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Differences between Technicians and Engineers: An Analysis Based on UK-SPEC

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Abstract: *This work compares and contrasts the similarities and differences amongst Engineering Technicians (EngTech), Incorporated Engineers (IEng) or Technologists, and Chartered Engineers (CEng). It examines the competencies and commitment requirements of five (5) generic areas as specified by the United Kingdom Standard for Professional Engineering Competence (UK-SPEC). These areas are: Knowledge and Understanding (KU); Design and Development of processes, systems, services and products (DD); Responsibility, Management or Leadership (RML); Communication and Inter-personal Skills (CIPS), and Professional Commitment (PC). It is found that in KU there are two (2) similarities and eight (8) differences; in DD three (3) similarities and eight (8) differences; in RML three (3) similarities and nine (9) differences; in CIPS there are one (1) similarity and two (2) differences and in PC there is one (1) similarity and three (3) differences. These similarities and differences are articulated in keywords associated by specific roles and responsibilities. The study analyses a local context of job advertisements for recruitment based on UK SPEC, and looks at first level requirements for the five (5) generic areas of competence and commitment and does not analyse their specific guidelines. A case study was performed in which six (6) companies' job application advertisements were compared with that of the UK SPEC requirements for EngTech, IEng and CEng in Trinidad and Tobago. The findings suggested that Top Management (TM) of firms to clarify the blurred lines of roles, responsibilities and authorities between technicians and engineers. TM can use the findings of the research to assign specific problems to either EngTech, IEng or CEng. Also, their individual skills set could be pooled to improve the effectiveness of the teams to which they are assigned. An Engineering Competency Structure (ECS) is proposed which could be of immense value to engineering professionals in fostering better teamwork between the two, hence increasing their effectiveness and efficiencies.*

Keywords: *Chartered engineers, technologists, engineering technicians*

1. Introduction

Engineering pervades the environment in which we all live, providing us with all our needs, dreams and ambitions. The technicians and engineers who make this possible enjoy contributing to teams through technical endeavor to sustain and improve lives. They possess an incredible range of creative talent that is underpinned by their enquiring minds and balanced by their intellect and judgement (UK-SPEC, 2014).

According to the Institution of Mechanical Engineers, United Kingdom (UK), "Engineering is a profession directed towards the skilled application of a distinctive body of knowledge based on mathematics, science, design, materials and manufacturing, integrated with sustainability, business and management, which is acquired through education and professional formation in a particular engineering discipline" (IMechE, 2019). It provides the technological base by which both our basic and more complex needs are developed and supplied. Engineering qualifications and associated registration with regulatory bodies fall into one of the three (3) areas, namely: Engineer, Engineering Technologist and the Engineering Technician (UNESCO, 2003).

The exact names of the titles awarded to registered persons may differ from country to country. For instance, the Engineering Council UK registers the three tracks as Chartered Engineer (CEng), Incorporated Engineer (IEng) and Technician Engineer (EngTech), whereas Ireland registers Chartered Engineers, Associate Engineers and Engineering Technicians. In some countries, only the engineer and engineering technologist tracks are registered. In others, the registrations of engineering technicians have only recently been embarked upon (UNESCO, 2003).

In the United States of America (USA), the accrediting body for engineering programmes is the Accreditation Board for Engineering and Technology (ABET), which was formally the Engineers' Council for

Professional Development (ECPD). The goals of the ECPD were to be "an engineering professional body dedicated to the education, accreditation, regulation, and professional development of engineering professionals and students in the United States" (ABET, 2020). These goals are achieved through programmes which are accredited when they satisfy eleven (11) general criteria. However, these criteria do not distinguish between the Technician and the Engineer and may be the cause of why there is an ongoing debate among engineering and engineering technology educators which questions where baccalaureate engineering technology (ET) graduates fit within the spectrum of engineering and technical careers (Land, 2012).

There is no doubt that technicians and engineers are to provide the competence to us with an increasingly high standard of living. Their combined efforts are generally classified under the profession of engineering. In order to perform this function, technicians and engineers must be clear regarding their roles and responsibilities required to perform their duties.

In addition to the debate regarding where engineering technology graduates fit within engineering and technical careers, there is very little literature on the appraisal of industry's attitudes about and experiences with engineering technicians vis-à-vis engineers. In 2010, the Engineering Technology Council (ETC) of the American Society for Engineering Education (ASEE) conducted a study to compare industry experiences and attitudes about the skills and capabilities of Engineering Technicians (EngTech) versus Engineers based on the responses from two hundred (200) companies (Land, 2012). The results showed that engineering and engineering technologists are treated the same for most engineering roles.

In situations where a company hires either Technicians or Engineers into similar engineering roles, there is no guarantee that those hired perform with the same effectiveness (Land, 2012). EngTech, IEng and CEng graduates play specific roles. If these roles blur, this mighty lead to inefficiencies and ineffectiveness in their assigned jobs. This study seeks to reduce the chances of this happening by distinguishing the similarities and differences of five (5) generic areas of competencies and commitment that Engineers and Technicians must have or acquire.

2. Classification of Technicians and Engineers

According to the United Kingdom Standard for Professional Engineering Competence (UK-SPEC, 2014), 'Technicians' refer to Engineering Technicians (EngTech), whereas 'Engineers' are classified as Incorporated Engineers (IEng) and Chartered Engineers (CEng). The similarities and differences of specific roles amongst EngTech, IEng and CEng are articulated, so that engineering professionals would understand their roles and responsibilities in teamwork and engineering management.

EngTech apply proven knowledge and understanding in solving practical engineering problems; IEng apply current and developing technology in maintaining and managing engineering design, development, manufacture, construction and operation; CEng develop apply, analyse, synthesise and evaluate solutions to engineering problems using new or existing technologies, through innovation, creativity and change. In addition, they may be technically accountable for complex systems with significant levels of risk. IEng and CEng use science, technology, engineering and mathematics at a higher level than the EngTech.

3. Competence and Commitment of Technicians and Engineers

The UK-Engineering Council defines competence as "the ability to carry out a task to an effective standard", and commitment as the ability to show that "they have adopted a set of values and behaviours that will maintain and enhance the reputation of the profession (UK-SPEC, 2014). To achieve competence and commitment, technicians and engineers must possess the right level of knowledge, understanding and skill in addition to a professional attitude. They must demonstrate a personal and professional commitment to society, their profession and the environment. To achieve this goal they must adopt a set of values and behaviours that will maintain and enhance the reputation of the profession.

The UK-SPEC (2014) has five (5) generic areas for assessing the competence and commitment of Technicians and Engineers. These are:

1) Knowledge and Understanding (KU) - Knowledge is "information that can be recalled" Understanding: "is the capacity to use concepts creatively", for example, in problem solving, in design, in explanations and in diagnosis (IMechE, 2019);
2) Design and development of processes, systems services and products (DD);
3) Responsibility, management or leadership (RML);
4) Communication and inter-personal skills (CIPS); and
5) Professional commitment (PC).

4. Similarities and Differences amongst EngTech, IEng and CEng

Table 1 lists the roles of the EngTech, IEng and the CEng with respect to the five (5) generic areas. The descriptions of each class are in line with the general or policy requirements as indicated in the UK-SPEC. Table 2 provides a list of the keywords used to describe the roles of the EngTech, IEng and the CEng in these areas.

Firstly, two similarities are identified in the areas of Knowledge and Understanding (KU). These are:

Table 1. Five (5) Generic Areas of Competence and Commitment Amongst EngTech, IEng and CEng

Areas	**Technicians**	**Engineers**	
	EngTech	**IEng**	**CEng**
1) Knowledge and Understanding (KU)	- Apply proven techniques and procedures to the solution of practical engineering problems; and 1. Apply technical and practical skills; 2. Have the knowhow to do the job; 3 Be able to go beyond the immediate requirements of the job; 4. Use initiative and experience in solving or improving a problem or a process; and 5. Apply safe systems of work.	- Demonstrate the theoretical knowledge to solve problems in developed technologies using well proven analytical techniques; and - Use a combination of general and specialist engineering knowledge and understanding to apply existing and emerging technology.	- Demonstrate the theoretical knowledge to solve problems in new technologies; - Develop new analytical techniques by using a combination of general and specialist engineering knowledge and understanding; and - Optimise the application of existing and emerging technology.
2) Design and Development of processes, systems, services and products (DD)	- Demonstrate ability to: 1. Design; 2. Development; 3. Manufacture; 4. Construction; 5. Commissioning; 6. Operation; and 7. Maintenance.	- Application and demonstration of knowledge of known technologies and methods; and - Apply and demonstrate theoretical and practical methods to their: 1. Design; 2. Development; 3. Manufacture; 4. Construction; 5. Commissioning; 6. Operation; 7. Maintenance; and 8. Decommissioning.	- Application and demonstration of knowledge in developing innovative products and services; - Technically responsible for complex engineering systems; and - Apply and demonstrate theory and practical methods to the analysis and solution of problems.
3) Responsibility, Management and Leadership (RML)	- Demonstrate supervisory or technical responsibility; and - Able to show personal responsibility in seeing a process through to completion within specifications.	- Demonstrate responsibility for project management while leading and developing other professional staff; and - Provide technical and commercial management.	- Accountable for project, finance and personnel management; Conduct cost/benefit analysis between technical and socio-economic factors; and - Provide technical and commercial leadership.
4) Communication and Interpersonal Skills (CIPS)	- Show how the individuals: 1. Take part in discussions; 2. Make presentations; 3. Synthesise information; and 4. Be able to develop documents.	- Demonstrate effective interpersonal skills.	- Demonstrate effective interpersonal skills.
5) Professional Commitment (PC)	- Personal commitment to: 1. Become part of the profession; 2. Upload standards; 3. Code of Conduct; and 4. Obligation to society, profession, and environment	- Commit to and demonstrate professional values and standards respectively; and - Show obligations to society, the profession and the environment.	- Be able to communicate technical matters; - Commit to professional values; and standards respectively; and - Show obligations to society, the profession and the environment.

Source: Modified from UK-SPEC (2014)

Table 2. Keywords used to distinguish EngTech, IEng and CEng

Areas	**EngTech,**		**IEng**		**CEng**	
1) Knowledge and Understanding (KU)	Apply General Existing	Technical and practical Initiative and experience Solve	Apply Demonstrate General Specialist Existing	Emerging Analytical Techniques Combination Solve	Apply Demonstrate General Specialist Existing Emerging	Analytical Techniques Combination Solve Optimise
2) Design and Development of processes, systems, services and products (DD)	Contribute Design, Develop Manufacture Construct Commission Operate,	Maintain Products Equipment Processes Systems Services	Apply Demonstrate Design, Develop Manufacture Construct Commission Operate Maintain	Decommission Re-cycle Processes Systems Services Products Theoretical Practical Methods	Apply Demonstrate Innovative Products Services Systems Technical Responsibility	Complex Theoretical Practical Methods Analysis Solution Problems
3) Responsibility, Management and Leadership (RML)	Supervisory Technical Personal Accept Exercise	Responsibility Process Completion Agreed Targets	Responsibility Project Financial Planning Management	Leading Developing Professional Technical Commercial	Accountable Project Finance Personnel Management	Trade-offs Technical Socio-economic

Table 2. Keywords used to distinguish EngTech, IEng and CEng *(Continued)*

Areas	EngTech		IEng		CEng	
4) Communication and Interpersonal Skills (CIPS)	Show Contribute Discussions Presentation Read	Synthesise Write Information Documents	Demonstrate Effective	Interpersonal Skills	Demonstrate Effective	Interpersonal Skills
5) Professional Commitment (PC)	Personal Commitment Become Part of Profession Professional Institution	Code Standards Conduct Recognise Obligation Society Environment	Demonstrate Personnel Commitment Professional Standards Recognising	Obligation Society Profession Environment	Demonstrate Personnel Commitment Professional Standards Recognising	Obligation Society Profession Environment

1) EngTech, IEng and CEng must use KU to solve engineering problems; and
2) EngTech, IEng and CEng must use existing KU.

There are also several differences identified in KU as follows:

1) EngTech focus on practical problems, while IEng and CEng are trained to solve problems of diverted grounds;
2) EngTech rely on technical and practical skills in addition to initiative and experience while IEng and CEng rely on theoretical and analytical skills ;
3) EngTech use existing technology, IEng use existing and emerging technology while CEng use existing, emerging and new technology;
4) EngTech must have general KU while IEng and CEng must have a combination of general and specialist KU;
5) CEng alone are required to optimise the application of existing, emerging and new technology;
6) EngTech must apply KU, while IEng and CEng must apply and demonstrate KU;
7) EngTech have general KU, while IEng and CEng have general and specialist engineering KU;
8) Emphasis is placed on EngTech to apply safe systems of work.

Having regards the similarities and differences of KU, the EngTech must be a specialist in practical matters relating in his/her chosen field. The IEng must work with the EngTech in managing day-to-day operations. The CEng must work with both EngTech and IEng in ensuring that the effectiveness and efficiency of operations are continually improved.

Secondly, for the areas of Design and Development of processes, systems, services and products (DD), several similarities are identified. These are:

1) EngTech, IEng and CEng use DD for processes , systems, services and products;
2) EngTech and IEng design, develop, manufacture, construct, commission, operate, and maintain; and
3) EngTech and CEng are required to use practical and theoretical methods in DD.

On the other hand, the main differences identified in DD are:

1) Emphasis is placed on the EngTech to design and develop equipment;
2) EngTech contribute and demonstrate while IEng and CEng apply and demonstrate; CEng also innovates;
3) IEng and CEng use practical and theoretical methods;
4) IEng apply decommission and re-cycle;
5) IEng use established technologies to deliver projects;
6) CEng design and develop innovative products and services;
7) CEng are technically responsibility for complex engineering systems;
8) CEng analyse, synthesise, and evaluate solutions to engineering problems.

In essence, the EngTech contribute to DD; the IEng work with the EngTech in using DD for solving routine problems. The CEng are directly responsible for using DD for solving complex or non-routine problems.

Thirdly, regarding the area of Responsibility, Management and Leadership (RML), the EngTech act in a Supervisory role, whereas the IEng act as a Manager, and the CEng as a Leader. The main similarities amongst them include:

1) EngTech, IEng and CEng must be technical;
2) EngTech and IEng demonstrate technical skills; and
3) IEng and CEng deal with projects and finance.

There are also several differences identified. These are:

1) EngTech have supervisory or technical responsibility;
2) EngTech have personal responsibility for ensuring that the process is completed according to specifications;
3) EngTech and IEng have responsibility while CEng has accountability;
4) IEng demonstrate responsibility for management;
5) IEng has some responsibility for providing leadership to other professional staff;

6) IEng provide technical and commercial management;
7) CEng are accountable for project, finance and personnel management;
8) CEng manage tradeoffs between technical and social economic factors; and
9) CEng provide technical and commercial leadership.

Fourthly, for the area of Communication and Interpersonal Skills (CIPS), EngTech, IEng and CEng share the same role i.e., must be able to communicate and have interpersonal skills. On the difference side, EngTech must show CIPS through contributing to discussions, making presentations, reading and synthesising information and writing different types of documents while IEng and CEng must demonstrate effective CIS in every aspect of their work. In short, EngTech is responsible for his/her personal conduct, while the IEng and CEng are equally responsible for the overall conduct of the organisation.

Lastly, within the context of Professional Commitment (PC), EngTech are responsible for his/her personal development, while the IEng and CEng are equally responsible for the overall development of the organiation. One similarity in the area is that EngTech, IEng and CEng must have professional commitment. On the other hand, there are several differences identified, including:

1) EngTech make a personal commitment by becoming a professional, while IEng and CEng must demonstrate a personal commitment through actual work with others and the society;
2) EngTech make personal commitment to (a) the Code of conduct; and (b) an obligation to society, profession and the environment; and
3) IEng and CEng demonstrate commitment to (a) the professional standards; and (b) the obligations to society, profession and the environment.

Based on above analyses, it can be deduced that the work in each role is analogous to the responsibilities of the technician, manager and leader, respectively. The practical implication of this is that, engineering programmes whose goals are to produce either one or a combination of these positions can design and tailor their programmes to match the requirements of the technician, manager or leader. In this way, academic institutions, employers and accrediting bodies will become more aligned to the demands of industry.

5. A Case Study Based on the UK-SPEC

A case study was performed using six (6) engineering companies (i.e., A, B, C, D, E, and F) in Trinidad and Tobago (T&T). Job application advertisement forms for EngTech, IEng and CEng positions were obtained.. It was intended to analyse a local context of job advertisements for recruitment to see how much they complied with the UK SPEC key words. The study looked at first level requirements for the five (5) generic areas of competence and commitment but would not analyse their specific guidelines.

Based on the case analysis, Companies A and B had similar requirements for the EngTech position, C and D for the IEng position and D and E for the CEng position. The keywords from the advertisement of each type of profession were obtained. The keywords used were compared with the roles of EngTech, IEng and CEng with respect to the five areas of KU, DD, RML, CIPS, and PC. Tables 3 and 4 show the relationship for the EngTech requirements for companies A and B, and the IENG requirements for companies C and D, respectively.

From Table 3, Companies A and B had advertised for an EngTech in which the successful applicant must have KU in thirteen (13) of the twenty-two (22) required areas of expertise; DD in four (4); CIPS in one (1); and PC in one (1). This indicated that EngTech have been called upon to perform tasks that they have not qualified to do.

Table 3. Keywords Used for EngTech in Companies A and B

Company A,B	Eng Tech					IENG					CENG				
ENGTECH	KU	DD	RML	CIPS	PC	KU	DD	RML	CIPS	PC	KU	DD	RML	CIPS	PC
Service		X					X					X			
Repair	X														
Install	X														
Overhaul	X														
Expedite	X														
Minimise	X														
Assist				X					X					X	
Maintain	X						X					X			
Inspect	X														
Troubleshoot	X														
Replace	X														
Follow requlations					X					X					X
Read and work				X											
Test	X														
Adjust	X														
Support				X					X					X	
Skilled	X					X					X				
Calibrate		X					X								
Modifies		X					X					X			
Plans	X							X					X		
Informs				X					X					X	
Configures		X					X					X			

From Table 4, Companies C and D have been asking for IEng with expertise in KU in five (5) of the twenty-three (23) requirements, DD in four (4); RML in four (4); CIPS in seven (7) and three (3) in PC. Again as showed in the case with the EngTech profile, several expertise asked for would not be in the expertise areas of their applications. In this case, the two (2) missing areas were ‘trouble shooting’ and ‘repair’.

While extending the analysis to the relationship for the CEng requirements for companies E and F, the findings are summarised in Table 5. Results show that there were twenty-six (26) requirements for CEng. KU had six (6), DD had five (5); RML had nine (9); CIPS had five (5), and PC three (3). Moreover, it is observed that for three (3) types of engineering jobs (EngTech, IEng and CEng), each would be required to perform the roles and responsibilities of the other two (2).

Table 4. Keywords Used for IEng in Companies C and D

Company C, D	Eng Tech					IENG					CENG				
IENG	KU	DD	RML	CIPS	PC	KU	DD	RML	CIPS	PC	KU	DD	RML	CIPS	PC
Monitoring	X					X									
Coordinating				X					X						
Planning								X					X		
Operations		X					X								
Cost								X					X		
Quality					X					X					X
HSE					X					X					X
Process control		X					X								
Collect						X					X				
Analyse						X					X				
Maintain		X					X								
Direct									X					X	
Liase									X					X	
Train								X							
Develop		X					X								
Leadership								X					X		
Trouble shooting	X					X									
Work ethic					X					X					X
Team									X					X	
Reporting				X					X					X	
Writing skills				X					X					X	
Assist									X					X	
Repair	X					X									

Table 5. Keywords Used for CEng in Companies E and F

Company E,F	Eng Tech					IENG					CENG				
CENG	KU	DD	RML	CIPS	PC	KU	DD	RML	CIPS	PC	KU	DD	RML	CIPS	PC
Support									X					X	
Integrity										X					X
Sustainance												X			
Cost effective								X					X		
Design		X					X					X			
Opportunities						X					X				
Drive										X					X
Optimization											X				
Continuous Improvement								X					X		
Coordinate									X					X	
Manage								X					X		
Coach													X		
Mentor													X		
Prioritise											X				
Business												X			
Develop							X					X			
Deliver						X	X	X	X	X	X	X		X	X
Specialized						X					X				
Accountable													X		
Cross discipline						X					X				
Integrate									X					X	
Advise													X		
Conduct									X					X	
Lead								X					X		
Review								X					X		
Technical	X					X				X					

6. A Proposed Engineering Competency Structure

Figure 1 depicts a proposed Engineering Competency Structure (ECS) that shows the relationship amongst the core skillsets of the engineering professionals, including, the engineering technician, the incorporated engineer and the chartered engineer. The five (5) generic areas constitute the structure that could be used to build an organisation which fit persons with the relevant qualifications to posts or jobs in the industry.

For KU, EngTech solve practical problems while IEng and CEng handle problems of diverted grounds. EngTech have skills based on practical experience, while EngTech and CEng have theoretical and analytical skills. EngTech possess KU of existing technology, IEng possess KU of existing and emerging technology, and CEng have KU of existing, emerging and new technology. EngTech have general KU, while IEng and CEng have general and specialist KU. EngTech apply while IEng and CEng demonstrate KU. EngTech apply safe systems of work.

EngTech contribute to DD, while IEng apply and demonstrate DD and CEng innovate. IEng deliver projects while CEng design and develop products and services. CEng take responsibility for complex DD and solving engineering problems.

For RML, EngTech have taken responsibility, while IEng manage and CEng lead. EngTech have personal responsibility; IEng have some responsibility for leading and developing others, while CEng are accountable for personnel management. IEng have some responsibility for commercial management, while CEng have accountability for commercial leadership.

In areas of CIS, EngTech must be able to read, write, discuss, synthesise and make presentations, while IEng and CEng must demonstrate effective CIS. Lastly, it is the personal responsibility of the EngTech to make a professional commitment (PC), while IEng and CEng demonstrate professional commitment.

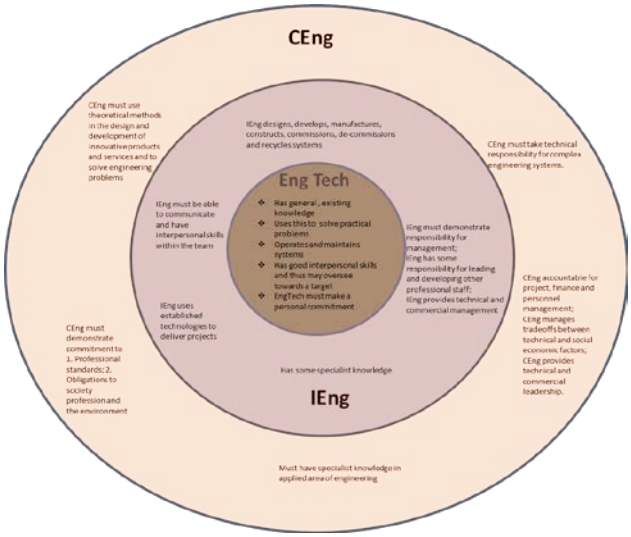

Figure 1. An Engineering Competency Structure (ECS)

7. Conclusion

The analysis of the similarities and differences amongst the five generic areas of the UK- SPEC shows that there are more differences than similarities, indicating that the roles and responsibilities of each are separate and distinct. These similarities and differences are articulated in keywords associated by specific roles and responsibilities (see Table 2). These keywords can be used by top management and supervisors in developing

job descriptions and assigning work instructions and in performance appraisals. They would give careful consideration when matching job specifications to required qualifications in performing most engineering roles

A case study was conducted involving six (6) engineering companies in Trinidad and Tobago. Their advertisements for EngTech, IEng and CEng were analysed, with respect to their keywords (which were compared with the keyword in Table 1). It was found that each type of engineering professional was required to perform the functions of the others. Individual skills set could be pooled to improve the effectiveness of the teams to which they are assigned. The study explored the similarities and differences amongst EngTech, IEng and CEng from a local context of job advertisements for recruitment based on the UK-SPEC. The proposed ECS could be of immense value to engineering professionals in fostering better teamwork between the two, hence increasing their effectiveness and efficiencies.

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