A CONTEMPORARY APPROACH TO ENGINEERING* EDUCATION

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*Engineering is used here to include Technicians, Technologists and Professional Engineers

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1. EXECUTIVE SUMMARY

This paper describes a holistic approach to engineering education at the post secondary level involving the HEART Trust / National Training Agency (Jamaica) and the University of Technology, Jamaica. It describes a seamless system of engineering education articulation that allows students to move across conventional boundaries of a national, Technical and Vocational Education and Training (TVET) system and a University's academic system.

2. INTRODUCTION

Traditionally, engineering education in British Commonwealth Countries has been designed on a three-tiered system. This is schematically shown in Figure 1. Jamaica, over the years has adopted this model, which in the opinion of the authors, has not served the country well.

It has splintered Jamaica's meagre resources, both from a physical and human resources point of view. Further, it has contributed to the very wide social divide amongst its people.

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The discussion that follows will amplify the above points and show how a contemporary approach as depicted schematically in Figure 2 is used to benefit and maximize best practice in the Jamaican labour market.

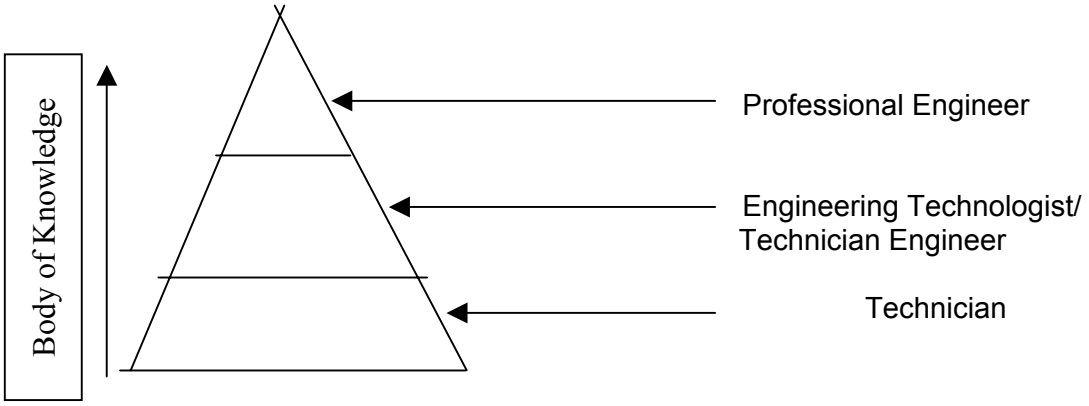


FIGURE 1 – THREE TIERED MODEL USED IN ENGINEERING EDUCATION

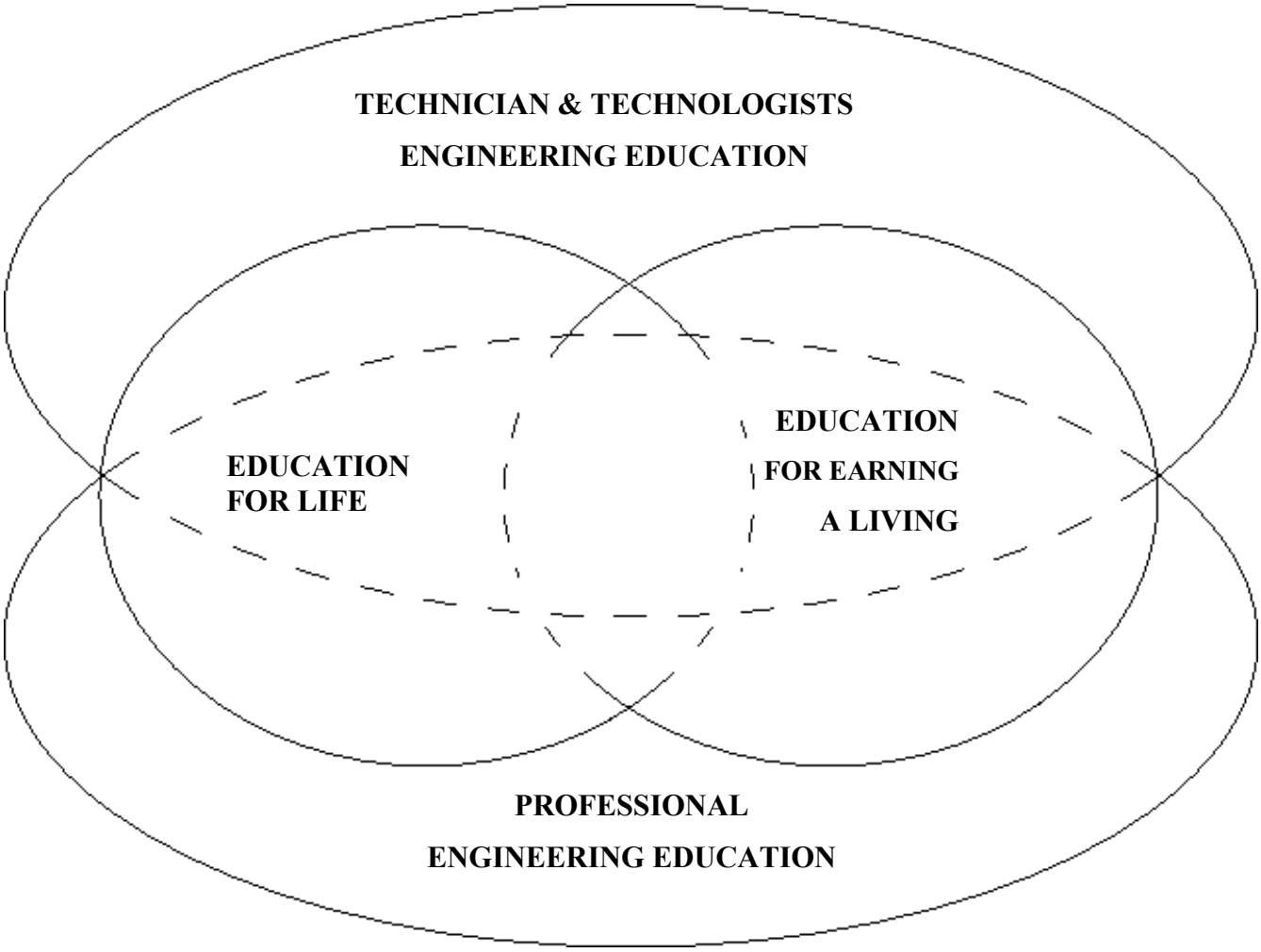


FIGURE 2: CONTEMPORARY MODEL FOR ENGINEERING EDUCATION

3. THE FORMATION PROCESS

The formation debate – "forming" one to become:-

- **a** Professional Engineer;
- **an** Engineering Technologist;
- **a** Technician;

has never been a subdued one. In most countries in which this hierarchical-based engineering education system has been on the agenda, the majority of commentators appeared to have adopted an elitist approach to compartmentalise each of these levels, without allowing credit transfer from the base to the apex.
(See Figure 1).

Another feature of the debate has been the suggestion by some in universities, that the "formation" of Technicians and Technologists is appropriate for other post-secondary training institutions, but not for university education. Implicit in this posture is the dualism between education and training; between thinking and doing; between theory and practice; between the intrinsically worthwhile and the useful; which bedevils our deliberations on education. The authors find this to be an unacceptable proposition hence throughout this paper no distinction is made between education and training. There exists a difficulty in seeing training as being a different kind of activity from education when applied to the learning processes that engage students to study and pass examinations. To the extent that training means learning to do something without understanding how or why, extrapolates to mean an inferior form of education.

Further, it is economically and sociologically myopic to consign a particular group of students or kind of work roles to a learning programme, which makes such an assumption. This notion has not served small island states, such as Jamaica well as empowerment skills – to enhance business competitiveness have eluded the nation. Indeed, the Labour Market Information Newsletter of Jamaica[1] alluded to this in examining the "soft skills" and their importance to nation building.

Further, if one examines all major advances in educational provision in the United Kingdom, it would show a direct underpinning of the nation's industrial and commercial needs.

3.1 Some repositioning points where educational provisions underpinned the UK's Industrial and Commercial needs[2] include:

1870 the foundation of the first state schools coincided with the end of a period of great prosperity, the beginning of the challenge by Germany and the USA to the U.K's industrial supremacy, and the realization that industrialization required a literate work force.

1902 the Balfour Act followed humiliation in the Boer Wars, the belief that this was linked to technical decline, and a need to compete more successfully with Germany.

1944 Butler's Act was related to the need for post-war industrial regeneration, led to the opening of higher levels of secondary education to non-fee payers and introduced grants for university under-graduates.

1960s the comprehensive re-organisation of secondary education occurred at a time of labour shortages.

1980s large-scale provision for vocational education (whether in schools and colleges or through Youth Training Scheme, for those who have left school) is a response to the collapse of the U.K's traditional manufacturing industries and the U.K's failure to compete with more technologically and commercially advanced nations.

According to Wallace, whatever the controversies caused by each of the first three developments, they all improved the general standard of education and widened opportunities. Hence, when a prescription is sought for future action in the field of Technical and Vocational Education and Training (TVET), consideration must be given both to programmes aimed at the development of the individual through understanding of technology and science and the mastery of practical skills, as well as programmes aimed at the preparation of the individual for employment in a particular occupation.

The School of Engineering, at the University of Technology Jamaica (UTech), has had a long history in innovative interventions in the engineering education process. Indeed, Davis[3] cites and has applied, Applied Behavioural Science (ABS) principles in an effort to institute these changes on a planned basis. From the period of 1958 to 1979, the Engineering Department, as it was called then, followed structures and strategies, typical of the British model, depicted in Figure 1 (up to the Technician Engineer). The Department made extensive use of two British examination bodies: the Union of Lancashire and Cheshire Institutes (U.L.C.I.) and the City and Guilds of London Institute (C.G.L.I.).

According to Davis, "by 1976, the challenges were, how to bring about creativity and innovation in the educational process that would better underpin Jamaica's industrial needs. Upon till then, a dependency syndrome, which had developed had virtually transformed staff members to mere mechanical tools in the process". The plan, which had been devised for engineering restructuring, included provisions for "Home Certification" for four sets of programmes:

1. Modular courses;
2. Part-time day release courses leading to the award of a Certificate;
3. Full-time courses leading to the award of a Diploma;
4. Full-time or Part-time courses leading to the award of a Degree.

The programmes were introduced on a phased basis, with the full-time degree programmes being introduced in the year 2001.

After decades of discussions about the divide between the TVET system and the Academic System[4], the contemporary approach now gaining acceptance is to fuse formal education, education for earning a living, education for life and informal education into a holistic model. As is depicted in Figure 2, they are not mutually exclusive. This recognition has been influenced by the evolving new work order; a revolution in information technology; the increasing adoption of a client-friendly; customer oriented business practices and the growth in the number of knowledge-based industries and organisations.

4. A Model for a Highly Articulated Engineering Training System

As the nation's leading technical and vocational training institution, UTech is committed to anchoring and leading collaborative activities to establish a high quality and cohesive post-secondary training and certification system for Jamaica.

As the National Training Agency, HEART Trust/NTA, in its role as training system co-ordinator, is committed to the proposition that UTech constitutes the pinnacle of the technical and vocational training system in Jamaica, and supports the idea that the post-secondary training system in Jamaica should allow for movement of trainees through the entire system from the vocational levels into tertiary institutions, and for the sharing of resources among training institutions to produce greater numbers of better trained and more highly qualified members of the labour force.

4.1 The UTech/HEART/NTA Model

In order to move from a rather "straight jacketed" approach of delivering engineering education to a more contemporary model that would better meet the needs of the nation, some issues had to be resolved.

4.2 Issues to be Resolved

- UTech's programmes had no provision for articulation with HEART/NTA system;
- Rationalisation of the use of scarce, physical and human resources was not made;
- Performance criteria/learning outcomes were not harmonized between the two systems;
- Status divide existed between the two institutions. Unfortunately, the further education sector in Jamaica is distinguished from higher education sector by the title VET (Vocational Education and Training), which perpetuates this unfortunate view;
- Matriculation requirements based on status quo;
- End users aloofness;
- Greater workplace reliance.

A Memorandum of Understanding[5] was signed between UTech and HEART/NTA in June 1997. The overall framework for co-operation reflects the commitment of both institutions to several principles.

5. Institutional Principles

These principles include:

- Mutual interest in the areas of programme development, training and upgrading of teachers and instructors, optimizing the uses of workshops and labs, and in assisting students and trainees to navigate the education and training system.

- Recognition of the role of the National Council for Technical and Vocational Education and Training (NCTVET) as the entity responsible for setting occupational and programme standards, certifying trained persons for occupations and accrediting TVET programmes. This recognition also indicates a joint commitment to the standards-driven, competency-based approach to preparing individuals for the world of work.

- Resource sharing and avoidance of duplication of effort.

- Financial support from the HEART Trust Fund to UTech and technical assistance from UTech to strengthen programming at the NCTVET (occupational) Levels 1, 2 and 3. (See attachment # 1)

- Institutional advancement in the areas of instructor/teacher preparation, staff development, programme development, technological development, entrepreneurship development, and implementation of community service initiatives.

- An increasing involvement in Caribbean regional efforts to reform and strengthen the education and training systems.

6. Collaborative Framework

The overall framework of the co-operation includes provision for a jointly constituted Institutional Co-operation Committee (ICC) and various Sub-Committees set up to address specific areas of co-operation and collaboration, such as:

- Articulation and Programme Development Activities;
- Training and Professional Development of Technical Teachers and Instructors;
- Entrepreneurial Skills Development Activities;
- Technology and Productivity Improvement Initiatives;
- Community Service Initiatives;
- Research Activities;
- Public Education Activities;
- Professional Development Activities and
- Joint Ventures in Professional Services.

A joint Committee has been formed to implement the co-operation efforts. The Committee is jointly chaired by the President, UTech and the Executive Director, HEART Trust/NTA, and meets regularly to review progress on current initiatives, for joint planning, and to examine ways and means to further deepen the co-operation. The Committee is comprised of senior personnel from each institution, appointed by the President, University of Technology and the Executive Director, HEART Trust/NTA.

The above initiatives brought into force an overall framework for co-operation, to include other areas (outside of engineering) of collaboration. These include:

6.1 Preparing TVET educators

Here synergies between the Faculty of Education and Liberal Studies at UTech and the Vocational Training Development Institute (operated by HEART/NTA), resulted in the development of a Bachelor of Education programme for TVET educators.
Both institutions agreed to phase out their existing programmes in favour of this joint effort.

6.2 Levels 4 and 5 Hospitality Accounting

The School of Business Administration at UTech in collaboration with the NCTVET, have combined resources to develop these modules which would be delivered by UTech.

6.3 Preparation of Engineering Technicians

This initiative is the primary example we are submitting as evidence of the contemporary approach to engineering education.

7. A Paradigm Shift

The models for engineering training that both institutions had followed prior to the dovetailing of both programmes are depicted in Figures 3 and 4. As can be seen, both institutions offered programmes leading to the award of technician engineer. Both models were designed without articulation, which created borders that did not allow cross-fertilization between programmes. The outcomes of such a system impact on students having to spend too long on their study, should they wish to access programmes across "boundaries".

Several meetings were held among stakeholders, to resolve the issues raised at 4.2, page 8. These discussions led to an agreement between UTech and National Tool and Engineering Institute (NTEI) for:

- mixed entry requirements to pursue a common first year programme;
- the second year (depending on examination profile) students will be placed partially on courses to satisfy NTEI's occupational levels or UTech's Engineering Technician Certification.

This is depicted schematically in Figure 5.

Students are registered under the joint agreement and attend both institutions, thereby, maximizing the human and physical resources.

The depth of common courses, is gradually reduced from the second year to the third year. This allows for greater emphasis to be placed on the orientation of the desired learning outcomes of the programme.

The model allows students to access points within the programme in a meaningful way to fit into a prescribed job market. It also allows re-entry into programmes, where exemption from courses passed will be given.

Further, the model reduces what is termed "wastages" where students spend time year after year repeating courses that they have failed, and are unable to position themselves for employment into a prescribed job market.

Finally, the model allows, also for students completing HEART/NTA programmes to fit into UTech's programmes with the necessary exemption of requisites. This type of holistic contemporary approach to engineering education, allows for flexibility and mobility of engineers to fit job market requirements. It is also a first step in the process to blur the divide between Vocational and Technical Engineering education.

8. Conclusion

After a year of discussion and design with stakeholders, the articulated Engineering Technician programme was launched in September 2000. The total number of students enrolled on the programme is twenty-seven. The status of students after the first year examination results are as follows:

STATUS	NUMBER OF STUDENTS
Promote to ETC 2	17
Promote to NTEI – Level 2	4
Make Good	5 (3 Subjects)
Make Good	1 (4 Subjects)
Total	**27 Students**

The results are most encouraging, which show that potentially all the students will move forward at a pace suitable to their needs, as a consequence of their results. Although this is the first year of the programme, it should be noted that no "wastages" took place. Hitherto, these students would have access the ETC programme offered at UTech on a day release basis, without the industrial attachment components. The "wastages" under this situation were unacceptable high.

Overall, in the first year, the programme outcomes achieved the stated objectives, but most importantly students are able to negotiate the engineering education and training systems in a more coherent way. It is envisaged that this type of training will make a better fit for the nation's industrial needs.

Attachment # 1

OCCUPATIONAL CERTIFICATION
GENERAL FRAMEWORK FOR OCCUPATIONAL LEVELS
National Council On Technical And Vocational Education And Training

LEVEL 1: ENRY-LEVEL: SEMI-SKILLED, APPRENTICE, SUPERVISED WORKER

Recognises competence in a significant range of varied work activities performed in a variety of contexts. Work activities range from simple and routine to more complex and non-routine involving some individual responsibility and autonomy. Collaboration with others through work groups or teams may often be a requirement. Substantial supervision is required especially during the early months evolving into more autonomy with time.

LEVEL 2: SKILLED WORKER: TECHNICAL/SPECIALIZED INDEPENDENT WORKER (LICENCED, ETC)

Recognises competence in a broad range of varied work activities performed in a wide variety of contexts, most of which are complex and non-routine. Considerable responsibility, autonomy, control, teamwork and guidance of others are required.

LEVEL 3: TECHNICIAN, SUPERVISOR, BASIC INSTRUCTOR/TRAINER

Recognises competence in a broad range of complex, technical or professional work activities performed in a wide variety of contexts and with a substantial degree of personal responsibility and autonomy. Responsibility for the work of others and the allocation of resources are often a requirement. The individual is capable of self-directed application, exhibits problem solving, planning, designing, and supervisory capabilities. With additional specialized training can provide basic instruction.

LEVEL 4: MASTER CRAFTSMAN, TECHNOLOGIST, MANAGERIAL, ENTREPRENEUR, ADVANCED INSTRUCTOR/TRAINER

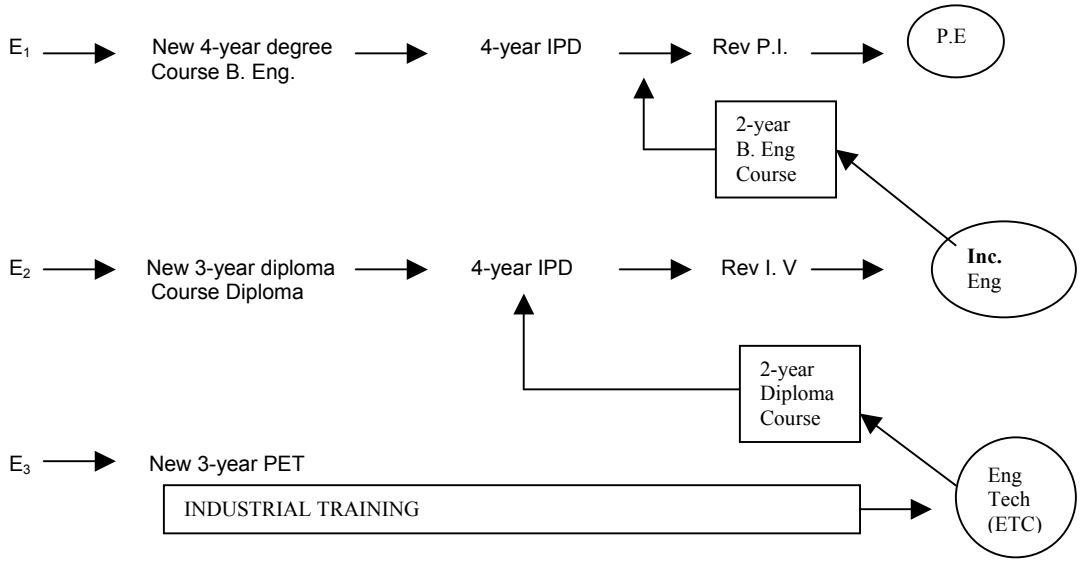
Recognises competence involving the application of a significant range of fundamental principles and complex techniques across a wide and unpredictable variety of contexts. Very substantial personal autonomy and often significant responsibility for the work and training of others and for the allocation of substantial resources, as well as personal accountabilities for analysis, diagnosis, design, planning, execution, and evaluation.

LEVEL 5: CHARTERED PROFESSIONAL AND/OR MANAGERIAL

Recognises the ability to exercise personal professional responsibility for the design, development, or improvement of a product, process, system or service. The award recognizes technical and managerial competencies at the highest levels and may be regulated by statutes and professional organisations, and may have several additional levels of award.

Memorandum of Understanding - Sept. 2000

ENGINEERING PROGRAMME AT UTECH



P.E.	=	Professional Engineer
Inc. Eng.	=	Incorporated Engineer (Engineering Technologist)
IPD	=	Industrial Professional Development
Rev P.I.	=	Relevant Industrial Interview (Professional interview)
PET	=	Part-time Engineering Technicians
E_1	=	5 CXC plus one year Pre-Requisite Course of Study
E_2	=	4 CXC or Preliminary Engineering Course of the requisite GPA
E_3	=	3 CXC or Preliminary Engineering Course at the requisite GPA
ETC	=	Engineering Technician Certificate

FIGURE 3

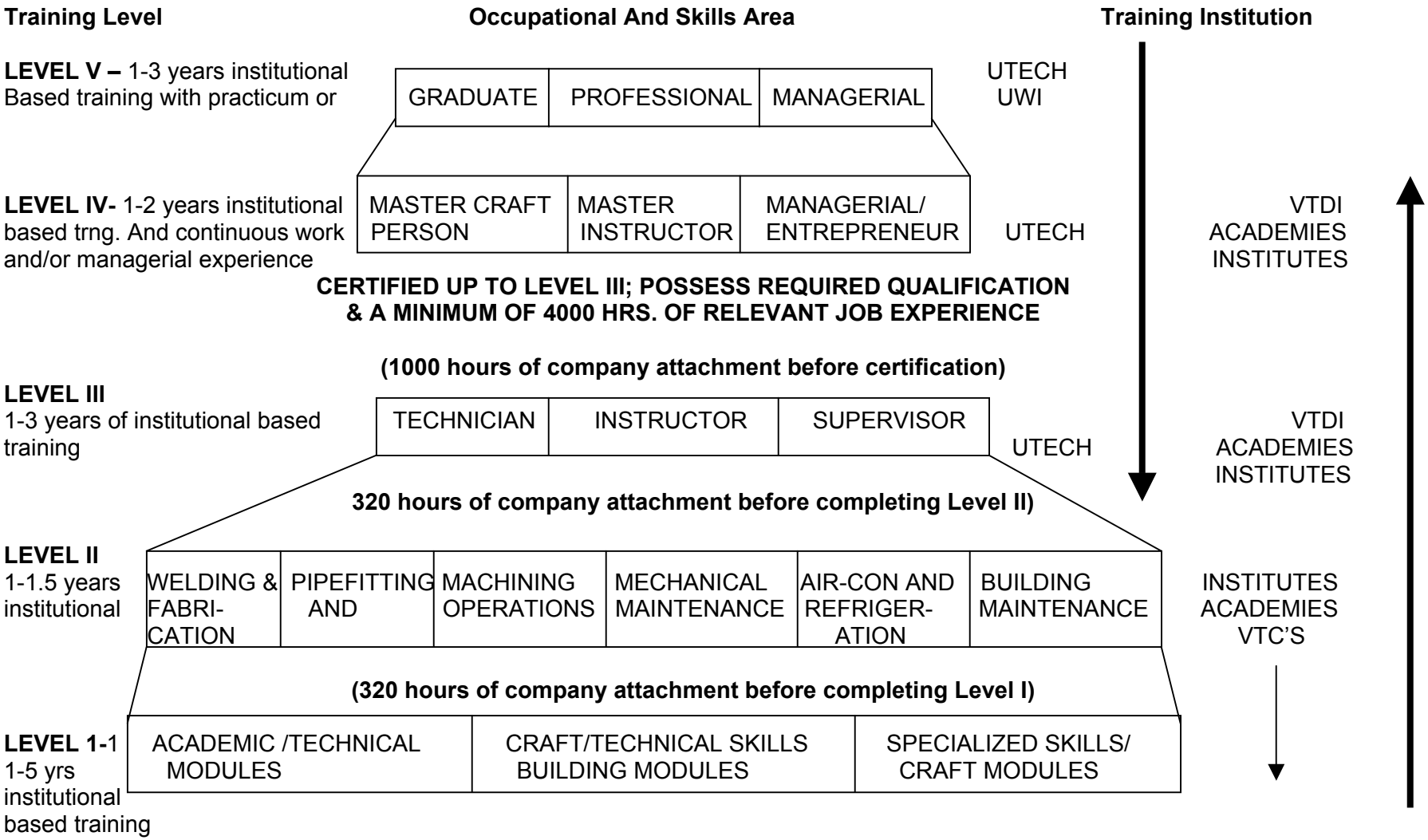


FIGURE 4 - HEART TRUST/NTA MECHANICAL MAINTENANCE SKILLS TRAINING PROGRAMME MODEL

COLLABORATIVE MODEL

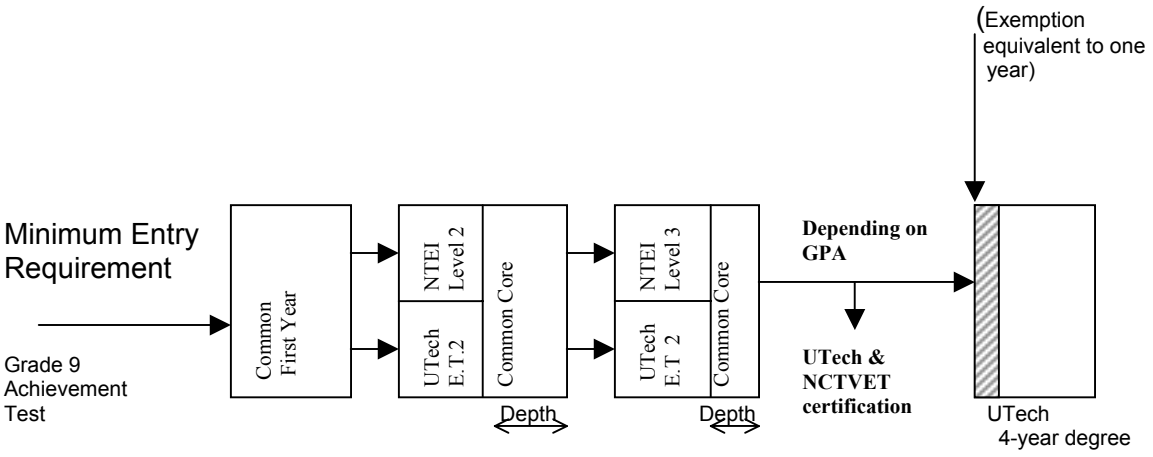


FIGURE 5

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