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End of the traditional engineering professional: Changing face in engineering education

Fidelis Ndambuki Kilonzo[1] and Urbanus Mutwiwa[2]

[1] Department of Agricultural & Biosystems Engineering, Kenyatta University

[2] Department of Agricultural and Biosystems Engineering, Jomo Kenyatta University of Agriculture & Technology

Corresponding author: fndambuki@gmail.com, 0732721448

Abstract

With the past glorification of STEM subjects in the Kenyan education systems, the attainment of an engineering degree was the dream come true for top students. In the recent past, the traditional engineering programmes have lost their allure due to a myriad of contributing factors. 1. The engineering education space has seen a plethora of programmes with an engineering tagline but offering very little in the traditional sense of engineering education. 2. The advent of the information age has seen the proliferation of para-professionals "who look unlike the traditional professionals taking up the work of professionals". 3. EBK while frustrating graduates continue to wage supremacy battles with KETRB over the use of engineering title while CUE has wedged them out of the accreditation struggle. 4. The welfare of engineering professional including their remuneration of has been one riddled with apathy and gross scorn from other professionals and employers. 5. The Covid-19 pandemic exacerbated the chronic financial crisis in the Universities coupled with reduced capitation funding to Universities and the government policy shift to favour midlevel TVET to University education. It is hardly surprising that fewer and fewer top students in high school are considering engineering as their dream profession.

Keywords: engineering programmes, para-professional, dream career, plethora, accreditation, remuneration

Introduction

Engineering is a term derived from the Latin *ingenium*, meaning "cleverness" and *ingeniare*, meaning "to contrive, devise". Engineering is the scientific process that transforms classical thinking into hard calculations. The engineer is therefore both a scientist and artist, as engineering is a human endeavor that is both creative and analytical (Petroski, 1992). This is well expounded by Kirkey (2018) thus "Engineering is the creative application of science, mathematical methods, and empirical evidence to the innovation, design, construction, and maintenance of structures, machines, materials, devices, systems, processes, and organizations. The discipline of engineering encompasses a broad range of more specialized fields of engineering, each with a more specific emphasis on particular areas of applied mathematics, applied science, and types of application".

> The discipline of engineering has evolved over the years with some elements of the definition being dropped and new ones emerging. The development of any of the major branches in engineering was preceded by an innovation in that field which led to a critical of operators in the field and the birth of the professional arm of engineering. The use of engineer as a person who worked/operates the military engines (a contraption not unlike engines as we know them) was the first reference to engineering. The design of civilian structures, such as bridges and buildings, matured as a technical discipline, the term civil engineering entered the lexicon as a way to distinguish between those specializing in the construction of such non-military projects (Kirkey 2018). Although inventions featuring use of mechanical features have been around for a long time, it was not until the advent of the steam engines and the birth of the industrial revolution in the 18th century than the mechanical engineering become mainstream as a technical profession. According to Kirkey 2018, the foundations of electrical engineering in the 1800s included the

experiments of Alessandro Volta, Michael Faraday, Georg Ohm and others and the invention of the electric telegraph in 1816 and the electric motor in 1872. The theoretical work of James Maxwell) and Heinrich Hertz in the late 19th century gave rise to the field of electronics. When conventional manual threshing process with flails was recognized in several European countries as no longer acceptable in the 1760s, experimentations with threshing devices started in England, Sweden, Denmark and Germany leading to the advent of Agricultural engineering (Herrman, 2011). The boom in manufacturing in the industrial revolution demand for new materials and processes led to the birth of chemical engineering. As technological innovations and inventions come along, it is therefore imperative that more engineering disciplines will emerge which maybe seem like fantasy in a scifiction movie. The information age has given birth to a whole new cadre of professionals many claiming a stake in the engineering profession.

With new challenges like developing countries wishing to leap frog in to first world countries, climate change, pandemic like COVUD-19 and information technology, the world demands a new crop of engineers to fix the myriad challenges. While universities have come-up with a variety of programs "thought" to address the challenges, it remains unclear how to equip students with the core knowledge they will need throughout their careers (Lord, 2021).

According to the Engineers Board of Kenya, 48 (out of a possible 103) engineering undergraduate programmes are accredited in 10 Universities in Kenya. These programmes fall under the following broad categories; Civil & structural Engineering, Mechanical & production engineering, Chemical & industrial Engineering, Electrical and Electronics Engineering, Agricultural & Biosystems Engineering, Mining and Mineral Engineering, and Marine Engineering (EBK, 2021). The breadth of these programmes referred to as the traditional engineering programmes is quite limited compared to the 2,000 engineering programs throughout the United States (Educating Engineers, 2021).

With the past glorification of science, technology, engineering and mathematics (STEM) in the Kenya education systems and beyond, the attainment of an engineering degree was the dream come true for many young top grade hardworking students. Except maybe for a medical and architectural degree, no other degree was sought after as much as an engineering degree. These branches of engineering herein referred to as traditional programmes in Kenya have however lost their allure due to a myriad of factors contributing severally or in combination. In order to keep them attractive, any competitive new programmes in emerging fields like telecommunication, computer engineering, software engineering, geospatial engineering have been bowbeaten to submission through denial of accreditation. Aspiring students are torn between a rock and a hard place, either the option of joining a so called "unregisterable" and highly demanded degree, opting for the traditional accredited but unattractive program or going to another profession altogether

Setting

In order to assess the attractiveness, the competitiveness and the trend in the selection of different programmes, the university and the programme cut off point are used. According to the Kenya Universities and Colleges Central Placement Service (KUCCPS); Cut-off points are the marks (cluster weight) of the last student to join a course in a university after all applicants for the course have been ranked based on their cluster weights. The cluster weights are calculated using the formula

$$C = \left[\sqrt{(R * {}^{t}/_{T})}\right] * 48 \text{ ----------eqn 1}$$

Where: C is the cluster weight, r is sum of 4 cluster subject, R=48, t is candidate grade points, and T=84

Cut-off points are only available after applicants have been placed and they have joined university/college. These cut off points are reviewed on a yearly basis and they heavily rely on candidates' performance at the Kenya Certificate of Secondary Education (KCSE) examinations, as well as preference/ demand for a course. A six year (2015-2020) cut off was available and downloaded via the KUCCPS student portal link.

Four cutoff point were ranked for the programmes in engineering and the top four programmes in each discipline were used for the analysis.

Results

Over the last six years, the traditional engineering programmes have seen a progressive decline in the cutoff points as shown in table 1. Medicine which is Engineering's traditional competitor, seems to consistently holding on to the highest cut-off points with the Violin upward bulging to the top end, fig 1, the engineering courses have the bulge to towards the bottom, indicating a declining trend. Some engineering programmes despite not being approved by the Engineers Board continue to be attractive to students just like the parent programme. Because of the market demand for IT graduates and the successful growth of telecoms in Kenya, Telecommunication Engineering, computer science and Software Engineering and are still competitive despite lack of accreditation. Some other programmes started off on a high note but the popularity dwindled with the stifling from the board. Geospatial and Geomatic Engineering were a go to course for those interested in Surveying and geography with an engineering touch but their attractive has taken a beating.

The tragic story of agricultural engineering clearly demonstrates the effect of misguided policy, misinformation, misuse of power and extended siblings' rivalry. While the programme was running its traditional course, the entry cutoff (2015) was comparable with the other engineering programmes albeit 2-3 points lower. Owing to market trends and the mainstreaming of environment in the engineering landscape through Environment Impact Assessments (EIA's), the agricultural engineering was remodelled to take advantage of this development and the curriculum was revised to have environmental engineering as a key thematic area. This move did not go down with the Civil Engineers who unfortunately were at the helm of the regulators. Consequently, the new variants of the discipline; Biosystems engineering, Environmental Engineering etc became unregisterable creating a dominoes effect on the popularity of the programme. Today the cutoff point is on average 10 cutoff points lower than its peers. The main proponents of the change, University of Nairobi and Egerton University have taken such a beating that its programme is less attractive than that of Kenyatta University despite former being accredited and the later not.

Table 1: Cluster points for the most sought-after science courses (KUCCPS, 2021)

Course	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**Average**
Medicine	45.14	44.63	42.78	43.69	44.66	44.85	44.29
Accredited Engineering programmes							
Civil	44.39	43.58	43.13	42.60	43.33	42.29	43.22
Electrical	43.46	43.31	43.05	41.95	42.59	41.84	42.70
Mechanical	43.35	42.12	41.62	41.27	42.05	40.85	41.88
Mechatronic	42.54	41.75	41.37	41.45	42.28	40.63	41.67
Agricultural	40.85	32.26	30.45	29.94	29.99	29.58	32.18
Popular Non- Accredited Engineering/Technology							
Aeronautical/Aerospace	43.60	42.42	42.43	42.55	43.10	41.45	42.59
Computer Science	44.11	42.54	41.91	41.46	42.38	42.20	42.43
Telecommunication	43.92	42.79	41.51	41.07	41.32	38.41	41.50
Software	41.73	40.34	40.37	40.26	41.59	40.91	40.87
Geospatial/Geomatic	41.84	40.59	38.81	38.66	39.52	39.09	39.75

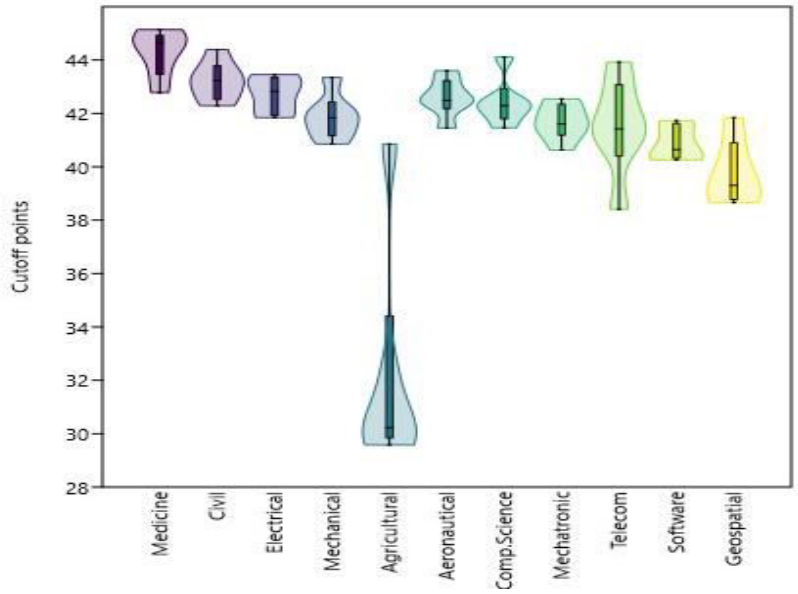

Figure 1: Six years (2015-2020) cut off average for different programmes related to Engineering and Technology

Discussion

The traditional engineering professional is thus underseige from both internal and external forces

External forces

Me too mentality

The engineering education space has seen a plethora of programmes with an engineering tagline but offering very little in the traditional sense of engineering education. Classic examples include; Financial engineering, Genetic engineering, Bioengineering, cell engineering, social engineering and so on. The loose use of the word has therefore led a misunderstanding and watering down of the profession. This opens the scene for even more "lollipop" engineering programmes.

Emergence of Para - professionalism

The advent of the information age has seen the proliferation of para professionals "who look unlike the traditional professionals tasking up the work of professionals" (Susskind, 2015). The use of computation-based skills (coding and modelling) has enabled people without or with very basic training in engineering take decisive roles in the design and implementation of engineering projects which were hitherto a preserve of the Engineers. This has not only encroached the sphere of influence of engineers but as Authors of the book put it, "this has created a new kind of trust a quasi (pseudo) trust". The end user is more concerned at the reliability and convenience of the service (trusted solution) and less on the specialist offering the service (trusted adviser). The easier it is for one to perform their responsibilities without need for professional stamp to prove his competence and proficiency, the more the invasion of the engineering field by the para-professionals. According to Trevor English (YEAR), it's much easier to invade the software engineering arena where proof of concept is the key performance indicator than in Civil Engineering where approvals for works of a licensed Practicing Engineer by an external authority is the norm rather than the exception.

Government shifting policy

The Covid-19 pandemic exacerbated the chronic financial crisis in the Universities, coupled with reduced capitation funding and the government policy shift to favour midlevel Technical training (TVET) to University education.

Engineering Faculty rigidness

The advent of the covid-19 threw the final straw that broke the camel's back. With engineering being a practical-oriented course, the learners had to stay home longer to await face to face classes while those in other programmes

were quick to switch to online teaching. The engineering faculty shot themselves in the foot with their adamant refusal to teach online in the guise of technical inoperability. Other than quickly re-engineering themselves and adopting technology like virtual laboratory (whose infrastructure is not available locally), technology assisted teaching and online learning with self- paced learning. Some potential students opted for other courses other than stay and wait for face-to-face teaching. The Covid-19 pandemic exacerbated the chronic financial crisis in the Universities coupled with reduced capitation funding to universities and the government policy shift to favour midlevel technical training (TVET) to University education.

Women in engineering

According to Tien et al., (1995), there is very low representation of women in engineering. It is hardly surprising that fewer and fewer students in high school are choosing engineering as their dream careers. Further is tragic that girls who are emerging as top performers in the university entry examinations (70 % and 50 % of top 15 KCSE in 2019 and 2020 respectively). For instance, an Informal survey in one class of a top girls' schools in Kenya indicated that 48 % of the respondents choose a medical profession as their first choice compared to 12% who choose an engineering career in aerospace and Computer engineering which are not registerable (as yet) courses in Kenya. None (0%) choose a traditional engineering career.

Internal forces

Engineering regulation

Over the years, engineering disciplines continue to attract the top students but while universities make efforts to improve teaching, and train the next generation of academics, battles on who should accredit the programs has seen protracted court battles between professional bodies, the commission for University Education leaving other stakeholders confused. The complications arising from the accreditation and recognition of engineering and technology programmes as created a legislative tussle which has seen the enactment of two Acts governing what would otherwise be a unified and well tiered profession. The Engineers Board of Kenya (EBK) and the Kenya Engineering Technology Registration Board (KETRB) continue to wage supremacy battles over the use of engineering title while commission for University education (CUE) has wedged them out of the accreditation struggle vide the courts enforced ruling. While courts have ruled and provided recommendations on way forward, for instance Odour and Muthoni, (2020), Oduor (2021a and b) there is reluctance on the complete implementation of the same. The change currently happening is necessary, although conservatives may question the speed at which it is happening. Due to this regulatory confusion, the reference to anyone with a technical training regardless of the level as an engineer has bought disrepute to the profession. These quack-professionals masquandering as engineer could be responsible for the high number of structures failing in the country.

Engineers' welfare

"…nurses are paid even higher than civil engineers who have degrees..." (Tukonews, 2021), This infamous comment attributed to Kakamega Governor and then chair of Council of Governors aptly summarizes the misery endured by engineers. The welfare of engineering professional including their remuneration of has been one riddled with apathy and gross scorn from other professionals. The payment of paltry Kshs. 25,000 in the profession's regulator mediated internship program and the entry of engineer in the civil service a grade lower than other professionals like doctors and architect, the frustration of the graduate engineers for lack of mentors and the none recognition of some cadre of graduates by the regulator leading to prolonged court battles has dented the image of the profession and cast doubt on its posterity. The ultra-conservative nature of the engineering regulator and the professional association bosom-buddies leads to a copy paste mentality and curtails creative engineering thinking which is construed as unconventional and risking taking.

Way Forward

In order to ensure that academic training continues to offer solutions to the myriad challenges facing the world, it is important to have all stakeholders work together for the common good. Universities ought to ensure adequate participation of all stakeholders (an ecosystem approach) during the development and review of academic programmes. Key stakeholders like professional bodies, who regulate the practice ought to participate actively, through the provision of feedback aimed at moving the process forward hence adding value to the product. This

includes value addition on the content of curriculum, and provision of opportunities for universities teaching the same. Moreover, professional bodies should ensure they continue to provide (singly or jointly) opportunities for continuous learning of their members, in addition to being at the forefront in engaging the private sector to ensure there are adequate opportunities for student/staff attachment as well as internships. Furthermore, professional bodies ought to add their voice in lobbying the government to allocate more resources to universities training engineers. The goal ought to be about ensuring that graduates and professionals meet the challenges of the current era, and NOT superiority battles. In conclusion, time has come for all to partner in order to re-engineer the engineering profession. In our view, it does not add value to have professional bodies examine Lecturers who hold relevant undergraduate and postgraduate degrees, before registering them; instead policies ought to be in place ensure only registered professionals are engaged as trainers/knowledge providers thus partners in the process thereby need to be honoured. On the other hand, lecturers and universities need to be well renumerated and compensated to ensure they remain on the path of continual improvement by actively exploiting opportunities provided by professional bodies including research, mentorship, internships, short courses, webinars etc. This will ensure that the lecturers adapt to the quickly changing environment in order to try meet the expectation of the stakeholder, albeit with limited resources. The media has a big role in ensuring that correct, accurate and actual information is communicated to the public to avoid creating doubt on the quality of engineering professionals.

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