative. However, its success would greatly depend on the availability of ICT in the African countries, especially in rural areas, and in particular on the ease with which trainees adapt to distance learning and the use of ICT.

5.17 Summary of Initiatives

Table 1 summarises the initiatives reviewed above and indicates the year they were established and their broad activities. The majority of the initiatives have been operational fairly recently and their activities have yet to develop fully. Most of the faculty development activities relate to upgrading of academic qualifications, usually to PhD. There is no initiative to encourage young engineering faculty to spend some time in industry to gain industrial experience. Also, although there are initiatives for curricula reform, for these to be effective they must be accompanied by pedagogical training of faculty; no such initiative could be found. Similarly, except at 2iE, there is no regional initiative to facilitate the placement of engineering students for industrial training, especially in view of the difficulty encountered by most institutions in placing students for training in industry locally. In view of the importance and significant activities in, for example, the extractive industries, in construction and in Information and Communication Technologies in several African countries, such placement could greatly help students to gain meaningful experience and even subsequent employment upon graduation.

Table 1: Summary of Regional Initiatives: Year of Establishment and Broad Activities

<table>
<thead>
<tr>
<th>No</th>
<th>Initiative</th>
<th>Year Established</th>
<th>Broad Actual or Proposed Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Higher Education Initiatives</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>African Network of Scientific &amp; Technological Institutions (ANSTI)</td>
<td>1980</td>
<td>Institutional collaboration; publication of research; faculty development</td>
</tr>
<tr>
<td>2</td>
<td>UNESCO Engineering Initiative (UEI)</td>
<td>2011</td>
<td>Faculty development; curricula reform; QA &amp; accreditation</td>
</tr>
<tr>
<td>3</td>
<td>Pan African University (PAU)</td>
<td>2011</td>
<td>Institutional networking for graduate training and research</td>
</tr>
<tr>
<td>4</td>
<td>Tuning Africa Project</td>
<td>2011</td>
<td>Curricula reform; improving quality</td>
</tr>
<tr>
<td>5</td>
<td>International Institute for Water and Environmental Engineering (2iE)</td>
<td>2007</td>
<td>Training and research at all levels; linkages with industry</td>
</tr>
<tr>
<td>6</td>
<td>African Engineering Education Association (AEEA)</td>
<td>2006</td>
<td>Networking conferences for improving engineering education; advocacy; involvement of diaspora; student exchanges</td>
</tr>
<tr>
<td>7</td>
<td>University Science, Humanities and Engineering Partnerships in Africa (USHEPiA)</td>
<td>1996</td>
<td>Regional research collaboration; faculty development</td>
</tr>
<tr>
<td>8</td>
<td>Regional Initiative in Science &amp; Education</td>
<td>2008</td>
<td>Institutional networking for research;</td>
</tr>
<tr>
<td>No.</td>
<td>Initiative</td>
<td>Regional Coverage</td>
<td>Relevance</td>
</tr>
<tr>
<td>-----</td>
<td>---------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>1</td>
<td>African Network of Scientific &amp; Technological Institutions (ANSTI)</td>
<td>Whole Africa</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>UNESCO Engineering Initiative (UEI)</td>
<td>Whole Africa</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>Pan African University (PAU)</td>
<td>Whole Africa</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Tuning Africa Project</td>
<td>Whole Africa</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>International Institute for Water and Environmental Engineering (2iE)</td>
<td>West &amp; Central Africa</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>African Engineering Education Association (AEEA)</td>
<td>Mostly Anglophone countries</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>University Science, Humanities and Engineering Partnerships in Africa (USHEPiA)</td>
<td>7 Southern/Eastern countries</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>Regional Initiative in Science &amp; Education (RISE)</td>
<td>9 Anglophone countries</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>Africa Engineers Forum (AEF)</td>
<td>Mostly Anglophone countries</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>Federation of African Engineering Organisations (FAEO)</td>
<td>Whole Africa</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 2 summarises the initiatives by their regional coverage and their relevance to the PASET initiative. From the regional coverage point of view, five of the initiatives cover the whole of Africa, or at least SSA. Six others cover mostly Anglophone countries. Limited information is available on engineering initiatives in Francophone or Lusophone countries. However, the growing trend is to consider Africa as one continent without any linguistic division. Most of the major funders to African higher education (the European Union, the World Bank, the African Development Bank, the African Union, etc.) ensure that their projects cover institutions in all linguistic areas.
<table>
<thead>
<tr>
<th></th>
<th>TVET Initiatives</th>
<th>Anglophone countries</th>
<th>Relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Africa-UK Engineering for Development Partnership</td>
<td>Anglophone countries</td>
<td>1</td>
</tr>
</tbody>
</table>

*Relevance to PASET: 3=very relevant; 2=relevant; 1=some relevance*

With regard to the relevance of an initiative to the PASET initiative, the main criterion used was whether it could lead to capacity building in technical, vocational and higher education in African countries from an engineering perspective. Eight of the initiatives are considered to be highly relevant to the PASET initiative and need to be closely studied by both the participating partner and the African countries. Five of the initiatives are relevant to PASET, but perhaps to a lesser degree. And two initiatives are only slightly relevant to the initiative, although both of them are still evolving.

6. ACCREDITATION OF ENGINEERING QUALIFICATIONS

6.1 Introduction

Engineering, like medicine, is an important field and some engineering activities carry risks to society, resulting, for example, from poor design, construction, operation or maintenance. It therefore needs to be regulated. Engineers also often need to operate in countries other than their own, and their qualifications and competencies need to be recognised across borders.

Accreditation is the formal recognition of an education or training programme through a quality assurance process to ensure that it meets the criteria prescribed for the type of programme. Usually, a decision is taken after an independent accreditation visit to the institution running the programme to look at the curriculum, staffing, physical facilities, funding and management of the programme.

6.2 Accreditation of Engineering Qualifications in Africa

In the majority of African countries (but not the Francophone ones), the regulation of the practice of engineering is done by a single statutory body. In Nigeria this body is known as the Council for the Regulation of Engineering in Nigeria (COREN); in Kenya, Tanzania and Uganda it is the Engineers Registration Board (ERB); and in South Africa it is the Engineering Council of South Africa (ECSA), one of the best known engineering regulatory bodies.

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31 See [https://www.ecsa.co.za/default.aspx](https://www.ecsa.co.za/default.aspx)
body in Africa. The core functions of these bodies are accreditation of engineering programmes, registration of professionals in specified categories and regulation of the practice of registered persons or firms. In Ghana, there is no accreditation body specifically for engineering. The National Accreditation Board is responsible for accrediting all tertiary education institutions and programmes in Ghana, and the registration of engineers is done by the Ghana Institution of Engineers after they have passed the Engineering Professional Examination. A few African countries have similar arrangements.

It is often believed that the accreditation of engineering programmes is more appropriate for private institutions which may not meet the minimum criteria. However, almost all the accreditation bodies now make no distinction between public and private universities. Indeed, there is an example in Kenya where, in 2011, the ERB refused the recognition of the engineering degrees of three of the country’s leading public universities. Also, a survey of 129 universities running engineering programmes in Nigeria revealed that, in 1999/2000, only 21 of them were fully accredited by COREN, 39 were denied accreditation, and the remaining 69 obtained interim accreditation.

6.3 International Accreditation of Engineering Qualifications

At the international level, there are three agreements that govern the accreditation and mutual recognition of engineering qualifications. These are the Washington Accord for professional engineering qualifications, usually of four years’ duration; the Sydney Accord for qualifications in engineering technology, usually of three years’ duration; and the Dublin Accord for technician qualification, usually of two years’ duration. There are at present 15 signatories to the Washington Accord, nine to the Sydney Accord and eight to the Dublin Accord. A signatory is the national body responsible for accrediting engineering programmes in a country. Programmes accredited by any signatory body is recognised by the other signatories. There are strict procedures to be followed, requiring a long process, before a country can become a signatory to these Accords.

The 15 signatories of the Accords are: Australia, Canada, Chinese Taipei, Hong Kong China, Ireland, Japan, Korea, Malaysia, New Zealand, Russia, Singapore, South Africa, Turkey, UK and USA. South Africa, through its ECSA, is the only African country that is a signatory to all three Accords. The Accords make it possible for a signatory to assist one or more developing countries in eventually gaining signatory status. The two countries assisted by ECSA are Botswana and Namibia. Of the PASET partner countries, only Korea, through its Accreditation Board for Engineering Education of Korea, is a signatory to the three Accords.

Another international accreditation body is the Accreditation Board for Engineering and Technology, Inc. (ABET), based in the USA. It is a non-governmental organisation that accredits post-secondary education programmes in applied science, engineering and engineering technology. ABET to date has accredited over 3,200 programmes from more


34 See [http://www.washingtonaccord.org/](http://www.washingtonaccord.org/)

35 See [http://www.abet.org/home/](http://www.abet.org/home/)
than 670 universities and colleges. The bulk of these programmes are in the USA but there are also accredited programmes in 23 other countries. Of these countries, the only one from Africa is South Africa, and within South Africa, the only institution which has ABET-accredited programmes is University of Pretoria. However, the two accredited programmes are non-engineering ones: Bachelor of Commerce in Informatics and in Information Systems.

ABET accreditation of a programme carries a significant initial cost as it requires an institutional visit of a review team of three persons over at least three days. These costs include accreditation review fees (which can be of the order of US$ 32,000), air travel for the team members (usually in Business Class) and all their local costs. There is also an annual maintenance fee for the accreditation.

The question that arises is whether other African countries and institutions should aim at becoming signatories of the Accords or at ABET accreditation. There is no doubt that these bestow prestige and international recognition on the engineering qualifications. However, the main purpose of international accreditation is to facilitate the mobility of engineering professionals among the different countries, especially the industrialised ones. But is this a priority for Africa? Would this not lead to greater brain drain of professionals from Africa to industrialised countries? Initiatives that encourage regional mobility of professional engineers within Africa would certainly be more important and appropriate.

6.4 Towards Regional Accreditation of Engineering Qualifications in Africa

In Africa, most of the accreditation bodies have national jurisdiction. But there are examples of regional cooperation in engineering regulation. Recently, the ERB’s of Kenya, Tanzania and Uganda signed a Mutual Recognition Agreement whereby programmes 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 Francophone African countries, has a programme for the recognition and equivalence of diplomas (PRED) awarded in all the countries, and PRED’s recognition of a diploma in one country is binding on all the others, although the majority of cases CAMES deals with are qualifications from private institutions. In most Francophone countries the recognition of qualifications from public institutions is the responsibility of the relevant Ministry.

Perhaps Africa should aim at establishing a regional body for the accreditation of engineering qualifications, building up from sub-regional initiatives. In East Africa there is already a Mutual Recognition Agreement among the ERB’s of Kenya, Tanzania and Uganda. The engineering accreditation bodies of the other countries of the East African Community, Rwanda and Burundi, could be brought on board. In Southern Africa, the very well established ECSA of South Africa, which already works with the accreditation bodies of Botswana and Namibia, could take the lead and establish a Mutual Recognition Agreement by inviting the other counties in the sub-region to join in. A similar approach could be adopted in West Africa with COREN of Nigeria leading the initiative.

ECSA, COREN and the ERB’s of East Africa are probably among the best engineering accreditation bodies in Anglophone Africa. Other African countries have established such a body but they may not have the expertise, experience and resources to effectively undertake

36 See http://www.erb.go.tz/
their accreditation functions. The sub-regional collaboration initiatives mentioned above would help to build their capacity. These initiatives should be supported by the well-established respective Regional Economic Community in each of Africa’s sub-regions.

7. CONCLUSIONS

Africa stands at a cross-roads in its development trajectory. It is widely acknowledged that the continent has huge potential for growth and development, and that its youthful population and abundant natural resources are key aspects that need to be fully exploited. Education and training, especially in science, engineering and technology, are necessary tools for the continent to unlock its potential.

Engineering and TVET are probably the areas requiring most attention, the former providing highly skilled personnel for technological and industrial development, and the latter for absorbing the high unemployment that currently plagues the youth of Africa. Both areas, however, face a number of challenges, including poor quality and relevance of educational provision, lack of human and financial resources, and poor linkages with industry. These challenges need to be addressed jointly and urgently by African governments, engineering education institutions and representatives of industry and the private sector. PASET partner countries can certainly provide assistance and support.

It is encouraging to note that several recent regional initiatives are already under way to address some of these challenges, as identified in this report, and these need to be supported, nurtured and extended. Two important considerations that run through the initiatives are harmonisation of approaches and collaboration among African institutions. Here, too, the PASET partner countries can play a supportive and catalytic role.

Accreditation of engineering qualifications in Africa is key to improving the quality of the awards. Most African countries have taken steps towards accreditation of their engineering qualifications but only a few have really established a robust accreditation system. This study suggests that these countries should take the lead in assisting the other countries, on a sub-regional basis, to improve their accreditation system, the ultimate goal being to establish a Pan-African engineering accreditation system. This is an area worthy of support by the PASET partner countries, all of which have well-established engineering accreditation systems.

In parallel to improving the quality of engineering education and training, there is a need to create a dynamic industrial environment in African countries. Only then can engineering and TVET thrive and achieve their full potential. Here as well, PASET partner countries that have significant industrial and manufacturing investments or are involved in major infrastructural development in Africa, can be enormously helpful by providing professional training to engineering students and by employing local engineering graduates whenever possible; in short by empowering African engineers and effecting technology transfer, vital for Africa’s economic and industrial development.

To some extent, this is a ‘chicken-and-egg’ situation, as industrial development can only take place when there is a pool of trained technical manpower, and the training of technical personnel is dependent of industry’s absorptive capacity. A national assessment of both
engineering capacity and needs in African countries can be of great help towards this end. The World Bank could assist the African countries participating in the PASET initiative to undertake such an assessment, where this has not been done yet. A similar regional assessment at the macro-level in Africa could also be very helpful.

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