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The Importance of Analysis of Internal Quality Management Systems and Self-Examination Processes in Engineering Accreditation Processes

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***Abstract*—**The accreditation process of engineering degree programmes is based on various reports evaluated by the relevant governing bodies of the institution of higher education. One of the aforementioned reports for the accreditation process is a self-assessment report which is to be completed by the applying institution. This paper seeks to emphasise the importance of analysis of internal quality management systems and self-examination processes in the engineering accreditation processes. A description of how the programme fulfils the criteria should be given. Relevant stakeholders all need to contribute in the writing and structuring of the self-assessment report. The last step is to gather evidence in the form of supporting documentation. In conclusion, the paper also identifies learning outcomes in a case study in seeking accreditation from an international relevant professional body.

***Keywords*—**Accreditation, governing bodies, self-assessment report, quality management.

I. Introduction

RE-curriculation is currently in higher education in South Africa because of the new Higher Education Qualification Sub-Framework alignment process required by all higher education institutions (HEIs). The new qualification will be determined in accordance with the new Higher Education Qualification Sub-Frame (HEQSF) developed by the Ministry of Education of South Africa on August 2, 2013. This is a requirement of all HEI to strive to keep the curriculum relevant. The new qualifications ensure that courses offered by the Cape Peninsula University of Technology (CPUT) can be directly compared to other institutions. The curriculum is developed through the standard processes during the development of new qualifications, not only locally but also internationally. A case study of the analysis of internal quality management systems and self-examination processes in the accreditation processes of replacing the existing masters in engineering, namely MTech: Electrical Engineering with a Master of Engineering in Electrical Engineering (Energy) is done. This course provides the students with the necessary knowledge and skills to conduct independent research in electrical engineering and to contribute to the production of knowledge by understanding, applying and evaluating existing and new knowledge.

The new Master of Engineering (MEng) will be available from 2016. The new qualifications ensure that the courses offered by CPUT can be directly compared to courses from other institutions in the benchmarking process for developing these new qualifications, not only at home but also internationally.

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II. Case Study

A. Background

CPUT is part of an EU Edulink consortium Programme on Energy Efficiency in Southern Africa (PEESA) that includes African and German partners. The objectives of the PEESA project are the installation of advanced curricula at the African partner universities that meet European quality standards for engineering education, to develop a methodology for curriculum design and to develop and implement a postgraduate master's degree level engineering programme.

Education in engineering in particular will play a key role in building Africa's future technological innovation. This change, has globally influenced the industry and employment, and requires issues such as developing a harmonious and collaborative approach to integrate education and practice. As global energy resources come under pressure, engineers are needed that have a broad and expansive awareness of energy related issues such as energy efficiency, energy management, energy policy, energy access, etc. This qualification will aim to address the current shortfall in this arena.

Energy access and energy efficiency are a priority for achieving the Millennium Development Goal to reduce poverty by 50% in Africa, by application of new technologies. To achieve these aims, the use of resources through the development of new technologies should be in the curriculum as well as be implemented. As a result, the outcome of a qualification should create a basis to generate new initiatives for the Energy Access and Efficiency sector and therefore have a positive impact on socio-economic conditions in Africa, as well as on overall the economy and standard of living in the country. This will be facilitated by leveraging the experience and expertise of the consortium members, not only in the subject-related fields, but also by strengthening institutional and regional networking capacities to address the needs of the African partner regions.

PEESA will deliver a high-level postgraduate programme in engineering that meets the needs of the respective African regions, and will therefore contribute towards building academic capacity. This initiative provides a wide range of learning and research projects that study regional expertise

based on regional societal needs. It ranges from natural resources to renewable resources, focusing on technologies, processes and standards for resource availability and management. This includes previously developed standards and building blocks in the energy sector (oil, gas, carbon, etc.) and renewables (solar, wind, biofuels, etc.) and provides the basis for development of Human Capital Development policies and standards of the participating countries' governments and its agencies.

The masters in energy programme have been listed as one of the career paths in the CPUT engineering faculty handbook and prospectus. The first intake was in 2016 followed by intakes in 2017 and 2018. A self-assessment report was compiled for the analysis of internal quality management systems and self-examination processes in the engineering accreditation processes. A description of how the programme fulfils the criteria follows. Relevant stakeholders need contributed in the writing and structuring of the self-assessment report.

B. Phasing Out of Old Qualifications

Pipeline MTech students will be able to continue the existing MTech up to when it is phased out or make a new Master of Engineering (MEng) qualification in the Electrical Electronic and Computer Engineering Department at CPUT [2]. See Table I. BTech graduates who wish to enrol in the MEng may be required to complete additional modules specified by the department.

TABLE I
NEW QUALIFICATIONS OFFERED BY CPUT [2]

Current Qualification	Will be replaced with	Students Currently Enrolled	Admission
National Diploma	Diploma	Pipeline students to be converted to the new Diploma	From school, TVETs and other HEIs
BTech	Advanced Diploma	Pipeline students to be converted to the new Advanced Diploma	Current ND graduates will be given admission to the new Advanced Diploma
MTech	Masters	Pipeline MTech student will be converted to the new Masters.	Current BTech graduates (with additional modules)
DTech	Doctoral	Pipeline DTech students to be converted to the new Doctoral qualification	Current MTech graduates will be admitted to the new Doctoral qualification

C. ASIIN Accreditation

The masters in energy programme of CPUT is busy with official application for 2019 EUR-ACE (European Accredited Engineer) accreditation. Their quality certificate issued for engineering degree programmes is recognised throughout Europe and worldwide. A set of standards that identifies high-quality engineering degree programmes in Europe is awarded by ENAEE (European Network for the Accreditation of Engineering Education). EUR-ACE guarantees the quality of an international engineering degree programme and its suitability as an entry route to the engineering profession by pre-professional accreditation. It also recognises the quality of science and the quality in industry.

ENAEE has authorized consenting bodies to approve and display bachelor's and master's degrees according to the EURACE criteria. ASIIN (Accreditation Agency for Degree Programs in Engineering, Computer Science, Science and Mathematics) is a non-profit organisation since 1999 that certifies engineering, IT, science and mathematics programme/system certification. It is the cooperation between HEIs, professional, societies and industry. It has expertise of about 1400 peers and 190 committee members. It does international programme accreditation and certification.

The different structures in the ASIIN programme certification process, such as the General assembly, ASIIN Board, Institutional experts, Audit teams, Accreditation commission, Appeal Board and ASIIN Headquarters are shown in Fig. 1. ASIIN's mission is to be a competent, reliable and result-oriented partner for universities and academic higher education [3].

There are about 4000 study programmes that has been given national approval and system accreditation, institutional certification with the national seal and international ASIIN approval.

The ASIIN headquarters is in Dusseldorf, Germany. ASIIN has 47 signatory countries within the European Higher Education Area, since 2005. See list of countries in Fig. 1.

III. ASIIN SELF-ASSESSMENT REPORT

In order to ensure that the master degree programmes in Electrical Engineering comply to the standards to apply for a EUR-ACE approval, a self-assessment report needs to be completed. This report includes expanded documents to tentatively start an accreditation procedure. Steps to successful accreditation are as follows:

- Step 1: Apply with ASIIN
- Step 2: Prepare the Self-Assessment Report
- Step 3: On-Site-Visit at university Campus
- Step 4: Accreditation Report
- Step 5: Discussion in Technical Committee
- Step 6: Decision by Accreditation Committee

The format of the appropriate ASIIN self-assessment report concerning the content, concept and implementation of the Degree Programme is as follows [1]:

A. Criterion 1. The Degree Programme: Concept, Content & Implementation

The objectives and learning outcomes of the program is an essential element of the academic qualification. It is well anchored, and easily understood and accessible to the

university community, viz. students, academic and supporting staff and the public.

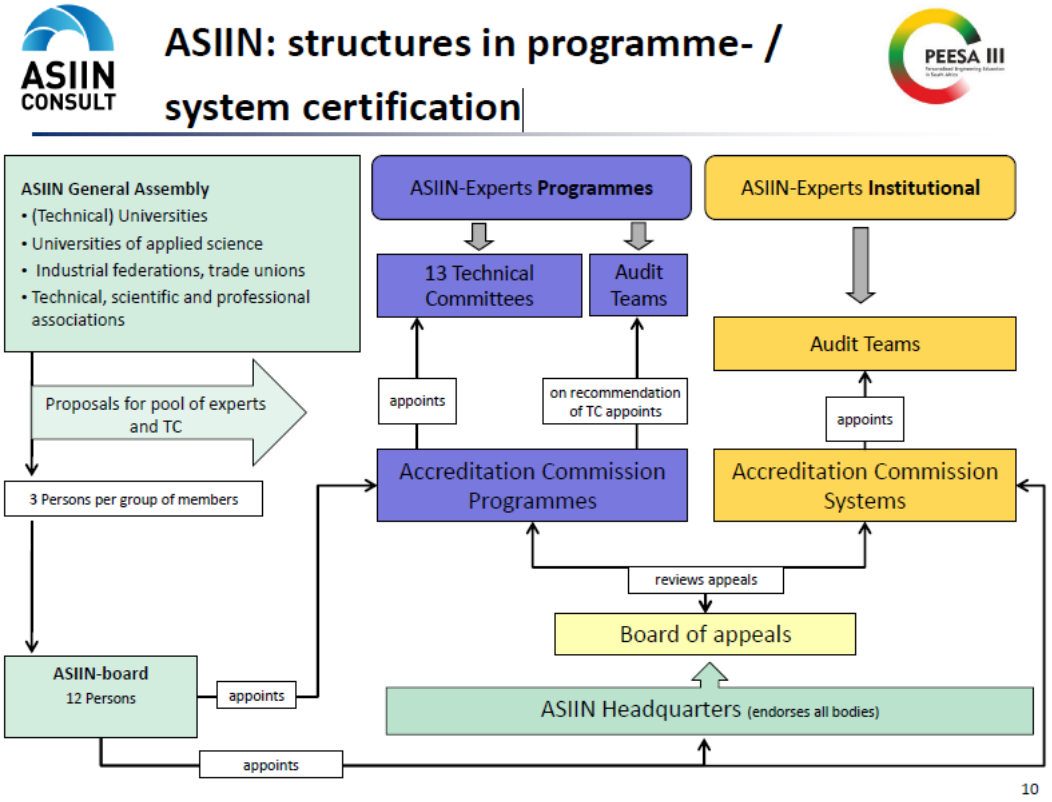

Fig. 1 Different structures in the ASIIN programme certification process [1]

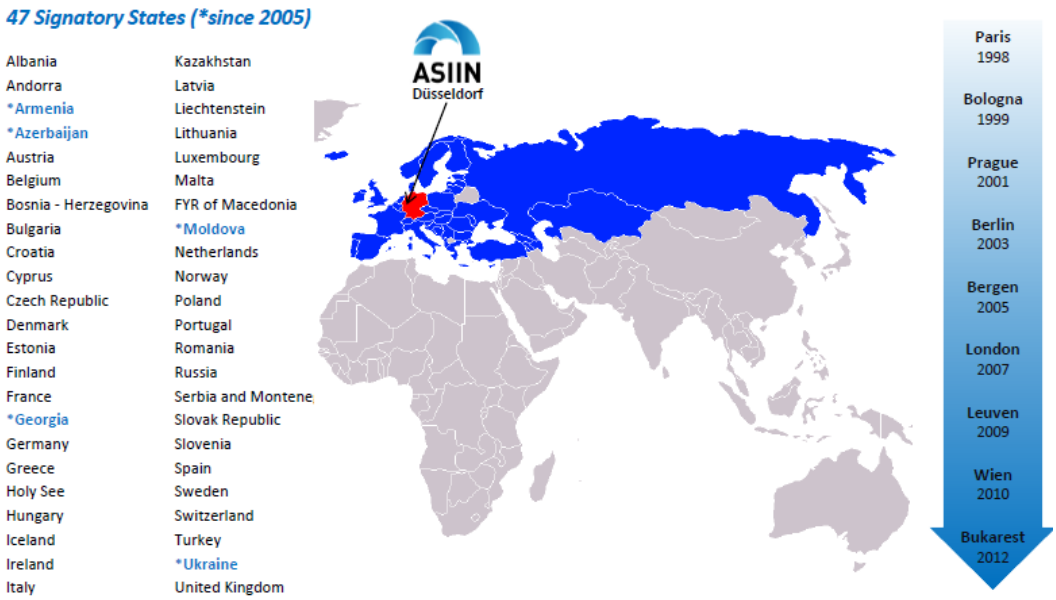

Fig. 2 ASIIN countries within the European Higher Education Area [1]

The purpose and aims of the study show the level of knowledge and examples of the outcomes described in ASIIN Subject-Specific Criteria (SSC).

A suitable qualifications profile is required by students to perform appropriate tasks for their needs. Stakeholders should be involved in managing and improving the education goals namely objectives and learning outcomes.

B. Criterion 2. The Degree Programme: Structures, Methods and Implementation and Tables

All degree programmes need a structure with modules. Each module is a combination of teaching and learning content. The estimated time budgets are realistic enough to enable students to complete the degree without exceeding the regular course duration according to the work load and credits.

The teaching methodology should cover teaching methods with instruments to support students in achieving the learning outcomes. The degree programme should be developed to be well-balanced between classroom-based learning and self-study.

C. Criterion 3. Exams: System, Concept and Organisation

Exams should measure individual students to determine whether they have reached the defined learning outcomes. Exams are structured to measure knowledge, skills and competences. Exams are module content-related. Exams provide continuous feedback on the progress in developing student competences. The degree programme has a thesis/dissertation or final project to ensure that students work practically and independently at the appropriate level. A form of assessment should be defined at each module. Mechanisms should be in place that ensure that all students learn the required details (tests, orals, assignments etc.) at the beginning of each module.

D. Criterion 4. Resources

The composition, scientific orientation and qualification of the teaching staff team are suitable for sustaining the degree. There are sufficient staff resources available for providing assistance and advice to student's administrative tasks. The research and development activities carried out by the teaching staff.

Staff development mechanisms should be in place for teaching staff who wish to further develop their professional and teaching skills.

The available funds and equipment form an important foundation for the programme. This includes guaranteed funds, sufficient and solid infrastructures and binding rules for all internal and external collaborations.

E. Criterion 5. Transparency and Documentation

The module descriptions should be accessible to all students and teaching staff and should contain the following:

- person(s) responsible for each module
- teaching method(s) and work load
- credit points
- intended learning outcomes
- module content
- admission and examination requirements
- form(s) of assessment and details explaining how the module mark is calculated
- recommended literature

F. Criterion 6. Quality Management: Quality Assessment and Development

The purpose of the regular assessment process is to ensure continuous improvement. All responsibilities and arrangements identified for development purposes are bound. Students and other stakeholders take part in the quality of the production process. Every issue and feature is known to everyone who signs in. It allows readers to compile product/ feasibility value, content and individual structures. All the methods and data used are well-known for that purpose, and are still using program improvements, with ideas identifying and resolving weaknesses.

IV. Learning Outcomes of Case Study Relevant Subject-Specific Criteria (SSC)

More research is needed to understand what students think they learn through discussion, and how they learn when tasks in their curriculum require them to move back and forth between physical and virtual spaces. Finding variables that explain changes in learning quality by dividing tasks into tangible and intangible learning environments is becoming increasingly important for those who are concerned about the quality of university learning and learning outcomes [4]. After having completed the Master of Engineering in Energy degree programme, students should have been exposed to the following Exit level Outcomes:

A. Exit-Level Outcome 1: Problem Solving

Identifying, designing, and implementing research methods to solve complex technical problems.

B. Exit-Level Outcome 2: Application of Scientific and Engineering Knowledge

Use expert knowledge in mathematics, environment and industrial engineering to solve complex technology problems [5].

C. Exit-Level Outcome 3: Engineering

Perform creative, procedural and non-procedural design and synthesis of components, systems, engineering works, products or processes, demonstrate the ability to propose interventions at an appropriate level within a system based on an understanding of interdependent relations and address intended and unintended consequences of interventions.

D. Exit-level Outcome 4: Research, Investigations, Experiments and Data Analysis

Demonstrate competence to conduct research, execute detailed technical investigations, implement strategies for the processing and management of information, including the review of current advances in the field, to produce new insights and solve complex engineering problems.

E. Exit-Level Outcome 5: Engineering Methods, Skills and Tools, incl. Information Technology

Demonstrate the ability to develop, choose and use appropriate techniques and creativity, resources and advanced technology, including technology, design and modelling, to

solve technical problems.

F. Exit-Level Outcome 6: Professional and Technical Communication

Demonstrate an ability to use the resources of academic, professional and occupational discourses to communicate and defend substantial ideas that are products of research, investigation and development.

G.Exit-Level Outcome 7: Sustainability and the Impact of Engineering Activity

Critically demonstrate awareness of environmental sustainability.

H.Exit-Level Outcome 8: Individual, Team and Multidisciplinary Working

Demonstrate competence to work effectively as an individual, in teams and in multidisciplinary environments.

I. Exit-Level Outcome 9: Independent Learning Ability

Demonstrate the ability to develop own learning strategies to sustain independent learning and academic and professional development, including effective interaction within the learning or professional group as a means of enhancing learning.

J. Exit-Level Outcome 10: Engineering Professionalism

Demonstrate a critical awareness of the need to act professionally and ethically, to exercise judgment and take responsibility within own limits of competence and where appropriate to account for leading and initiating processes and implementing systems, ensuring good resource and governance practices [5].

Once the Self-Assessment Report is prepared and submitted to ASIIN, an On-Site-Visit at the relevant university campus takes place. This is followed by an evaluation and discussion of the Accreditation Report by a Technical Committee and the final decision by the Accreditation Committee.

V. Conclusion

Learning outcomes are being replaced by graduate attributes in the new qualifications in South Africa. The compilation of learning outcomes, however, is very important in the ASIIN Self-Assessment Report. It helps to explain more clearly to students what is expected of them and thus help to guide them in their studies and how to achieve their necessary knowledge and skills. It is also helpful in achieving mobility, comparability and transparency of qualifications.

Once the Self-Assessment Report is prepared and submitted to ASIIN an On-Site-Visit at the relevant university Campus. This is followed by an evaluation and discussion of the Accreditation Report by a Technical Committee and the final decision is made by the Accreditation Committee.

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