Challenges of Engineering Accreditation: Developing Countries

Syed M S Wahid [a]; John Pumwa [a], and Nosare Maika [b].
Department of Mechanical Engineering, PNG University of Technology, PNG [a], Appropriate Technology & Community Development Institute, PNG University of Technology, PNG [b]
Corresponding Author Email: syed.wahid@pnguot.ac.pg

Abstract
This paper presents the ongoing processes and challenges facing engineering universities of developing countries and in particular Papua New Guinea University of Technology (PNUOT) in its attempt in gaining formal recognition of Washington Accord through accreditation. It proposes new curriculum including teaching and learning process based on student learning outcomes and their mitigation process. It emphasises the importance of excellent versatile presentation methods including use of improved computer-based teaching aids and explores attributes such as challenges of tertiary engineering teaching, curriculum development, classrooms with dedicated computers and involvement with industry. The objective of this paper is to disseminate to the wider community the challenges educational institutions may face in their attempt to get engineering degrees accredited, that may be beneficial to universities of developing countries.

1.0 Introduction

The PNG University of Technology is the only degree awarding institution in PNG, that offers Bachelors, Masters and PhD's degrees in mechanical, civil, electrical and mining disciplines. The engineering departments of Papua New Guinea University of Technology procures students of highest caliber based on their final secondary school examination results and entrance aptitude test, conducted by the university and the Office of Higher Education (OHE). There seems to be a large variation of student qualities with varied standards. Developing the engineering program at PNGUOT one needs to consider quality of students coming from secondary education system. It is generally anticipated that rural PNG students are disadvantaged compared to urban students, when it comes to proficiency in available technologies due to limited availability of technology in rural PNG. A joint comprehensive evaluation by school authorities, leading enterprises and local tertiary institutions may be a way forward in identifying these shortcomings. The other more practical option is that the tertiary institutions become more proactive in identifying the deficiency of skills and knowledge of intake students in their engineering programs and set examinable short courses / bridging courses. Successful completion of these short courses/bridging courses may lead student entry to tertiary engineering programs. The tertiary institution management may formulate the detailed bridging program after consultation with the stake holders. The proposed short course/bridging course may take place during the semester break between November and January.

Engineering departments of the PNGUOT enrolls around one hundred and twenty students per year. The length of the engineering degree programs is four years full time and is divided into eight semesters. Student graduation is based on successful completion of the theoretical courses laboratory works, final year projects and completion of approved industrial training of at least ten weeks that every student must successfully complete during their long semester break.

The engineering departments of PNGUOT are yet to be recognized by many of the global universities. The University is seeking assistance from external experts and utilizing its internal resources in relation to implementing a system that would be acceptable to the global era for its engineering departments. It is envisaged that it would be a huge challenge to successfully transform the present engineering curriculum to an internationally accredited system. Many of the universities around the globe have had their engineering degrees been accredited through Washington accord- i.e. mutual recognition of engineering degrees among the accord signatories. One such signatory of the accord is Australia and the regulatory body for that purpose is Engineers Australia. The PNG University of Technology is in the process of applying for a membership of accord through Engineers Australia. The procedure includes satisfying the accreditation requirements as per the guidelines provided by Engineers Australia followed by visit of its representatives to the applied institution and a decision on accreditation. A number of studies conducted by earlier researches on marker and board-based methods of tertiary teaching reveals their ineffectiveness in learning outcomes (Henshaw et al. (1991), Lang et al. (1999), Caso et al. (2002), Mills et al. (2003), Wankat, (2002)). Brawner et al. (2002) reports faculty teaching practices survey conducted by Southeastern University and College Coalition for Engineering Education in 1999 in regard to educational policies. Their findings indicated that majority of respondents used active team-based learning methods even when it was not mandatory to do so. Mariasingam et al (2007) in their research paper presented a scenario of changing work environments for engineers that includes globalization, outsourcing and merging technologies. John (2007) argues engineering education in developing countries should include significant coverage of entrepreneurships -how to start, operate and grow business. This would influence job growth. Bell et al., (2006) in their research paper indicated meaningful learning processes. In other words, learning process is student centred. In such cases learners are exposed to real world problems that needs a methodological approach. It is a two-way learning process and teachers are to encourage the learners with their learning processes,

One of the contributing factors of globalization is the continuous innovation of communications such as improvement of internet services and devices e.g. computers and smart phones. It is a known fact that our learning processes are changing due to the rapid development of the communication systems that is at our disposal. By using technology as a tool, a person at a remote location can now be educated at the touch of a screen. As a result, tertiary learning methods are changing from pen and white board to distant learning methods or blended methods. Blended learning integrates formal and informal learning, face-to-face and online experiences, directed paths and reliance on self-direction and digital references and group connections, in order to achieve individual and organizational goals (Sethy 2008).

Sethy (2008) identifies education as one of the prominent domains where advanced technologies are used. The author suggests a good education system should set out to achieve the highest goal and will be defined as the process of acquiring and developing knowledge.

Sharifi et al. (2011) indicated due to globalization, important learning processes such as creativity, innovation and collaboration etc. are among those finding places in structured education systems.

The paper explores criteria that needs to be addressed prior to applying for accreditation resulting in mutual recognition of engineering degrees among the accord signatory countries. These are as follows:

2.0 Tertiary engineering teaching-employment perspective:

Although no reliable statistics exist on absorption of PNGUOT engineering graduates by the industry within three months of their graduation, however it is estimated that most of the mechanical graduates are absorbed in the industry within that afore mentioned time frame. This is backed up by a report conducted by Jones & McGavin (2015). Their report provided extensive evidence of the range of hard skills in demand in PNG. Their report suggests skill shortages in the area of mechanical engineering.

These can be attributed to the fact that, Papua New Guinea (PNG) having a stable democratic government and being rich in resources specifically in the areas of hydrocarbon fuels, mineral resources, virgin bushland, tropical weather, mountain rivers, vast coast line and underground hot water reservoirs attracts foreign entrepreneurs/investors and potential multinational employers. Many of our graduates are being employed by these enterprises. However, these companies having worldwide businesses and global commitments and are at the forefront of recruiting locally produced engineering graduates, that at some stage needs to be trained on recognized training institutions/workplaces, be comparable to the global engineering standards. Many of these graduates will also have overseas commitments.

3.0 Curriculum: Tertiary engineering teaching-learning - employment perspective

Recognizing the shortcomings of engineering education provided in PNGUOT, that at this stage is alien to the education standard of many developed countries, the Government of PNG, industry leaders, educationists, Institution of Engineers, PNG and the PNGUOT are making commitments to review its engineering institutions degree program, that would be recognized by the countries around the globe. Thus, the present curriculum of the engineering departments of PNGUOT previously developed and regularly modified until now, is in the process of further modification. PNGUOT being a public university accepted the challenge of accreditation years ago, have now secured promised support and sponsorship from local and global corporations. The proposed model is based on Australian engineering degree structure, It is established that the present four years degree program is suffice, however curriculums of the engineering programs needs to be in line with the Engineers Australia's guidelines, one of the signatories of Washington Accord (Refer Table 1 to Table 4). Table 1 refers to year 1, semester 1 and semester 2. It is to be noted that year 1 is a common year for all the engineering disciplines.

Transition to developed curriculum year 1 has already been implemented in 2018-2019 academic year. Proposed second year, third year and fourth year curriculums would be implemented on academic years 2021-2022 and 2022-2023. respectively.

Engineering education is continuously evolving towards student learning rather than classroom-based teaching. Accredited engineering programs requires graduates to achieve and demonstrate a set of specified learning outcomes such as Subject learning outcomes, course learning outcomes and graduate capabilities. The curriculum developed is based on as follow:

- First year, second year, third year and fourth year courses in red (see figures 1, 2, 3 and 4) are designed for all engineering students. Course synopsizes were documented by respective departments.
- Second year, third year and fourth year courses in black (see figures 2,3 and 4) are mandatory mechanical subjects. Course synopsizes were documented by respective departments.

- Third year and fourth year courses in blue are documented by the mechanical department of PNGUOT

Course curriculums were developed based on a total of six contact hours/week for each course and is designed for 13-week semester.

Each engineering faculty prepared subject outlines for core and electives. The subject outline covers attributes such as synopsis, subject topics, subject learning outcomes (SLO), Assessment task (AT) and their weightings.

SLO are mapped to each of National Qualification Framework (NQF), Course Learning Outcome (CLO), Graduate Attribute (GA) and Assessment Task (AT). Assessment topics are linked with the topics that provide material to enable their completion.

The information was disseminated to stakeholders such as industry experts for their comments and feedbacks.

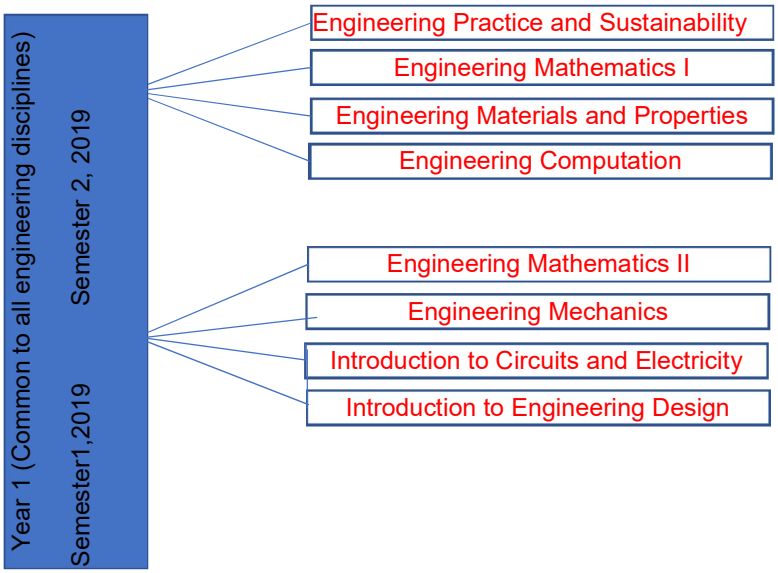

Figure 1 Proposed Year 1 Program

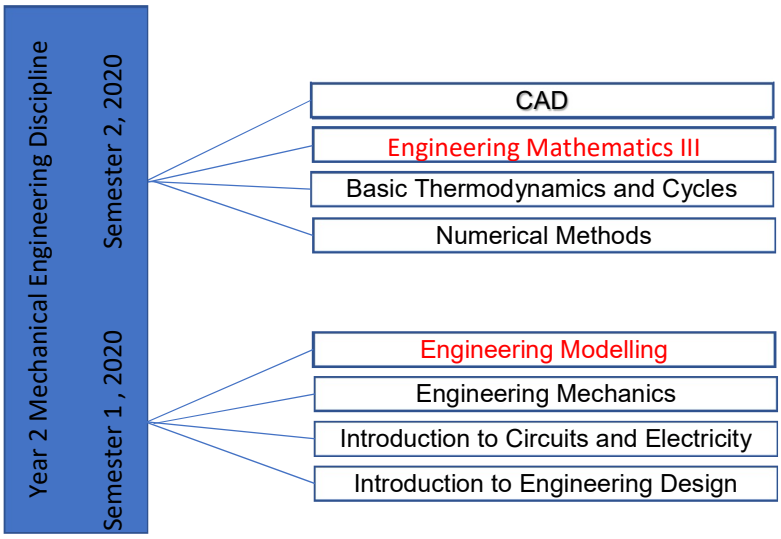

Figure 2 Proposed Year 2 Program

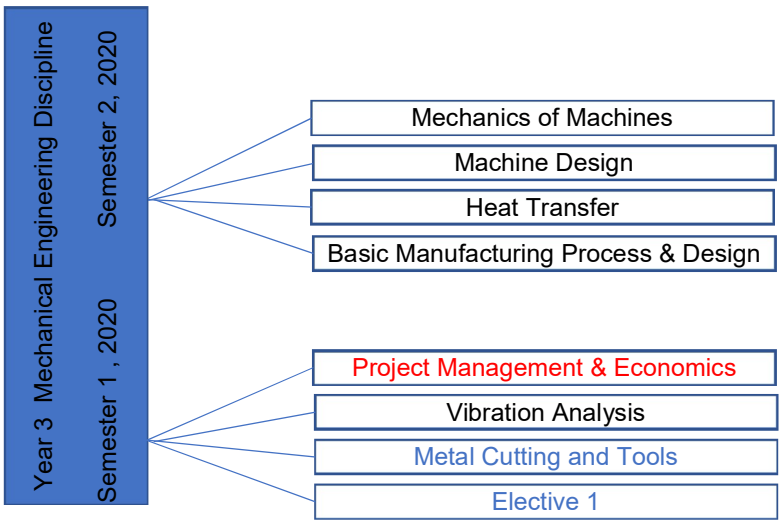

Figure 3 Proposed Year 3 Program

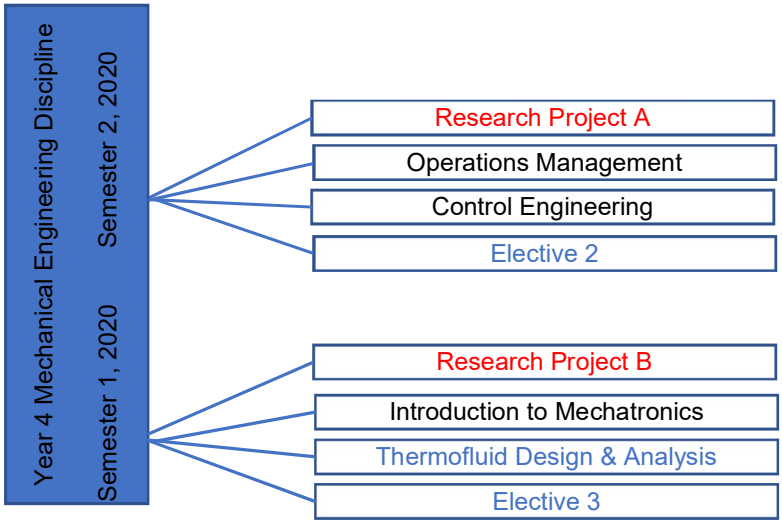

Figure 4 Proposed Year 4 Program

4.0 Challenges that needs to be addressed

Transfer of knowledge- Secondary level

Whereas in the western world, basic communication through high speed internet is a norm, however, 87% of population of PNG lives in rural areas without access to electricity (United Nations, 2015). Thus, a vast majority of secondary students from rural areas of PNG, are deprived of modern technology as such many of these rural schools are not in pace with the university when it comes to use of technology in delivering the required outcome due to inadequate available resources. This is a complex problem and PNG government has established policies to address the issues. Lower than expected pace of industrialisation in PNG is having an added contribution to the problem. In the changing world a clear pathway needs to be defined and issues mitigated on the transition from secondary school to the university. impact on to the issues.

Transfer of knowledge- University teaching and research

With the availability of modern technologies, traditional engineering is becoming more dynamic. Impact of globalization thus requires an urgent need to convert our classrooms into computer laboratories for students to access on appropriate tools to solve real world engineering problems.

With the availability of modern technologies, traditional engineering is becoming more dynamic. There is also been more emphasis on project-based learnings through the changes of course curriculum. This requires an urgent need to convert our classrooms into computer laboratories for students to access on appropriate tools to solve real world engineering problems.

Standard updated laboratory equipment in any engineering branch is an essential educational requirement. Presently it is very rare for PNG industries to provide research agendas to universities and consequently a very small number of researches attracts industry sponsorship. One of the measurable criteria for university excellence is the quality of research and fund generation for the conduction of research. High caliber research professionals need to be hired by the universities with added intensives provided to retain them. Universities must take the initiative to attract external research agenda and required funds.

The engineering departments of PNG University of Technology is following the world university trend in developing its curricula, focusing on project-based learning outcome for advanced year students. Developed curricula needs to be realistic and workable, based on the PNG educational structure/industry requirements and not merely a replica of curriculum implemented by advanced countries.

Vast majority of academic staff and students of PNG University of Technology reside within the university campus and the challenge is to have access of consistent high-speed internet service available to all students and staff members.

5.0 Conclusion:

The paper discusses the challenges of engineering education in PNG, in particular, curriculum development. It proposes new curriculum including teaching and learning process based on student learning outcomes and their mitigation process. The paper also emphasises the importance of excellent versatile presentation methods including use of improved computer-based teaching aids.

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