PRELIMINARY STUDY: ENGINEERING EDUCATION EVALUATION
A DESKTOP STUDY, CONCEPTUAL FRAMEWORK AND QUESTIONNAIRE
INCLUDING ACTION POINTS
July 2008

For the
NEPAD Science and Technology Consolidated Plan of Action:
Programme 3.2: Building Engineering Capacity for Manufacturing

By
Dr. Cuthbert F. Mhilu
Department of Energy Engineering
College of Engineering and Technology
University of Dar es Salaam
Dar es Salaam
Tanzania

Dr. A.A. Ilemobade¹ and P.A. Olubambi²
¹School of Civil & Environmental Engineering
University of the Witwatersrand
Johannesburg
South Africa

²School of Chemical & Metallurgical Engineering
# Contents

Introduction: ................................................................. 3

1. MOTIVATION FOR THIS STUDY AND TERMS OF REFERENCE .......... 4

2. STRUCTURE OF THE REPORT ........................................... 4

3. ENGINEERING CAPACITY FRAMEWORK FORMULATION ............... 5
   3.1 Situation analysis ....................................................... 5
   3.2 Education and training of engineers ................................. 8

4. ENGINEERING EDUCATION CHALLENGES WITHIN SADC ............ 9

5. DEVELOPMENT OF A CONCEPTUAL FRAMEWORK FOR ASSESSING
   ENGINEERING EDUCATION ............................................. 10
   5.1 Curriculum .................................................................. 11
   5.2 Teaching and learning ................................................... 12
   5.3 Engineering popularity and entry qualification ..................... 12
   5.4 Industry involvement .................................................... 13
   5.5 Engineering accreditation ............................................. 13
   5.6 Institutional collaborations ............................................ 13
   5.7 Summary .................................................................... 14

6. A PROPOSED CONCEPTUAL FRAMEWORK FOR ASSESSING
   ENGINEERING EDUCATION, TRAINING AND CAPACITIES WITHIN SADC
   UNIVERSITIES ................................................................ 15
   6.1 (Engineering) Student based input .................................... 16
   6.2 Institutional based input .................................................. 19
   6.3 Industry based input ....................................................... 30

7. References ...................................................................... 35

8. Bibliography .................................................................... 36

9. NEPAD-SARUA Engineering Round Table Action Points: ............ 37
   A Road Map .................................................................... 37
   Sequence of developments: ................................................. 37
   Responsibilities and resources: .......................................... 37
   Problem Statement ............................................................ 38
   The Purpose ..................................................................... 38


**Introduction:**

In the second half of 2007 the NEPAD Office for Science and Technology held discussions with SARUA to explore ways to begin the implementation of the NEPAD Science & Technology Consolidated Plan of Action for the Southern Africa region.

The result was a commissioned draft preliminary study of engineering education in the region and a draft framework and set of questionnaires for a subsequent survey and study of each university in the region providing engineering education.

A round table meeting was convened on June 9-10, 2008 in Pretoria, South Africa, comprising the Deputy Vice-Chancellors and Deans responsible for Engineering research and education in the public universities of the SADC region. At this meeting the draft report, framework and questionnaires were refined and approved, and the proposed institutional survey and study were endorsed.

This report contains these approved documents and a summary of agreed action points from the round table. We hope you find these useful reading and that those of you who are responsible for planning and providing education for our regional engineering graduates and post-graduates will participate in the regional institutional survey and study to ensure its success and the future of engineering education and research for our region.

---

John Mugabe  
Head  
Office for Science & Technology  
NEPAD

Piyushi Kotecha  
CEO  
SARUA
1. MOTIVATION FOR THIS STUDY AND TERMS OF REFERENCE

The exclusion of the African continent from the industrial revolution stimulated by advances in manufacturing clearly demonstrates the need for African countries to build strong engineering capacity. Globalization is largely influenced by the capacity of nations and their firms to produce new and novel industrial goods and services. This capacity is to a large extent of an engineering nature. Indeed revolutionary technological, economic and related industrial opportunities will be tapped by those countries with a strong engineering base. Africa's low and declining levels of industrialization are manifestation of its limited, and in many cases, qualitatively poor engineering base. The continent relies on a narrow range of economic activities mainly because it is not able to add value to its abundant natural resources through manufacturing and thus most of its countries export raw materials. Its economic change and industrial transformation will depend on the strengthening of manufacturing capacity. To achieve this, the quality of engineering education and training needs to be improved and more engineers generated. Higher education institutions - universities and technical colleges - have crucial roles to play to enable Africa to build engineering capacity. They have to be at the forefront of continental engineering programmes.

African leaders and the international community have recognized and begun to put emphasis on the urgency of strengthening the continent’s engineering capacity through the revitalization of higher education institutions. The NEPAD framework document puts emphasis on the need to establish networks that are aimed at improving the quality of engineering training and increasing numbers of African engineers. The Commission for Africa calls for:

"specific action for strengthening science, engineering and technology capacity.... Scientific skills and knowledge enable countries to find their own solutions to their own problems, and bring about step-changes in areas from health, water supply, sanitation and energy to the new challenges of urbanization and climate change. And critically, they unlock the potential of innovation and technology to accelerate economic growth, and enter the global economy."

The Terms of Reference for this preliminary study include the following:

a. To undertake a desk study and from this, develop a draft conceptual framework for assessing the status of engineering education, training and capacities in SADC universities; and

b. To develop questionnaires based on the framework developed in (a). Information generated using the questionnaires would be used to populate the framework for the SADC universities involved in the study.

2. STRUCTURE OF THE REPORT

A general overview of engineering capacity and the formulation of a framework for assessing engineering education, training and capacity is presented in chapter 3.0. Challenges facing engineering education within SADC are presented in chapter 4.0 while literature on the different components that should comprise the evaluation framework is presented in chapter 5.0. The proposed evaluation framework for this study and the related questionnaires are presented in chapter 6.0.
3. ENGINEERING CAPACITY FRAMEWORK FORMULATION

3.1 Situation analysis

Economic development is specifically related with the introduction of industrial technology that has a significant socio-economic impact on the development of a society. The concept;

“…technology can be defined as a comprehensive process integrating the various factors of production such as human labour, know-how, production management, energy, materials and machinery.”

The interaction of a person, the machinery and materials with the intention of producing new products, is the “technique.” The techniques lead to changes in the use of labour and product. Development of technology depends particularly on the capacity of engineering. Engineering as we understand it today developed with the Industrial Revolution, fundamentally rooted in mechanical engineering. The history of mechanical engineering goes back to the time when human, first tried to make machines to apply more power to perform work.

The Engineers Council of Professional Development (USA), has defined engineering as the creative application of “…scientific principles to design or develop structures, machines, apparatus, or manufacturing processes, or works utilizing them singly or in combination; or to forecast their behaviour under specific operating conditions, with respect to intended function, economics of operation and safety to life and property.”

On the basis of the above definition, building the engineering capacity of a nation need the following three elements to be considered;

• Engineering production
• Engineering research
• Engineering human resource

Given the political development programme and economic conditions of a country, it becomes a challenge to identify and specify the potentials of and obstacles to the development of engineering and self-sustained industrialization. As such, the framework for building engineering capacity should consider these factors and focus made on the institutions concerned with the development of the technical and social productive forces.

3.1.1 Engineering production

To build a strong national economy, various production activities need specific kinds of power-driven machinery and equipment for a particular product or process. Machine building requires metalworking machines called “machine tools”. Machine tools transform raw materials into different parts, either by cutting or by forming metals.

Building capacity to develop the machine tool industry becomes the vehicle for technological development in the engineering sector. To shed some light on this, a typical standard products structure of the engineering sector can be arranged according to Figure 1.
It may be observed from Figure 1 that, building the engineering capacity in the region would require the structuring or re-structuring of curricular in higher education institutions such that a solid technical know-how in both machine building and metal fabrication could be acquired. In many SADC countries currently, there exist limited machine building, tool-making, and metal working sectors. These sectors supply the technological inputs necessary for other production activities.

3.1.2 Engineering research

History shows that research is to be considered as a major productive force in the process of industrialization. Although in the history of European industrialization production, education and research developed slowly in successive stages, no time can be lost in the development of Africa. Hence, production and research for development of the engineering sector should be considered an integral part in engineering education curricular, linking it with industries.

In engineering education, the following five research levels may be distinguished;
(i). **Basic research:** Is carried on with little regard to any possible usefulness.

(ii). **Oriented research:** Is itself directed towards obtaining knowledge which prove useful. Most industrial enterprises claim that part of their efforts is of this nature.

(iii). **Applied research:** This usually is, referring to the application of information exposed by oriented research, for the construction of devices or materials that have an industrial use.

(iv). **Technical development:** Is the process of converting an idea into an article (product), which can be manufactured in sufficient quantities and at low cost.

(v). **Design work:** This one refers in general to the task of translating sketches, notes, models and even prototypes for which parts to be machined, and act as the guide and reference for manufacturing.

These stages of the scientific and technological chain, beginning with oriented research and culminating in the production of hardware involves “innovation”. There would be no innovation without engineering research. It generally leads to the development of cost – reducing and labour simplifying techniques.

It is therefore important that, some mechanisms are put in place to increase the awareness of the need to establish collaborative engineering research and development (R&D) programmes/projects within the region, and to develop techniques and new products. However, for engineering R&D to take place in a critical manner and on a larger scale, SADC countries should establish the following:

- National science and technology (S&T) policies
- Formal funding structures to build R&D capacities

According to the above requirements, the engineering institutions should be equipped with necessary technical facilities as part of the engineering education and training programme, to support research and development activities. In addition, collaboration is essential for existing engineering institutions to be able to share human and physical resources, and above all, research outputs should find their way to the industry, to stimulate the industrialization process in the region.

### 3.1.3 Engineering human resource

When national training programmes are being planned, the types of industrial personnel that are needed to achieve building a strong capacity in manufacturing must be considered. The development of manufacturing human resource requires also a parallel development of human resource in many other specialized areas for supporting related activities such as:

- Processing of raw materials and intermediate products
- Energy, transport and communication services
- Construction
- Financial services
- Supply services for equipment, parts and materials
- Marketing services
- Installation, maintenance and repair services
- Education and training services

Our main concern here is with the engineering cadre, which has the most crucial role to play in the process of industrialization. The engineering cadre includes in particular three
categories of human resource which may be distinguished according to the type of education and training qualifications required:

- Engineers (University degrees: BSc(Eng), MSc.(Eng), PhD)
- Technicians (Full Technical Certificate: FTC, Advanced Diploma:HND)
- Technologists
- Skilled Craftsmen (Trade Certificates: Grades III, II, I)

According to the history of industrialization, there must therefore exist a clearly defined training strategy for the development of engineering human resource. The development of the engineering cadre (engineers, technicians and skilled craftsmen) should be combined in a recommended ratio. In accordance to the International Labour Organization (ILO), the standard skill-mix ratio between engineers, technicians and skilled craftsmen should be in the range of 1:5:25 in order to secure effective operation of the manufacturing sector. This can be used as a reference for evaluation of existing structure on training. On the basis of the above, the question arises whether enhancing engineering capacity should only focus on the increase of engineers only.

General education and training of the engineering cadre in broad terms is the process of building up the knowledge, the skills, the working abilities, the creative capability and the attitudes of all people. Here, one may again ask questions about how the present arrangements and future prospects for engineering education in SADC be best characterized? How could the growing tendency of upgrading existing technical colleges in the region to offer degree programmes maintain the skill-mix ratio?

### 3.2 Education and training of engineers

The distinction between education and training is often blurred. Education is usually perceived as being broader than training, not specifically task- or goal-oriented, but as an essential building block for personal development. While qualifications are an integral and important part of education, future and potential employment has not usually been an issue, until recently.

On the other hand, training focuses very much on the goal and the end product. It can be defined more narrowly than education and usually offers a direct learning path that is often skills – based. It frequently implies a short but intensive process undertaken to improve work – capability.

Those involved in the business of education or training need to define their target markets and ask themselves whether they are offering education or training or both, as potential buyers are now much more concerned with such issue. Useful engineering education has to integrate general education, formal practical training and professional experience in the field.

In practice a well-trained graduate engineer is expected, when necessary, to operate and innovate beyond current practices and take responsibility at the strategic level. The technician is expected to give support to the engineer to innovate, operate and manage processes within current practice.

In most SADC countries the most common basic fields of engineering are:
As far as the education and training are concerned the basic fields of engineering mentioned will require further specialization according to the particular industrial activity. The standard and context of engineering education and training in SADC countries has to be periodically modified and harmonized where necessary to match with changes in science and technology.

As a necessary yardstick, this framework can serve as a tool for conducting the evaluation of the existing engineering education and training in SADC countries, and would therefore require seeking information and data to establish the following:

- the type of regional education and research collaborations
- the topology of the types of curricular, structures and enrolment
- the types of potential centres of excellence to spearhead collaboration which are most likely to enhance capacities
- the degree structure, teaching and evaluation methods
- establish capacities (human, physical and infrastructure)

4. ENGINEERING EDUCATION CHALLENGES WITHIN SADC

The need to position SADC, and indeed Africa, in the vanguard of global technological development and advancement has stimulated a strong need to produce engineers who will be able to lead the region into new technologies and innovations in especially the manufacturing sector. This has become a formidable challenge and thus, increases the pressure on institutions of higher learning within the region to demonstrate effectiveness in their educational programmes, and to produce engineers with the knowledge and skills that will enable the region to engage proactively in the competitive global manufacturing industry. As new manufacturing technologies emerge, with increasing global competition, it has become imperative for our higher institutions of learning (universities, technikons and technical colleges) to develop and understand means of educating the emerging generations of engineers to meet the region’s manufacturing needs. This is particularly a practical and urgent need in the SADC region, as there are abundant resources with limited and/or dearth of local human resources.

The identification of the key/critical engineering skills required within national and regional development priorities (such as the NEPAD CPA, and SADC) continues to be difficult. The adoption of the entire range of engineering disciples in most tertiary institutions of learning rather than the concentration on some disciplines is common and indicative of the difficulty in identifying the required critical skills. Also, establishing practical and strategic relationships between industry, tertiary institutions, government and other stakeholders is also a challenge for engineering education. For engineering to be relevant, these relationships must exist and be active.
In addition to the challenges above, institutions of higher learning are under pressure to both attract prospective students into their engineering programmes, and graduate qualified engineers who will meet growing demands within the manufacturing industry. Engineers in SADC, like their counterparts elsewhere, therefore need to be equipped appropriately especially in this era of globalization (Antonio, 2004).

An improvement in engineering education is therefore imperative. Current research has revealed flaws in the process of engineering education and calls have been made for a reform of science and engineering education (Harris and Brophy, 2005). According to Forbes (2004), the policy and legislative commitment of the South African Government as evidenced by the Education White Paper 3 of 1997, the National Plan for Higher Education 2001, and the establishment of the Higher Education Quality Committee (HEQC) of the Council on Higher Education (CHE), have articulated the purpose of higher education as meeting the learning needs and aspirations of individuals. There have been repeated calls for higher education to be more responsive, accountable, relevant and accessible. This obviously implies a possible disjuncture between policy objectives and the ability of higher education institutions to deliver on their mandate (Forbes, 2004).

To better understand the challenges and mitigate it, there is need for a holistic evaluation and analysis of existing engineering education programmes within SADC. This process would provide useful details about current programmes and curricula, the quality of engineers produced, and the performances of different engineering professions within industry. An evaluation is also needed in order to determine the effectiveness of instructional innovations and to measure the year-to-year effectiveness of educational programmes (Harris and Brophy, 2005). Evaluation plays an important role in the engineering learning process and in the advancement of engineering education. According to Olds et al. (2005), high-quality evaluations can provide educators with information they can use to move the engineering field forward, whilst inadequate or poorly constructed evaluations can cause educators to pursue ineffective paths, resulting in the loss of time, money, and energy.

Integrating a process of evaluation and continuous improvement within engineering education therefore becomes a way forward. This should be the major goal of every engineering education programme within SADC higher institutions. For an evaluation to be effective, it must be outcomes-driven, with clear articulation of the qualities, successes, and/or failures that characterize engineering education within SADC.

Prior to actual evaluation, a conceptual evaluation framework is important. This paper attempts to articulate a holistic conceptual evaluation framework that will guide evaluation of engineering education within SADC.

5. DEVELOPMENT OF A CONCEPTUAL FRAMEWORK FOR ASSESSING ENGINEERING EDUCATION

The development of a conceptual evaluation framework and associated indicators suitable for evaluating the effectiveness of engineering education, training and capacity is critical for the manufacturing industry. Irrespective of the approach adopted, a
conceptual evaluation framework should be based on systems analysis. According to Ewert et al. (2005), systems analysis helps in dealing with the analysis and understanding of complex, large-scale systems and the interactions within those systems. Analysis and evaluation of these complex interrelationships requires the integration of knowledge from different facets using various indices.

Several approaches can be used to assess engineering education. According to Olds et al. (2005), engineering education evaluation methodologies could broadly include two major approaches: descriptive studies which involve qualitative, quantitative, and mixed research methods to describe the current state of a phenomenon, and experimental studies that entail quantitative techniques for examining how a phenomenon changes as a result of an intervention. Although problems facing engineering education globally are similar, nevertheless, assessing engineering education within a particular region requires identifying typical regional problems.

Several fora relating to engineering education have been organised in the past (e.g. UNESCO, 1996; and the 3rd African Regional Conference on Engineering Education and 4th Southern African Conference on Engineering Education, 2006). Various problems facing engineering education in Africa were identified and in particular, recommendations on important factors such as finance, university-industry collaboration, student creativity, innovation in the delivery and administration of engineering education, training for self-employment, staff development and the amelioration of the brain-drain were highlighted (Ilemobade and Ballim, 2005).

An understanding of the problems facing SADC, together with several of the approaches and indices that have been used to assess global engineering education with successful outcomes, thus becomes useful when assessing the quality of engineering education within SADC. Some of these successful approaches will be considered when developing a conceptual evaluation framework for engineering education within SADC.

5.1. Curriculum

The type of engineering curricula used in each institution, its renewal and modification has been observed to be a key indicator of engineering education evaluation. In solving problems associated with engineering curriculum to meet societal need, Harrison (2002), observed that engineering educators often consider two basic remedies or options: exclude some important subject matter from the curriculum which should reasonably be included or attempt to cover all important subject areas, dedicating less time to each specific area than was previously given. The best choice among these options is however not obvious, and thus coping with the problem of course overloading in engineering education is non-trivial (Harrison, 2002). Gomes et al. (2006) described a curriculum renewal process where the curriculum could be designed to incorporate an integrated framework for teaching all core concepts, enabling technologies and engineering practice paradigms. Curriculum modification in this wise was therefore achieved by determining the attributes of the desired engineering graduates, followed by the design of mechanisms needed to integrate these attributes within the curriculum. According to Gomez et al. (2006), the curriculum redesigning process could include sourcing input from diverse sources such as the university, the wider engineering faculty, industry and professional bodies. This will encompass liaison with industry and with professional bodies, bridges between the school and a consortium of industry
representatives, feedback from relevant stakeholders including the entire student body as well as their elected representatives.

5.2. **Teaching and learning**

Effective teaching and learning methods adopted in engineering education have been recognized as another index in assessing engineering education and a useful method in promoting effective student learning (Lee and Yeap, 2004 and 2005). According to Lee and Yeap (2004), improvement in student learning through maximizing opportunities for learning in every lesson, produces students with the right skills and knowledge that delight the employers. Lee and Yeap (2005) observed that the effectiveness of the teaching process is dependant on the facilitation of communication, involvement and interaction among students, lecturers and course content. Since excellence in engineering education comes from innovative teaching techniques and effective instructional materials, Lee and Yeap (2005) suggested that changes in the traditional way of delivering engineering education is very necessary.

Assessing effective learning can also be associated with the level of group work activities carried out by students. Group work could improve interpersonal and teamwork skills, where students may teach and learn from each other, explore new paths and consolidate understanding. Kok-Soo (2003) describes the conduct and delivery of the teaching, and the evaluation of engineering contexts using a project-based approach that cultivates an active learning process among students through group work. It was observed that group work assessment allows academic staff to gauge the true stage of progress and contribution of each member. Inconsistent contribution by different group members and uneven workload was easily highlighted as a minus. However, through group work and real life projects, students learned to appreciate teamwork and the multidisciplinary nature of engineering, the role of the engineer in society, including environmental engineering and ethics.

5.3. **Engineering popularity and entry qualification**

The attractiveness of engineering degrees has continued to decline in recent years despite the increase in the global demand for engineers. UNESCO (1996) reported a decline both in the quality of engineering student intake and the facilities that are required to make good engineers. According to Bowen et al. (2007), many factors affect the supply of students entering higher education to study engineering; two of which are insufficient mathematical preparedness and poor understanding regarding engineering as a career option. Two reasons attributed to this includes intake from ill-prepared student bodies and more critically, the indicators used to measure the ability of secondary school leavers are most often, useless. Belward et al. (2007) also observed similar i.e. a general dissatisfaction in the numeracy skills of engineering students. They attributed the decline in student ability and performance to the lack of basic mathematical skills.

The decline in the number of students choosing to study engineering is, to some extent, an international phenomenon. The decline in the performance and numbers of engineering students in the SADC region could be attributed to the disadvantaged backgrounds of many students coupled with the poor status of engineering and the growing public disquiet with scientific experts. In many SADC institutions, students from
disadvantaged backgrounds have exhibited a lack of the following: effective study attitudes and strategies, peer learning, articulation and communication of understandings, positive coping skills, self-reliance, and confidence (Grayson, 1997). For these reasons, several approaches have been adopted to upgrade these students including the utilization of a Science/Engineering Foundation Programme (Grayson, 1996) (for example, at the University of the Witwatersrand), extended curricula and the two-year pre-engineering programme (at the University of Namibia). Whether these programmes have been successful is another question.

5.4. Industry involvement

In assessing engineering education, industrial involvement in evaluating the performance of engineers in the workplace as well as in attesting the conformity of engineering curricula is imperative (Fonselius et al., 2001). Since engineering curriculum should produce graduates who possess skills and expertise needed to function effectively in the workplace, Gupta et al. (1994) suggested that an effective way of assuring the relevance of engineering curricula is to study the needs of the employers and find how well the current engineering curricula are meeting the demands of the workplace. Such an evaluation can identify areas of deficiency where more attention can be focused. Based on the results of the industry feedback, curricula can be revised so that engineering graduates possess the needed skills in the workplace. According to Elizandro and Matson (2001), an industrial advisory board can be profitable in providing advice and counsel to engineering institutions on institutional activities and curriculum review. Gatchell et al. (2004) carried out an investigation using a sample of both academic and industrial engineers to determine the importance of some topics/courses for undergraduate education, and to examine the critical skills important for engineers. Subject areas were designated and respondents were requested to rate the importance of these areas within an undergraduate engineering program. From the investigation, relative importance of certain fundamental concepts to engineering education and practice were determined.

5.5. Engineering accreditation

Engineering education can also be evaluated on the basis of the method and process of engineering accreditation (Olds et al. 2005). This will help in assessing relevant infrastructures within each institution, staff/students ratios, and will assist each engineering program to be adaptable to the changing nature of the engineering world into the future. Stakeholders include faculty staff, students, alumni, and industry employers. The analysis of learning outcomes may be one of the most pressing challenges faced by accreditation agencies because of the complex processes involved in determining the level of skills development within students using different teaching and learning methods. This is extremely relevant not only for accreditation purposes but also because it provides specific information when devising quality and improvement strategies for curricula.

5.6. Institutional collaborations

The extent of established international collaborations amongst researchers in an engineering institution has also been observed to be an indicator in assessing
engineering education (Anwar and Jackson, 2000; Brodeur et al., 2002; Olds et al 2005). According to Anwar and Jackson (2000), some of the academic preparation required by undergraduates should come from international collaborative experiences that develop abilities and familiarity with information technology, teamwork, and engineering design methodologies in a global environment. This is because, with the globalization of the economy, it is becoming increasingly important for engineering and engineering technology graduates to have international and cultural opportunities and experiences as a part of their undergraduate curricula; and thus be prepared to work in multicultural teams in multinational corporations. Collaborations with educational researchers offer the possibility of even greater and more rapid advancements in the evaluation of engineering education (Olds et al., 2005).

5.6.1. **Outlook on regional collaborations**
Some hopes for real push in regional collaboration of the higher education and research have been fortified by the creation of the SADC Vice-Chancellors Association in 2005. Some core processes of regional cooperation were reported, involving faculty-based collaborations in teaching, research and in the development of innovative products and processes.

Examples of the major collaborative activities identified are:

- Undergraduate engineering training between The University of Witwatersrand (Wits) and The University of Namibia (UNAM) since 2000.
- Engineering education and research collaboration between The University of Dar es Salaam (UDSM) and The University Eduardo Mondlane (UEM) since 2004 and extended to Makere University (MAK).
- Innovation and clusters based competitiveness to respond more effectively to specific challenges and opportunities that Africa is facing in global competition. The collaboration is also between University of Dar es Salaam (UDSM) and The University Eduardo Mondlane (UEM) since 2004 and extended to Makere University (MAK), including stakeholders from industry.
- Research collaboration in Sustainable Energy between the International Council for Science ICSU – Regional Office for Africa (Pretoria), Malawi, Mauritius, Mozambique, South Africa, Tanzania and extended outside SADC to involve Cameroon, Ghana, Kenya, Nigeria, Sudan and Uganda.
- The University of Cape Town Mellon programme

The characteristics of the collaboration modes stated above, are based on institutional efforts. Lessons to be lent from these collaborative efforts could also assist SARUA in shaping future collaboration in engineering education and training in SADC countries.

5.7 **Summary**
Assessment and evaluation have become extremely important in engineering education in the past decade or to put it more accurately, their importance has become widely recognized (Felder and Brent, 2004). There is need to constantly remember the ultimate goal of engineering education evaluation i.e. to improve student learning and skills development. This goal begins with setting the relevant objectives and definition of the evaluation indicators. Evaluation is an integrated and important component that should be considered throughout the research design and educational process (Olds et al.,
2005). Owing to the fact that the evaluation of the complex interrelationships between evaluation indicators requires integration of knowledge from different disciplines, engineering education evaluation should be holistic. All parties responsible for engineering education must therefore reappraise their roles in transforming the engineering profession by providing future engineers with experiences to help form values, attitudes and behaviours that are characteristic of an inclusive and socially aware profession (Wattus, 2003). Implementing a comprehensive evaluation process in an educational institution therefore presents several challenges to administrators, faculty, and students (Jack, 1999). Interested parties and especially administrators must provide a great deal of support and resources if the process of design, evaluation, implementation and improvement is to become an integral part of an institution’s educational fabric (Nichols, 1991; McGourty et al., 1998). Students also need to take a more proactive role in their own education and in their evaluation of the knowledge gained and skills acquired throughout their program (Loacker and Mentkowski, 1993). There is simply no single action that an institution can take in order to implement an effective evaluation process.

6. A PROPOSED CONCEPTUAL FRAMEWORK FOR ASSESSING ENGINEERING EDUCATION, TRAINING AND CAPACITIES WITHIN SADC UNIVERSITIES

A holistic evaluation of engineering education, training and capacity within each SADC institution will require input from different stakeholders i.e. a sample of engineering students, academics, administrators, accrediting institutions and participating industries. The framework presented below would provide consistency for the evaluation exercise but data from the different respondents within each institution will need to be generated.
6.1  *(Engineering) Student based input*

6.1.1  *Framework*

- Student based input
  - Engineering popularity and preparedness
    - Engineering career awareness
    - Motivation for engineering education
    - Financial and other academic related background
6.1.2. Questionnaire
It is anticipated that a sample of engineering students in each university will be approached to fill in the questionnaire below.

Start.

We would like to request a few minutes of your time to assist in assessing the status of engineering education within SADC universities. Your contribution to this research will immensely help. Your details are not required hence ensuring confidentiality.

Section A: Background Information
1. Gender: □ Male □ Female
2. Age bracket: □ Below 20 □ 20 – 25 □ 25 - 30 □ Above 30
3. Name of your institution? ______________________________________________
4. Your current course of study?
   □ Agricultural Engineering □ Chemical and Process Engineering □ Civil Engineering
   □ Electrical & Electronics Engineering □ Mechanical & Industrial Engineering □ Mining Engineering
   □ Metallurgical Engineering □ Others (specify ______________________________)
5. Your current year of study? □ Year one □ Year two □ Year three □ Year four □ Year five
6. Study programme?
   □ B.Sc. (Eng.) □ B.Eng □ B.Ing □ N.Dip □ H.Dip
   □ Other (____________________________________________________________________)
7. Your nationality: ___________________________________________________________

Section B: Career awareness
8. What type of secondary school did you attend? □ Public □ Private
9. Did you have good mathematics and science teachers? □ Yes □ No
10. Did your school have well equipped laboratories? □ Yes □ No
11. What was your School leaving grade in mathematics? ______________________________
12. What was your School leaving grade in (i) Science___ (ii) Chemistry___ (iii) Biology___ (iv) Physics ___
13. Did you attend any career planning session before gaining admission? □ Yes □ No
14. If No, how did you hear about the engineering course you are currently studying?
   □ Friend □ Teacher □ Relative □ Other (specify ______________________________)
15. What motivated you to choose an engineering career?
   □ To obtain a good job □ I love engineering □ To obtain a good salary □ Prestige
   □ Others (specify ______________________________)

Section C: Motivation
16. Are you enjoying your current course of study? □ Yes □ No
17. If your answer is No, why?
   □ Financial challenges □ Uninteresting methods of teaching
   □ Study environment is discouraging □ Family problems □ Work overload
   □ Others (specify ______________________________)
18. What is your present Cumulative Average mark? ____________________________
19. How are your studies currently financed?
   - Loan □ Self sponsorship □ Parents/Guardian □ Others (specify ____________)
20. Where do you reside?
   - On campus accommodation □ Private accommodation □ With Parents/Guardian □ Others (specify ____________)
21. Do you have adequate learning materials for your studies? □ Yes □ No
22. Do you actively participate in group learning activities? □ Yes □ No
23. Do you normally have tutorial classes in most of your courses? □ Yes □ No
24. How can you rate your current laboratory classes? □ Excellent □ Good □ Fair □ Poor
25. Do you ask the lecturer questions during classes? □ Yes □ No
26. If your answer is No, why? □ Shyness □ Fear □ Other (specify _________________)
27. Do you feel free to approach your lecturers for clarity after classes? □ Yes □ No
28. If your answer is No, why? □ Fear □ Lecturer difficult to approach □ Other (specify ____________)
29. Will you encourage any of your relatives or friends to study engineering? □ Yes □ No
30. If No, why? _______________________________________________________________________
31. Do you intend to pursue a postgraduate qualification after graduation? If ‘Yes’ in which discipline?
   - No Why? _________________________________________________________________
   - Yes □ Engineering □ Commerce / Management □ Humanities □ Education
     □ Other (_______________________________________________________________)
32. What is your dream career/occupation after graduating? ________________________________

End. Thank you
6.2 Institutional based input

6.2.1 Framework

6.2.2 Questionnaire

It is anticipated that the Dean of Engineering or suitable representative will fill in the questionnaire below. As a result of the large amount of data required to conduct a holistic evaluation, it may be pertinent during the round table meeting to agree on a few components to be assessed rather than the entire list in the framework above. The questionnaire below is comprehensive, dealing with each component highlighted in the framework above.

Start.

Higher education institutions (universities and technical colleges) have crucial roles to play to enable Africa build engineering capacity. This questionnaire seeks therefore to gather relevant information that will aid us assess engineering education, training and capacity within the SADC region. We would be grateful if you could take the time to complete this questionnaire to assist us in this work.

1. Name of tertiary Institution: ________________________________
### Section A: Human resource profiles

#### 2. Academic staff profile:

<table>
<thead>
<tr>
<th>Schools</th>
<th>No of academic staff</th>
<th>Academic Grades (No)</th>
<th>% male</th>
<th>% female</th>
<th>Distribution of highest academic qualifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural Eng</td>
<td></td>
<td>Professor: Ass Professor: Snr Lecturer: Lecturer: Junior Lecturer: Researcher:</td>
<td></td>
<td></td>
<td>PhD MSc PG Diploma BSc</td>
</tr>
<tr>
<td>Chemical Eng</td>
<td></td>
<td>Professor: Ass Professor: Snr Lecturer: Lecturer: Junior Lecturer: Researcher:</td>
<td></td>
<td></td>
<td>PhD MSc PG Diploma BSc</td>
</tr>
<tr>
<td>Civil Eng</td>
<td></td>
<td>Professor: Ass Professor: Snr Lecturer: Lecturer: Junior Lecturer: Researcher:</td>
<td></td>
<td></td>
<td>PhD MSc PG Diploma BSc</td>
</tr>
<tr>
<td>Electrical Eng</td>
<td></td>
<td>Professor: Ass Professor: Snr Lecturer: Lecturer: Junior Lecturer: Researcher:</td>
<td></td>
<td></td>
<td>PhD MSc PG Diploma BSc</td>
</tr>
<tr>
<td>Mechanical Eng</td>
<td></td>
<td>Professor: Ass Professor: Snr Lecturer: Lecturer: Junior Lecturer: Researcher:</td>
<td></td>
<td></td>
<td>PhD MSc PG Diploma BSc</td>
</tr>
<tr>
<td>Mining Eng</td>
<td></td>
<td>Professor: Ass Professor: Snr Lecturer: Lecturer: Junior Lecturer: Researcher:</td>
<td></td>
<td></td>
<td>PhD MSc PG Diploma BSc</td>
</tr>
<tr>
<td>Metallurgical Eng</td>
<td></td>
<td>Professor: Ass Professor: Snr Lecturer: Lecturer: Junior Lecturer: Researcher:</td>
<td></td>
<td></td>
<td>PhD MSc PG Diploma BSc</td>
</tr>
<tr>
<td>Other Eng</td>
<td></td>
<td>Professor: Ass Professor: Snr Lecturer: Lecturer: Junior Lecturer: Researcher:</td>
<td></td>
<td></td>
<td>PhD MSc PG Diploma BSc</td>
</tr>
</tbody>
</table>
3. Allocation of staff time and percentage to the academic project:

<table>
<thead>
<tr>
<th></th>
<th>Teaching (%)</th>
<th>Research (%)</th>
<th>Admin (%)</th>
<th>Community service (%)</th>
<th>Professional service (%)</th>
<th>Other (pls specify) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recommended</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Actual</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. Average number of lectures per engineering teaching staff per annum: ________________

5. Average number of academic staff leaving the institution per annum: ________________

6. Criteria for promotion:

<table>
<thead>
<tr>
<th>Academic Grades</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professor</td>
<td></td>
</tr>
<tr>
<td>Ass Professor</td>
<td></td>
</tr>
<tr>
<td>Snr Lecturer</td>
<td></td>
</tr>
<tr>
<td>Lecturer</td>
<td></td>
</tr>
<tr>
<td>Junior Lecturer</td>
<td></td>
</tr>
<tr>
<td>Researcher</td>
<td></td>
</tr>
</tbody>
</table>
### Schools

<table>
<thead>
<tr>
<th>Schools</th>
<th>Number of technical / technologist staff</th>
<th>% male</th>
<th>% female</th>
<th>Distribution of highest academic qualifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural Eng</td>
<td></td>
<td></td>
<td></td>
<td>PhD, MSc, PG Diploma, BSc, Matric / 'A' levels, Certificate</td>
</tr>
<tr>
<td>Chemical Eng</td>
<td></td>
<td></td>
<td></td>
<td>PhD, MSc, PG Diploma, BSc, Matric / 'A' levels, Certificate</td>
</tr>
<tr>
<td>Civil Eng</td>
<td></td>
<td></td>
<td></td>
<td>PhD, MSc, PG Diploma, BSc, Matric / 'A' levels, Certificate</td>
</tr>
<tr>
<td>Electrical Eng</td>
<td></td>
<td></td>
<td></td>
<td>PhD, MSc, PG Diploma, BSc, Matric / 'A' levels, Certificate</td>
</tr>
<tr>
<td>Mechanical Eng</td>
<td></td>
<td></td>
<td></td>
<td>PhD, MSc, PG Diploma, BSc, Matric / 'A' levels, Certificate</td>
</tr>
<tr>
<td>Mining Eng</td>
<td></td>
<td></td>
<td></td>
<td>PhD, MSc, PG Diploma, BSc, Matric / 'A' levels, Certificate</td>
</tr>
<tr>
<td>Metallurgical Eng</td>
<td></td>
<td></td>
<td></td>
<td>PhD, MSc, PG Diploma, BSc, Matric / 'A' levels, Certificate</td>
</tr>
<tr>
<td>Other Eng</td>
<td></td>
<td></td>
<td></td>
<td>PhD, MSc, PG Diploma, BSc, Matric / 'A' levels, Certificate</td>
</tr>
</tbody>
</table>
8. Undergraduate student profile:

<table>
<thead>
<tr>
<th>Schools</th>
<th>Total No. of undergraduate students</th>
<th>Minimum entry score (Total score = ?)</th>
<th>Staff:Student ratio</th>
<th>% male</th>
<th>% female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural Eng</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical Eng</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Civil Eng</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical Eng</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical Eng</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mining Eng</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metallurgical Eng</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Eng</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>_______________</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Eng</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

9. Average tuition cost per engineering student: ____________________________ Currency: __________

Section B: Curriculum

10. Prescribed duration for an undergraduate engineering degree: _____________________ years

11. % of engineering manufacturing content in the undergraduate curriculum? ______________ %

12. Vacation work at an engineering / related institution is compulsory:  

   ☐ Yes  ☐ No

13. Total time spent by students undertaking Vacation work at an engineering / related institution ______

14. Internship at an engineering / related institution is compulsory:  

   ☐ Yes  ☐ No

15. Total time spent by students undertaking an internship at an engineering / related institution ______

16. Please fill the table below for one of your engineering disciplines (e.g. Civil Engineering, 1st to 4th Year). Approximations are acceptable.

<table>
<thead>
<tr>
<th>CURRICULUM FOR THE DEPARTMENT OF __________________________ ENGINEERING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yr of study</td>
</tr>
<tr>
<td>-------------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Yr of study</td>
</tr>
<tr>
<td>------------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

17. How often is curriculum within the faculty internally (faculty / departmental committees, etc) reviewed:

   ____________ every ____________ years by ________________ (whom)
   ____________ every ____________ years by ________________ (whom)

18. How often is curriculum within the faculty externally (accreditation / other) reviewed:

   ____________ every ____________ years by ________________ (whom)
   ____________ every ____________ years by ________________ (whom)
19. Please indicate the mode used to externally examine the quality and marking of your courses:
- [ ] One external examiner for the entire department / school
- [ ] One external examiner for courses pertaining to an entire year of study
- [ ] One external examiner per course

Section C: Infrastructure

20. On average, does each academic staff member have an office?  [ ] Yes  [ ] No

21. Please indicate which on the following teaching infrastructure are used everyday in classrooms:
- [ ] Chalk and board
- [ ] Overhead projector and overhead slides
- [ ] Data projector and computer
- [ ] ICT (e.g. online lectures/tutorials, etc such as WebCT)

22. Library resources easily accessible to students:
- [ ] Internet
- [ ] Electronic library resources accessible on the Internet
- [ ] Textbooks used in the classroom
- [ ] Journals and Periodicals

23. Assessment of readily available laboratory/workshop infrastructure for teaching and learning:
- [ ] Excellent
- [ ] Good
- [ ] Fair
- [ ] Poor

24. On average, how often is equipment in your laboratories replaced?
- [ ] Every year
- [ ] Every 2 years
- [ ] Every 3 years
- [ ] Every 4 years
- [ ] Every 5 years and above

25. Assessment of adequate classrooms for teaching and learning:
- [ ] Excellent
- [ ] Good
- [ ] Fair
- [ ] Poor

Section D: Teaching, learning and throughput

26. The month academic year commences: ______________ Month academic year ends: __________

27. Average number of teaching weeks (excluding exams) in a semester: ____________________ weeks

28. Please indicate the teaching and learning aids typically used and recommended/made available to the students:
- [ ] Course notes
- [ ] PowerPoint slides
- [ ] Recommended textbooks

29. For each assessment mode below, indicate for a typical engineering course, the approximate percentage each mode contributes towards 100%:
- [ ] Assignments _____%
- [ ] Test _____%
- [ ] Laboratory / workshops _____%
- [ ] Project / Field work _____%
- [ ] Tutorials _____%
- [ ] Other (Specify ______________________________________________________) _____%

30. Faculty undergraduate statistics

<table>
<thead>
<tr>
<th>Year of 1st reg.</th>
<th>Enrolments</th>
<th>Total graduated</th>
<th>Graduated at the min. time</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>100%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>2001</td>
<td>100%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>2002</td>
<td>100%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>2003</td>
<td>100%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>2004</td>
<td>100%</td>
<td>%</td>
<td>%</td>
</tr>
</tbody>
</table>
31. Please fill below a longitudinal analysis of a set of students who have passed through your engineering programme and have all graduated and dropped out.

<table>
<thead>
<tr>
<th>Yr of 1st registration</th>
<th>No. who registered</th>
<th>Graduated in</th>
<th>Total graduated (%)</th>
<th>No. who dropped-out were excluded after one or more yrs of registration</th>
<th>Of these graduates and those still registered (No.)</th>
<th>Still registered</th>
<th>Average No. of yrs to graduate</th>
<th>Average No. of Student Yrs per Graduate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4 years</td>
<td>5 years</td>
<td>6 or more</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

32. Estimated percentage of 1st year engineering students that move to another faculty at the end of each academic year: ____________%

33. Do the performances of the first year students in the faculty match-up with their university entry grades?
   - Yes
   - No
   - Not sure

34. If 'No', how would you assess/correlate their preparedness for engineering?
   - Fair
   - Weak
   - Poor

35. What factors are responsible for poor student performance?
   - Insufficient mathematics and science
   - Lack of confidence
   - Poor study attitudes
   - Poor articulation
   - Others (specify _______________________________)

36. What is your opinion about the general attitude of students to group work?
   - Excellent
   - Good
   - Fair
   - Poor

37. What is your opinion about the general attitude of students to asking questions during classes?
   - Excellent
   - Good
   - Fair
   - Poor

38. What is your opinion about the general attitude of students to tutorial?
   - Excellent
   - Good
   - Fair
   - Poor

39. What is your opinion about the general attitude of students to after class consultation with the lecturer?
   - Excellent
   - Good
   - Fair
   - Poor
Section E: Research activity and output

40. Postgraduate degree programmes offered and prescribed duration:

- PG Diploma ____ years
- MSc (course work only) ___ years
- MSc (research only) ___ years
- MSc (50% course work & 50% research) ___ years
- PhD ___ years
- Others (Specify__________________________) ___ years

41. Postgraduate / staff areas of research:

<table>
<thead>
<tr>
<th>Schools</th>
<th>Area 1</th>
<th>Area 2</th>
<th>Area 3</th>
<th>Area 4</th>
<th>Area 5</th>
<th>Area 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural Eng</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical Eng</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Civil Eng</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical Eng</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical Eng</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mining Eng</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metallurgical Eng</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Eng</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

42. Average research output per academic staff per annum in the faculty:

<table>
<thead>
<tr>
<th>Journal articles (No.)</th>
<th>Conference papers (No.)</th>
<th>Postgraduate student (MSc, PhD) graduated (No.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

43. Please indicate if the faculty is engaged in any of the areas of manufacturing research below:

- Minerals & Metals processing
- Food
- Plastics
- Automobile
- Pharmaceuticals
- Others (specify ____________________________________________)

44. Does the faculty generally have adequate research infrastructure?  Yes  No

45. Sources of research funds:

- Industries
- International funding organizations
- Your institution
- Government
- Research institutes
- Others (specify ____________________________________________)
Section F: Academic support programmes
46. Please list the academic support programmes currently available for engineering students

<table>
<thead>
<tr>
<th>S/No</th>
<th>Academic support programme</th>
<th>Brief description of the programme</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Section G: Staff development
47. Please list the staff development initiatives (teaching, learning and research) currently available for engineering staff

<table>
<thead>
<tr>
<th>S/No</th>
<th>Staff development initiative</th>
<th>Brief description of the initiative</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Section H: Collaborations
48. Do you have any ongoing SADC/international collaborations/linkages?  [ ] Yes  [ ] No
49. If any, please indicate 5 departments/institutions that your faculty/department/staff are collaborating with and the nature of such collaboration:

Collaborating with ____________ Nature: [ ] Research  [ ] Teaching  [ ] Admin  [ ] Other (__________)
Collaborating with ____________ Nature: [ ] Research  [ ] Teaching  [ ] Admin  [ ] Other (__________)
Collaborating with ____________ Nature: [ ] Research  [ ] Teaching  [ ] Admin  [ ] Other (__________)
Collaborating with ____________ Nature: [ ] Research  [ ] Teaching  [ ] Admin  [ ] Other (__________)
Collaborating with ____________ Nature: [ ] Research  [ ] Teaching  [ ] Admin  [ ] Other (__________)

50. To what extent do collaborations/linkages ensure the retention of academic staff within your institution

[ ] Significant  [ ] Insignificant  [ ] Counter productive
Section I: Accreditation / Quality Assurance

51. Please list the organizations currently providing accreditation / quality assurance to your engineering programmes

<table>
<thead>
<tr>
<th>S/No</th>
<th>Organization</th>
<th>Service (accreditation OR QA?)</th>
<th>Duration between each service (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

_End. Thank you_
6.3 Industry based input

6.3.1 Framework

![Diagram of Industry / Employer based input]

6.3.2 Questionnaire

A sample of engineering related industries will be approached. Industry includes employers, professional registration and accreditation bodies, and research institutes.

Start.

Higher education institutions (universities and technical colleges) have crucial roles to play to enable Africa build engineering capacity. This questionnaire seeks therefore to gather relevant information that will aid us assess engineering education, training and capacity within the SADC region. We would be grateful if you could take the time to complete this questionnaire to assist us in this work.

Section A: Background Information

1. Name of your organization? _________________________________________________
2. Ownership of your company? ☐ Public ☐ Private ☐ Other (specify __________________)
3. Which sector(s) does your organization primarily belong to?
   ☐ Mineral/Metal processing ☐ Education ☐ Research ☐ Training ☐ Quality assurance
   ☐ Food processing ☐ Plastics ☐ Petroleum/ petrochemical ☐ Automobile
   ☐ Energy ☐ Telecom ☐ Consultancy / Project Management
   ☐ Construction ☐ Chemicals ☐ Others (specify _____________________________)

Section B: Opportunities and evaluation

4. How many workers does your organization employ? ☐ <20 ☐ 20-50 ☐ 50-100 ☐ >100
5. What percentage of your employees are (i) Engineers:__% (ii) Technologists:__% (iii) Technicians:__%
Of the percentages in (5) above, indicate the percentages that are expatriate staff:
(i) Engineers:__% (ii) Technologists:__% (iii) Technicians:__%

6. What percentage of your organization’s senior and middle-level management are
(i) Engineers:__% (ii) Technologists:__% (iii) Technicians:__%

7. • What percentage of your engineering positions is currently filled? ________________________%
• What percentage of your Technologist positions is currently filled? ________________________%
• What percentage of your Technician positions is currently filled? ________________________%

8. What is your current budget for student development ____________________________

9. Please indicate if your organization currently provides financial assistance to engineering/technical students, the number of students benefiting and the institutions where the students are based
☐ Bursaries ___(No of students); ______(Institution 1) ______(Institution 2) ______(Institution 3)
☐ Loans ___(No of students); ______(Institution 1) ______(Institution 2) ______(Institution 3)
☐ Scholarships ___(No of students); ______(Institution 1) ______(Institution 2) ______(Institution 3)
☐ Awards ___(No of students); ______(Institution 1) ______(Institution 2) ______(Institution 3)

10. Of the students you provide financial assistance to, what percentage return to work for your organization?
☐ Bursaries _____(%) ☐ Loans ______(%) ☐ Scholarships ______(%) ☐ Awards ______(%)

11. Do engineering/technical students undertake vacation work/practical experience in your Organization?
☐ No ☐ Yes. (Maximum duration [ ] 3 months [ ] 6 months [ ] 12 months [ ] Other [ ])

12. Do engineering/technical students undertake internships in your Organization annually?
☐ No ☐ Yes. (Typical duration [ ] 3 months [ ] 6 months [ ] 12 months [ ] Other [ ])

13. What percentage of interns return to work for your organization? ___________%

14. Please indicate other company based/initiated processes, incentives, programmes, etc in place to motivate, involve, and/or retain engineering/technical students within your organization or the profession:
☐ Mentoring ☐ Monitoring progress ☐ Competitions ☐ Events
☐ Information dissemination (magazines, newsletters, etc) ☐ Career talks ☐ Sponsorships
☐ ____________________ ☐ ____________________ ☐ __________________

15. Please provide a brief description of the different programmes highlighted above:

<table>
<thead>
<tr>
<th>S/No</th>
<th>Initiative</th>
<th>Brief description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
16. Below is a performance assessment table for engineers/technicians currently employed in your organization but trained in different institutions. Space for 5 different institutions has been provided. Please, objectively assess the level of performance of the engineers/technicians from the different institutions using the criteria below:

<table>
<thead>
<tr>
<th>Institution</th>
<th>Assessment of performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of Institution</td>
<td>Specialized Knowledge</td>
</tr>
<tr>
<td>1.</td>
<td>Excellent</td>
</tr>
<tr>
<td>2.</td>
<td>Excellent</td>
</tr>
<tr>
<td>3.</td>
<td>Excellent</td>
</tr>
<tr>
<td>4.</td>
<td>Excellent</td>
</tr>
<tr>
<td>5.</td>
<td>Excellent</td>
</tr>
</tbody>
</table>

**Section C: Collaboration**

17. Please indicate 5 departments/organizations that your organization/staff are collaborating with and the nature of such collaboration:

Collaboration with _______________ Nature: Research Teaching Admin Other (__________)

Collaboration with _______________ Nature: Research Teaching Admin Other (__________)

Collaboration with _______________ Nature: Research Teaching Admin Other (__________)

Collaboration with _______________ Nature: Research Teaching Admin Other (__________)

Collaboration with _______________ Nature: Research Teaching Admin Other (__________)
18. If ‘Yes’ please indicate your general contribution to the collaborations above

Collaboration 1
- Funds
- Personnel
- Equipment
- Other (_______________________________)

Collaboration 2
- Funds
- Personnel
- Equipment
- Other (_______________________________)

Collaboration 3
- Funds
- Personnel
- Equipment
- Other (_______________________________)

Collaboration 4
- Funds
- Personnel
- Equipment
- Other (_______________________________)

Collaboration 5
- Funds
- Personnel
- Equipment
- Other (_______________________________)

19. How do you generally carry out your organizational research

- In our R&D section
- Using Universities
- Using research institutes
- Others (specify _____)

20. Do you fund research in tertiary institutions that is not related to your company’s business? ⎨Yes ⎪No ⎩

Section D: Participation in engineering curriculum

21. Is your organization involved in engineering curriculum development/modification/assessment/accreditation in one or more tertiary institutions? ⎨No ⎪Yes ( □ Regularly □ Rarely) ⎩

22. If ‘Yes’, indicate the level of participation

- Passive
- Active

23. Based on the performance assessment of your engineers undertaken above, please correlate the relevance of the different institutions’ engineering/technical curricula with the needs of your company

<table>
<thead>
<tr>
<th>Name of institution</th>
<th>Correlating the relevance of the different institutions’ engineering/technical curricula to the needs of my company</th>
<th>Possible areas of improvement in the curricula</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>□ Excellent □ Average □ Poor</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>□ Excellent □ Average □ Poor</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>□ Excellent □ Average □ Poor</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>□ Excellent □ Average □ Poor</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>□ Excellent □ Average □ Poor</td>
<td></td>
</tr>
</tbody>
</table>

Section E: Professional registration

24. Level of importance given by your organization to the professional registration of your engineers

- High
- Medium
- Low

25. Does your organization provide professionally registration status for engineering students and graduates?

- No
- Yes
26. If ‘Yes’ please indicate the following

<table>
<thead>
<tr>
<th>Grade of registration</th>
<th>Important criteria required in order to be registered</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
</tr>
</tbody>
</table>

Section F: Definitions

27. Please provide a definition (based on your organisation’s understanding) for the following:
   - Engineer: _______________________________________________________
   - Technologist: _________________________________________________
   - Technician: ________________________________________________

*End. Thank you*
7. References


Ilemobade A.A and Ballim Y, (2005), Undergraduate engineering training through institutional collaboration in the Southern African region, SAJHE 19 (4) pp.735-753.


8. Bibliography


9. NEPAD-SARUA Engineering Round Table Action Points:

A Road Map

Engineering Education in Southern Africa for the 21st Century

Sequence of developments:

1) The NEPAD Science & Technology Consolidated Plan of Action 2006
2) NEPAD-SARUA Engineering Round Table June 9-10 2008
3) Regional Evaluation 2008 - date to be decided by NEPAD:
   - final set of questionnaires formally agreed by NEPAD
   - technical assessment of questionnaire (e.g. by HRSC specialists)
   - team visits HEIs and collect data (volunteers from participants at the Round Table)
   - data processing
   - team analysis together with other selected specialists
   - colloquium with Framework stakeholders:
     i) HEIs,
     ii) industry,
     iii) students,
     iv) associations & councils
     v) government

Responsibilities and resources:

SARUA:
- team = 14 in pairs (volunteers from Round Table participants)
- visits to all HEIs providing engineering education (± 55)
- Overall commitment, max. 1 week in total for each team member (but not necessarily in one block)
- mid-August to mid-September 2008

NEPAD:
- funding – budget to be determined by NEPAD
- arrange government assistance (visas, local drivers, etc.)
Problem Statement

The delivery of qualified and competent engineering human capital in SADC is insufficient to meet the needs for sustainable technological development and to ensure the well-being of their people through the attainment of the MDGs.

The landscape that has led to this situation is only partially understood. Strategic interventions are required to place Southern Africa in a position to beneficiate and develop its vast resources by ensuring adequate human capital is in place.

The Purpose

To better understand the size and shape of the engineering education landscape in order to design and implement step change to improve the production of qualified and competent engineering human capital. The step change is to be achieved by ensuring relevant shifts in policy and practice through partnerships between government, industry and higher education in the region. It must ensure appropriate differentiation and a complementary skills base across the range of engineering professions, against a principled set of defined knowledge skills and competency outcomes.