Collaborative Meta-Profile Development Using the Tuning Methodology to Harmonize Mechanical Engineering Education in Africa

Venkata, R.A[1], Chinyama, M.P[2], Onana, C.A[3], Delpouve, B[4], Raidandi, D[5], Megahed, M.M[6], Yakasham, L.K[7], Sackey, S.M[8], Kayibanda, V[9], Chama, S[10], Mahomed, N[11]

[1]Jimma University, Ethiopia., [2]University of Malawi, Malawi., [3]University de Yaoundi I, Cameron., [4]University of Lille I, France., [5]University de Yaoundi I, Cameron., [6]Cairo University, Egypt., [7]Institute of Superior DE Techniques Appliquees Kinshasa, DR Congo., [8]Kwame Nkrumah University of Science and Technology, Ghana., [9]Kigali Institute of Technology, Rwanda., [10]Copper Belt University, Zambia., [11]Cape Peninsula University of Technology, South Africa.

Introduction

The African Higher Education system is undergoing a tremendous transformation process. This includes a number of national, regional and continental initiatives among which are the Nyerere mobility Scheme, the African Higher Education Harmonization and Quality Assurance programme, and the Pan African University. In addition these, at the institutional level, reform is underway in most countries. Socio-economic development in Africa is fast emerging as a fundamental policy driver among many African countries. Traditionally, African countries have failed to exploit intra-African trade although organizations such as COMESA, CEMAC, ECOWAS, SADC and others have been established to improve regional cooperation.

It is envisaged that future transport networks and shared infrastructure projects will require cooperation amongst engineers from different African countries. Moreover, recent intra-African technology development initiatives such as Satellite Technology programme for establishing an African Satellite Constellation, the Square Kilometre Array (SKA) Programme, the African Laser Centre, Regional hydropower building programmes etc., have brought to fore the need for harmonization of engineering programmes across Africa, and the development of curricula that address the specific technological needs of the Continent, (Galal, Salah and Mohammed, 2008 and ARCEE, 2006).The need for technology transfer and reception will further advance the cause of harmonisation of engineering curricula across Africa. Such harmonisation will enhance intra-African mobility, at various levels, namely: high-level research in areas of specialization which necessitates the use of scarce and expensive resources, postgraduate programmes in specialist areas, and joint engineering programmes based on intra-African meta-profiles.

The Place of Tuning: One transformation initiative which links institutional, national, regional, continental and international endeavours is the African Higher Education Harmonisation and Tuning Project (Tuning Africa), which is part of an AU-EU strategic partnership initiative (www.tuningafrica.org). The Tuning methodology is an interactive process in which academics develop high quality curricula and learning standards for students through the identification of generic and subject specific competencies in consultation with employers, students, graduates, peers and other stakeholders involved in higher education. Mechanical engineering is one of 5 subject areas whose harmonisation is being piloted in Africa as part of this initiative with representation from countries shown in Table 1.

Table 1: List of Universities and Countries.

No	Country	Universities
1	Cameroon	University de Yaounde I
2	Central African Republic	Université de Bangui
3	Democratic Republic of Congo	Institut Supérieur de Techniques Appliquées Kinshasa
4	Egypt	Cairo University
5	Ethiopia	Jimma University
6	Ghana	Kwame Nkrumah University of Science and Technology
7	Malawi	University of Malawi - the Polytechnic
8	Tunisia	Ecole Nationale d'Ingénieurs de Tunis
9	Rwanda	Kigali Institute of Science and Technology
10	Zambia	Copperbelt University
11	South Africa	Cape Peninsula University of Technology

The history of tuning started in various countries at various times and the main aim is to collaboratively contribute to revitalizing and reforming Mechanical Engineering higher education in Africa, to make it more responsive to Africa's developmental needs. Tuning projects in higher education in Africa may further help to improve staff capacity to design and develop curricula, *provide* opportunities for generation of additional resources and support effective and productive networking. Tuning holds a promise to help establish compatible academic structures, and reference standards across Africa, which would facilitate student and staff mobility as well as enhance cooperation, not only among African academic institutions, but also between African institutions and those in the rest of the world.

Tuning Methodology

The objective of the first phase of the "Tuning Project" is to conceive a mental conception of the "Mechanical Engineering" (ME) degree profile. This is termed here as the degree "Meta-Profile". The procedure followed in developing this meta profile includes the definition of Mechanical Engineering, development of a suitable professional profile of the graduate mechanical engineer, and evolution of initial set of generic graduate competencies and specific competencies. Later, consultation processes with four groups of stakeholders: academics, employers, students, and graduates. Stakeholders were asked to rate the "importance" and the current level of "achievement" of each generic and subject specific competence and also to rank all competencies in a descending order of importance. This rating is made on a scale of 4 as follows: strong =4/4, moderate =3/4, weak =2/4, none =1/4. And finally, reordering and classification of competencies based on the results, development of ME Meta-Profile and followed by comparison of the developed meta profile with existing profiles.

Development of Generic and ME Competencies

Sessions of extensive discussions and deliberations among the representatives of African Universities have focussed on developing two sets of competencies. The first set is common to all subject areas and hence is termed as "Generic Competencies". The second set of competencies were concerned with holders of a bachelor in "Mechanical Engineering"

Generic Competencies: Working in collaboration with four other subject area groups, the following 18 generic competences (Table 2) were agreed upon to as characteristics of holders of a first degree (Bachelor) in any of the subject areas (Mechanical Engineering, Civil Engineering, Teacher Education, Medicine, Agriculture).

Mechanical Engineering Specific Competencies*:* Through deliberations between representatives of the 11 universities participating in the ME subject group, 19 competencies specific to ME were evolved (Table 2).

Results of Consultation Process

A total of 4323 stakeholder respondents provided answers to the generic competencies questionnaire. A total of 3812 respondents provided answers to the "subject specific" competencies. About 13 % of the responses were associated with ME stakeholders. Analyses of data sets pertaining to levels of importance, achievement and ranking, as expressed by the three groups of stakeholders and competencies, were conducted.

For each set of data, and for each stakeholder group, the following procedure was followed:

- Competencies are ordered in descending order of importance
- The corresponding levels of achievement are recorded against each competence, and hence the level of the gap between importance and achievement was obtained
- The ranking of each competence is then recorded
- For the 18 common generic competencies, the top-7, bottom-7 and the middle 4 generic competencies are identified

Similarly, the top-7, bottom-7 and the middle 5 ME competencies are identified

Analysis of Consultation Results for Generic Competencies

Table 3 shows the numeric data of the views of ME stakeholder groups in the common generic competencies and the following observations can be made:

- Levels of achievement are lower than levels of importance.
- Highest gaps between importance and achievement levels are affiliated to competencies #4, 17, 2 and 5.
- Competencies #1and 4 are placed at the top of the list in importance and ranking.
- Competencies #13, 18, 14 & 16 are at the bottom of importance and ranking list.
- Generic competencies #1and 4 are agreed upon as the two most highly ranked competencies in a ME graduate. Employers and academicians rank the use (# 6) much more highly than students and graduates. Of all areas, only the ME disciplines rank (# 6) highly, which indicates that the use of innovation is an inherent feature of the discipline.
- There could have been an overlap between competence # 10 and competence # 6 as employers rank use of technology much higher than its creation. This may probably be interpreted by the nature of industry in Africa where most technology is imported, not created. On the other hand, students and graduates rank creation of technology much higher than its use.
- Students and graduates of the ME discipline rank competence # 11, much higher than academics and employers of ME discipline. Students and graduates of "All Areas" ranked competence # 11, much lower than their ME counterparts. It is puzzling that employers do not rank leadership and teamwork skills highly.

- ME graduates identify competence # 17, as having the largest gap between importance and achievement. This provides an example of competencies that need rectification, improvement, and reinforcement in current curricula.
- Competence # 7, is ranked very low by students and graduates as well as academics. This feature reflects the fact that local/national languages are not typically employed in technical communications and reporting in the ME discipline.

Table 2: List of Generic and Specific Competencies

Generic Competencies	Specific Competencies
1. Ability for conceptual thinking, analysis and synthesis.	1. Ability to apply knowledge of the basic and applied sciences of mechanical engineering.
2. Professionalism, ethical values and commitment to UBUNTU	2. Ability to identify, evaluate and implement the most appropriate technologies for the context in hand.
3. Capacity for critical evaluation and self-awareness.	3. Capacity to create, innovate and contribute to technological development.
4. Ability to translate knowledge into practice.	4. Capacity to conceive, analyze, design and manufacture mechanical products and systems
5. Objective decision making and practical cost effective problem solving skills.	5. Skills in planning and executing mechanical engineering projects.
6.	6. Capacity to supervise, inspect and monitor mechanical engineering systems.
7. Capacity to use innovative and appropriate technologies.	7. Capacity to operate, maintain and rehabilitate mechanical engineering systems.
8. Ability to learn to learn and capacity for lifelong learning.	8. Skills in evaluating the environmental and socio-economic impact of mechanical projects.
9. Flexibility, adaptability and ability to anticipate and respond to new situations.	9. Capacity to model and simulate mechanical engineering systems and processes.
10. Ability for creative and innovative thinking.	10. Skills in selecting, mobilizing and administering material resources, tools and equipment cost-effectively
11. Leadership, management and team work skills.	11. Capacity to integrate legal, economic and financial aspects in decision-making in mechanical engineering projects.
12. Communication and interpersonal skills.	12. Capacity for spatial abstraction, graphic representation and engineering drawings.
13. Environmental and economic consciousness.	13. Providing mechanical engineering solutions to societal problems for sustainable development.
14. Ability to work in an intra and intercultural and/or international context.	14. Skills in safety and risk management in mechanical engineering systems
15. Ability to work independently.	15. Skills in using information technologies, software and tools for mechanical engineering.
16. Ability to evaluate, review and enhance quality.	16. Capacity to interact with multidisciplinary groups towards developing integrated solutions.
17. Self-confidence, entrepreneurial spirit and skills.	17. Skills in employing quality control techniques in managing materials, products, resources and services.
18. Commitment to preserve African identity and cultural heritage.	18. Capacity to conduct life cycle assessment for products and systems
	19. Capacity to employ mechanical engineering skills to transform local natural resources into products or services through value addition.

Analysis of Consultation Results for ME Competencies

Table 4 provides the raw data of the responses to the questionnaire of ME specific competencies with regard to how the various categories of stakeholders evaluated the levels of importance and achievement of each competence in current curricula, and how they ranked the 19 competencies.

The following observations can be made:

- Levels of achievement are generally viewed lower than levels of importance.
- Academicians, students and graduates commonly identified the competence # 19, as the largest gap between levels of importance and achievement. Employers and students commonly identified the competence # 14, as a large gap between levels of importance and achievement.
- Competences #18 and 16 are seen by academicians, employers and graduates, respectively as competencies with large gap between levels of importance and achievement.
- The most highly ranked competencies are competence #1, 4, 2, 3 and 5. However, there appears to be some overlapping between competence #1, and competence # 4, as by definition, design encompass application of knowledge.
- Competencies #1, #4, #2 stand out as the most highly ranked by students, employers and academicians. Competence #3 is ranked high by all stakeholders except employers. This reflects the preference of employers to use technology rather than create technology. On the other hand, graduates rank design higher than application of knowledge.
- Next, a second batch of competencies that are also ranked high by most of the stakeholders. These include competences #13 and # 19. All stakeholders ranked #19 high. However, the gap between importance and achievement of this competence is high for students and graduates.
- Competencies #17, #18 and #14 are ranked very low by almost all stakeholders. This may be, perhaps, due to the low level of technological development in the continent, quality culture and technological innovation.
- Graduates rank the competence #12 very low, while the competence # 4 is ranked very high, despite the fact that drawing is the tool by which designers express their thoughts. It is believed that graduates and students tend to rank competencies according the degree of complexity.
- Regarding employers, the data reveals a small gap between importance and achievement levels for those competencies #1 and #9. This indicates that, in the eyes of employers, academics have performed their task properly.

Profile Development

After taking an overview of the degree profiles from the participating universities and considering the specific learning outcomes for ME first cycle study programmes, a consensus emerged with regard to the core elements of a ME curriculum. These are depicted in Figure 1, in the form of a pyramid, with their average weightings in percentages indicated. To aptly summarize the key professional tasks constituting the very core (structured combination of competencies that gives identity) of ME and to help conceive the *Meta-Profile* (mental conception for visualization to help in constructing a degree profile) and to be able to reflect and analyze possible and diverse real degree profiles, the conclusions and inferences drawn from the stakeholder consultation process have been extensively used. It was agreed that the core can be characterized as *"Design, Manufacture and Operate Mechanical Systems". Design* is aimed at the realization of new or modified artifacts or systems, with the intention of creating value in accordance with predefined requirements and desires (Meijers, Overveld and Perrenet, 2005). *Manufacturing* involves translating design (digital or otherwise) into physical reality while *Operation* inherently involves safe and efficient use & application of the system.

Table 3: Main Features of Mechanical Engineering Stakeholders Responses to the Questionnaire of the Generic Competencies.

	Data of Mechanical Engineering Stakeholders Reponses to the Questionnaire of Generic Competencies																			
	Academics					Employers					Students					Graduates				
	Competence #	Importance	Achievement	Gap	Ranking Top-Down	Competence #	Importance	Achievement	Gap	Ranking Top-Down	Competence #	Importance	Achievement	Gap	Ranking Top-Down	Competence #	Importance	Achievement	Gap	Ranking Top-Down
Top 7	4	3.81	2.85	0.96	1	5	3.74	2.47	1.27	1	4	3.76	2.6	1.16	1	1	3.75	2.84	0.91	4
	10	3.66	2.94	0.72	4	4	3.74	2.38	1.36	4	10	3.74	2.81	0.93	4	4	3.74	2.6	1.14	1
	1	3.63	2.77	0.86	6	12	3.7	2.51	1.19	6	11	3.69	2.94	0.75	10	5	3.64	2.81	0.83	11
	6	3.59	2.82	0.77	10	17	3.69	2.49	1.2	5	6	3.65	2.49	1.16	11	6	3.63	2.63	1	10
	2	3.58	2.61	0.97	5	11	3.69	2.64	1.05	2	17	3.63	2.53	1.1	17	10	3.63	2.61	1.02	5
	17	3.57	2.8	0.77	2	1	3.69	2.81	0.88	9	5	3.63	2.79	0.84	5	17	3.61	2.48	1.13	17
	11	3.53	2.84	0.69	11	10	3.67	2.53	1.14	8	9	3.6	2.73	0.87	6	11	3.6	2.81	0.79	6
The 4 in the Middle	15	3.52	2.74	0.78	3	16	3.66	2.62	1.04	10	16	3.6	2.69	0.91	2	16	3.59	2.66	0.93	12
	16	3.49	2.76	0.73	17	6	3.66	2.66	1	11	12	3.52	2.87	0.65	9	12	3.56	2.67	0.89	15
	5	3.47	2.67	0.8	8	2	3.64	2.51	1.13	13	1	3.52	2.91	0.61	12	3	3.53	2.54	0.99	8
	7	3.45	2.7	0.75	18	9	3.62	2.7	0.92	7	3	3.48	2.75	0.73	3	2	3.51	2.52	0.99	2
Bottom 7	9	3.43	2.73	0.7	9	8	3.56	2.75	0.81	17	7	3.47	2.9	0.57	13	15	3.48	2.75	0.73	9
	3	3.42	2.56	0.86	15	7	3.47	2.64	0.83	3	15	3.47	2.86	0.61	8	9	3.46	2.77	0.69	3
	12	3.37	2.66	0.71	12	15	3.47	2.67	0.8	12	2	3.46	2.55	0.91	7	7	3.46	2.76	0.7	7
	13	3.33	2.65	0.68	14	3	3.43	2.44	0.99	16	13	3.4	2.56	0.84	18	8	3.38	2.83	0.55	13
	8	3.27	2.77	0.5	16	14	3.41	2.48	0.93	14	8	3.38	2.76	0.62	15	14	3.35	2.4	0.95	18
	14	3.25	2.38	0.87	13	13	3.36	2.4	0.96	18	14	3.26	2.39	0.87	14	13	3.35	2.44	0.91	16
	18	3.18	2.32	0.86	7	18	3.05	2.4	0.65	15	18	3.22	2.25	0.97	16	18	3.2	2.1	1.1	14

Table 4: Main features of ME stakeholders' responses to the questionnaire of the subject-specific competencies.

	Data of Mechanical Engineering Stakeholders Reponses to the Questionnaire of ME Specific Competencies																			
	Academics					Employers					Students					Graduates				
	Competence #	Importance	Achievement	Gap	Ranking Top-Down	Competence #	Importance	Achievement	Gap	Ranking Top-Down	Competence #	Importance	Achievement	Gap	Ranking Top-Down	Competence #	Importance	Achievement	Gap	Ranking Top-Down
Top 7	1	3.82	3.11	0.71	1	15	3.72	2.8	0.92	1	1	3.82	3.03	0.79	1	1	3.74	3.16	0.58	4
	4	3.69	2.9	0.79	4	14	3.71	2.3	1.41	4	15	3.78	2.72	1.06	4	5	3.67	2.85	0.82	1
	15	3.66	2.85	0.81	2	1	3.69	3.07	0.62	2	4	3.78	2.89	0.89	2	19	3.65	2.57	1.08	3
	3	3.65	2.83	0.82	3	6	3.67	2.94	0.73	5	3	3.74	2.5	1.24	3	4	3.64	2.82	0.82	5
	12	3.63	2.86	0.77	19	4	3.66	2.71	0.95	19	2	3.72	2.62	1.1	5	7	3.64	2.73	0.91	2
	2	3.62	2.69	0.93	13	12	3.64	2.75	0.89	3	9	3.71	2.62	1.09	13	2	3.63	2.65	0.98	19
	19	3.62	2.55	1.07	5	19	3.64	2.42	1.22	7	5	3.71	2.84	0.87	19	3	3.62	2.63	0.99	13
The 5 in the Middle	5	3.61	2.84	0.77	9	2	3.63	2.59	1.04	8	14	3.7	2.69	1.01	15	14	3.62	2.57	1.05	7
	6	3.53	2.83	0.7	10	5	3.6	2.73	0.87	15	12	3.69	3.06	0.63	9	6	3.61	2.83	0.78	6
	7	3.52	2.74	0.78	7	17	3.56	2.52	1.04	12	13	3.67	2.66	1.01	7	13	3.6	2.7	0.9	15
	13	3.48	2.64	0.84	15	7	3.56	2.56	1	11	6	3.67	2.7	0.97	12	15	3.59	2.81	0.78	9
	10	3.47	2.73	0.74	16	10	3.55	2.48	1.07	6	19	3.65	2.46	1.19	8	12	3.53	2.93	0.6	16
Bottom 7	9	3.4	2.66	0.74	8	18	3.48	2.25	1.23	9	7	3.62	2.66	0.96	6	16	3.51	2.52	0.99	14
	17	3.4	2.67	0.73	11	16	3.44	2.18	1.26	14	10	3.62	2.54	1.08	10	9	3.49	2.67	0.82	12
	8	3.39	2.47	0.92	12	3	3.43	2.43	1	13	17	3.54	2.57	0.97	16	17	3.49	2.65	0.84	10
	14	3.37	2.4	0.97	6	13	3.43	2.41	1.02	16	11	3.51	2.52	0.99	14	11	3.45	2.42	1.03	8
	18	3.36	2.38	0.98	17	9	3.37	2.92	0.45	10	16	3.47	2.38	1.09	11	10	3.42	2.72	0.7	11
	16	3.34	2.39	0.95	14	11	3.3	2.15	1.15	17	18	3.44	2.41	1.03	17	18	3.4	2.47	0.93	17
	11	3.3	2.39	0.91	18	8	3.27	2.52	0.75	18	8	3.4	2.43	0.97	18	8	3.39	2.57	0.82	18

Constituent Profiles and Clusters: The approach followed by the ME group for Meta-Profile development is in line with the development of a competency-based curriculum (Kouwenhoven, 2009). This started with the formulation of a *professional profile* with key occupational tasks, followed by a *graduate profile* with (selected) core competencies that relate directly to the professional profile and subsequently to the *curriculum profile* where the final attainment levels of the graduate are defined in competence standards for both generic and specific competencies. For greater clarity, competency is understood to be the capability to choose and use (apply) an integrated combination of knowledge, skills and attitudes with the intention of executing a task up to standard in a certain context, with personal characteristics such as motivation, self-confidence, will power being part of that context (Kouwenhoven, 2010).

Profile Clusters: Based on a ranking of the generic and ME specific competencies following the consultation process, clustering was done in terms of cognitive attributes - the drivers and the driven. Drivers are grouped under different categories such as knowledge, skills and attitudes. The driving and the driven elements are conceptualized in terms of gears.

Core and Knowledge Clusters: Each of the competency clusters including the ME core is constituted by both specific and generic competencies with the exception of innovation and creativity and entrepreneurial skills. Broadly, this suggests that they aid and reinforce each other. Ability to be creative and for innovative thinking as well as capacity to contribute to technological development are adjoined with the core competency cluster. This is especially important in the African context, characterized by low level of technological development, and is to be emphasized not only for cost effective utilization of scarce resources but also for acquiring the competitive edge in the global context. A range of ME specific competencies address this aspect and the ability to transform local national resources into products or services through value addition is central. Even under the ME Sciences cluster, the ability to translate knowledge into practice suggests that mere acquisition of knowledge is not enough and what is more important is, what can be done or realized with that. The Quality cluster completes the knowledge grouping of competency clusters, where apart from quality related aspects, safety and risk assessment is appropriately highlighted.

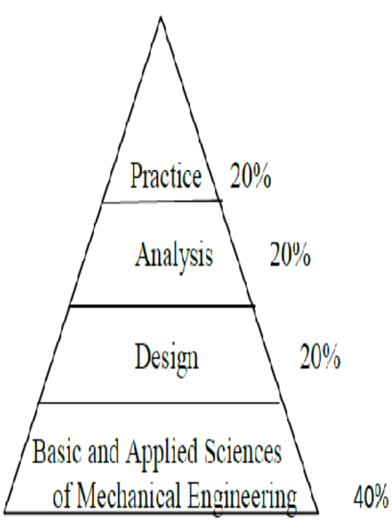

Figure 1: Core Elements of a First Degree in Mechanical Engineering

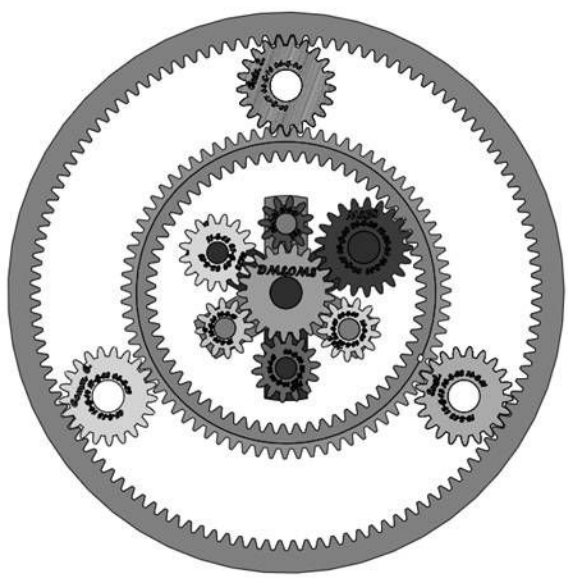

Figure.2: Mechanical Engineering Meta Profile: A Pictorial Version

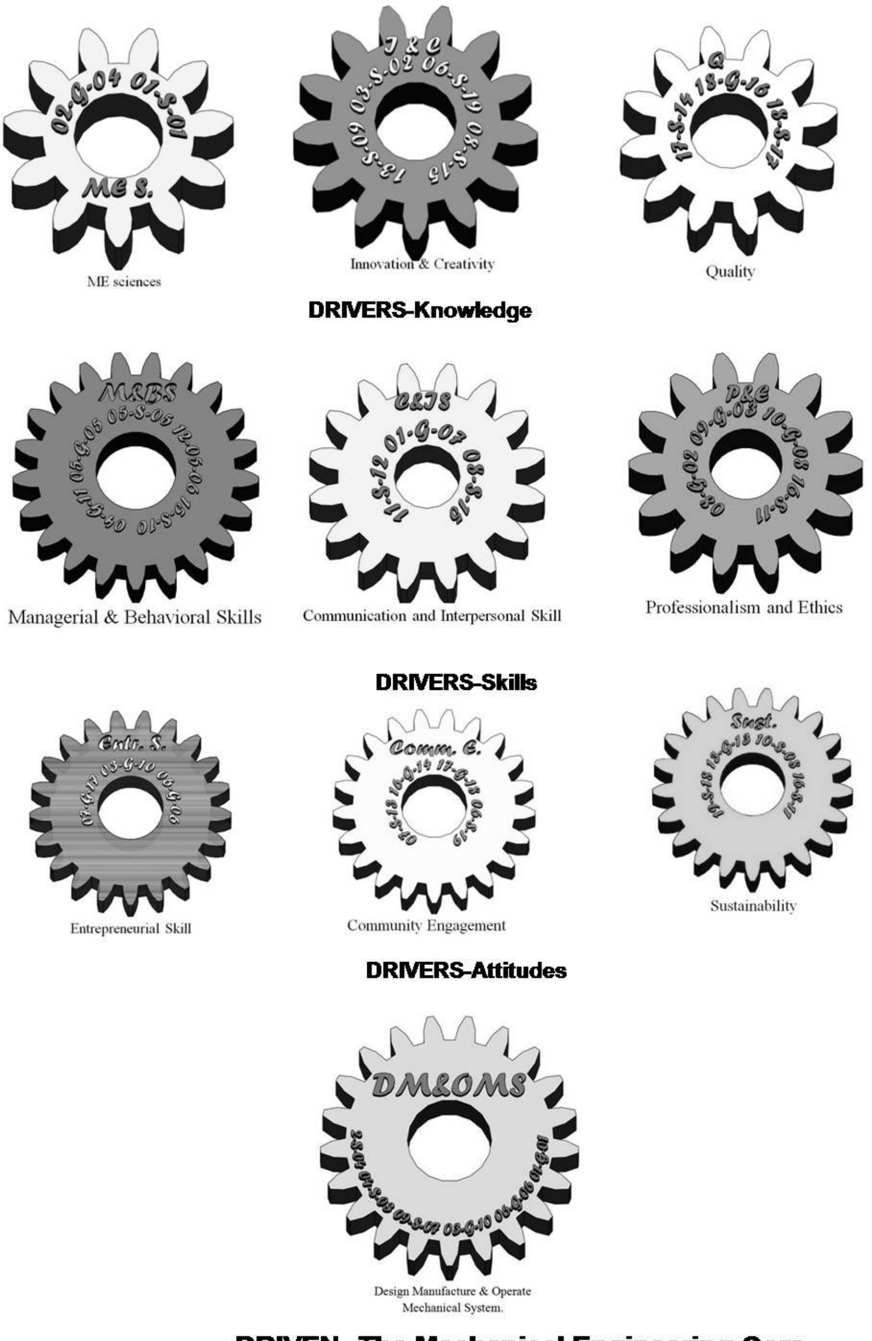

Figure 2(b): Competency clusters represented by gears-Drivers and driven.

Skills Cluster: A plethora of skills encompassing resource management (both material and human), practical problem solving, leadership, team work, cost effective decision making, planning, supervision, monitoring and execution of ME projects, needed by ME graduates is grouped under managerial and behavioural cluster. Communication (technical drafting/drawing as well as oral) is given due importance under communication and interpersonal skills cluster where the ability to use ICT is included.

Attitudes Cluster: Positive attitudes to serve the society and influence sustainable development forms the central theme under this cluster grouping. The entrepreneurial skills cluster with ability for creative and innovative thinking as the common thread signifies the need for entrepreneurial spirit, self-confidence and the capacity to use innovative and appropriate technologies for the context in hand. The community engagement cluster is an embodiment, of the need for leveraging ME solutions to societal problems and local community development. The need for sustainability outlook is portrayed by the abilities for socio-economic and environmental impact assessment of ME projects as well as life cycle assessment of products and systems as a separate competency cluster under this grouping. The integration of legal and financial aspects is again clubbed here due to its relevance. Strong emphasis on sustainability is especially called for in the curriculum profile in the present day context.

The Meta-Profile: With all the gears (drivers and the driven) assembled as shown in Figure 2, the linkages and the relation between different factors as well as the synergy between various competency clusters in delivering and realizing the ME core, i.e., *Design, manufacture and operate mechanical systems* can be easily understood. The inter-meshing gear teeth shows the common subset space between the two competency clusters and this is extended by the other gears in contact as well. The same thing can be felt through animation in electronic version of this report.

In order to construct the Meta-Profile, the ME core (hexagonal space visualized to reveal the core specializations as well as the core professional tasks presented earlier) is conceived to be inter connected and serviced by the 6 planets and the 3 outer spaces (apexes of each of the triangles)with the basis shown in Table 5.The 6 planets are ME Sciences, Innovation & Creativity, Quality, Managerial and Behavioural skills, Communication and interpersonal skills, Professionalism and Ethics while the outer spaces represent Community Engagement, Entrepreneurial skills and Sustainability. Thus the Meta-Profile arrived at is represented as shown in Fig. 3 below. The groups of competencies associated with each of the core, 6 planets and 3 spaces in Fig. 3 are written according to the following code: **Final Rank, Type: G or S, Original Order**. Thus, a competence coded as 08-G-02 is interpreted as: the generic competence, whose original order is (02) and final ranking is (08). From the original list, this competence is readily identified as: Professionalism, ethical values and commitment to Ubuntu (meaning “humanness” or respect for the well-being and dignity of fellow human beings).

Discussion

The Tuning project gives Africa an instrument which can improve teaching and learning methods with a view to enhancing the curriculum of higher education institutions. Analysis of consultation data for all-areas stakeholders of generic competencies and ME stakeholder groups of the proposed 19 subject-specific competences yielded a number of important general observations. Levels of importance were much higher than levels of achievement. Having developed and defined generic and specific competences and the detailed meta profile for ME, a comparison of the developed meta profile is then made with existing degree profiles. In general the following observations are recorded:

- There exists a remarkable coincidence between the two especially in the ME core area of designing, manufacturing and operations of ME systems.

Table 5: Construction of Mechanical Engineering Meta-Profile: Conceptual Basis

Core		Design, Manufacture and Operation of Mechanical Systems					
Core-Affiliated Competencies		02-S-04	04-S-03	09-S-07	03-G-10	06-G-06	01-G-01 14-S-16
Associated Planets							
Planet-1	Mechanical Engineering Sciences	01-S-01	02-G-04				
Planet-2	Innovation and Creativity	13-S-09	03-S-02	06-S-19	08-S-15		
Planet-3	Managerial and Behavioural Skills	04-G-11	05-G-05	05-S-05	12-S-06	15-S-10	12-G-09
Planet-4	Quality	17-S-14	18-G-16	18-S-17			
Planet-5	Communication and Interpersonal Skills	11-S-12	14-G-07	11-G-12	08-S-15		
Planet-6	Professionalism and Ethics	08-G-02	09-G03	10-G-08	16-S-11	15-G-15	
Outer Spaces							
Space-1	Entrepreneurial Skills	07-G-17	03-G-10	06-G-06			
Space-2	Community Engagement	07-S-13	16-G-14	17-G-18	06-S-19		
Space-3	Sustainability	19-S-18	13-G-13	10-S-08	16-S-11		

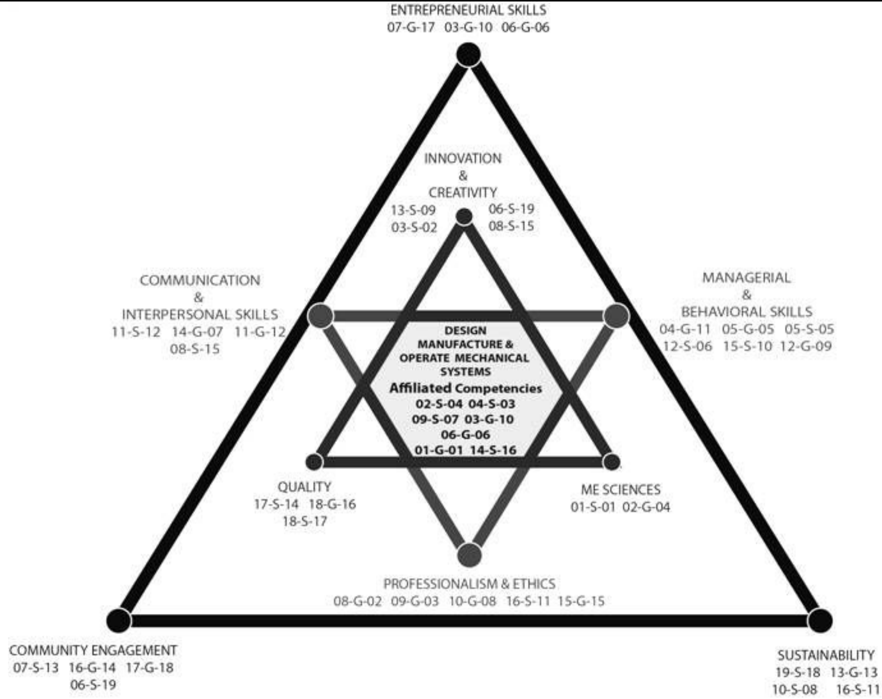

Figure 3: Graphical Representation of Mechanical Engineering Meta Profile.

- There was poor correlation between the two, with the existing lacking in emphasis in the areas of innovation and creativity, managerial and behavioural skills and quality
- Further, the existing has serious lack of emphasis in the areas of professional ethics, community engagement, environment and social economic impact assessment and product life cycle assessment.

- Other areas of highest differences between the two included commitment to African identity and provision of ME solutions towards sustainable development.
- Whereas some established degree programmes incorporated some aspects of the integration of legal and financial issues, and in others totally absent.
- It is agreed that the developed one is better than the existing, where in the developed one not only addresses current societal expectations upon a ME graduate but also takes care of the future expectations. Hence, there is a need to review and harmonize existing ones with the developed about which there is unanimous agreement in the ME-SAG.
- Therefore, it is imperative that the developed meta profile be validated by other key stake holders.

Concluding Remarks and Recommendations

In summary, 18 generic competences and 19 ME -specific competencies have been developed, analyzed and synergized, with input from stakeholders, to form a meta-profile that will inform the next phase of the project, which is the actual curriculum development.

The following future engagements are recommended to be pursued, as well:

- Deepening the process by defining detailed learning objectives and outcomes.
- Carrying out gap analysis between the existing curricula & the developed meta profile
- Extending the process to cover: Civil, Electrical and Chemical engineering disciplines.
- Developing generic competencies for all engineering disciplines
- Immediate future work must cover *validation*, *dissemination*, and *implementation*.

When the meta-profile presented is realized by a specific degree program profile, quality can definitely be ensured since the competencies expected can be demonstrated. When harmonization of degree profiles is carried out based on this meta-profile across Africa, mobility will be facilitated leading to exchange of expertise, experience and best practices among different African HEIs which in turn would contribute to capacity building and subsequently achieving quality from a sustainable perspective.

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