

## Functional Education in Petroleum Engineering in Nigeria: Expectations and Benefits

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### Abstract

The educational system for the training and capacity development of our engineers in the tertiary institutions in Nigeria, has greatly decayed to a low level. We see a critical shortage of skilled staff of relevant experiences, in the mid-level, and subsequently, top management positions, needed to effectively drive operations and grow assets, in the Petroleum Industry. This is particularly evident in the Marginal Fields and small indigenous companies in Nigeria. In this paper, we seek functional education for petroleum engineering in Nigeria, with new trends in training, capacity building, and best practices, to fully drive and sustain growth and emerging expectations in the future oil and gas industry. We posit critical decisions to define future direction of engineering education, especially, petroleum; admission requirements for entry level students; and inclusive synergy for all stakeholders, are major requirements to functional education in Nigeria. We present ideas, and infer that best practices, with effective synergy among stakeholders, hold the key to grow and sustain quality petroleum engineering education in Nigeria. Centres of excellence in capacity building are proposed to deliver the needed human resource to qualitatively drive the future oil & gas industry to excellence. Functional engineers will be available for employment; leading to sustainable growth of the petroleum industry, especially, for the indigenous companies, expected to play greater role in growing reserves for both crude oil and natural gas. Being the major sources of our GDP, the economic impact of these additional reserves of petroleum resources, from the functional education of potential petroleum engineers, will greatly accelerate the transformation agenda of the Federal Republic of Nigeria, through the availability of more funds to the government, to drive development.

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**Keywords:** training, capacity building, functional education, functional engineers, GDP, Nigeria.

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### INTRODUCTION

Petroleum resources – crude oil and natural gas assets, form the backbone of the economy of Nigeria, which have greatly impacted in the continuous search for development and growth. In Nigeria, the Petroleum Industry remains the most active and important industry, with emerging trends, such as:

- The greater exploration in our deep and ultra-deep environments
  - The discovery of very important fields: Bonga, Akpo, Erha, and Agbami
- The introduction/emergence of new technologies for these environments
  - Floating, Drilling, Production, Storage, and Off-loading Vessels (FDPSO)
  - Smart fluids for High Pressure, High Temperature
- The greater synergy between core petroleum engineers and non-core human resource
- The urgent need for highly skilled and talented manpower (Idigbe and Onaiwu, 2011; Idigbe and Onwuachi-Iheagwara, 2013)

The human resource is the key to the success of the petroleum industry in Nigeria. A gap is developing in the mid-level, and ultimately, the top management

level of companies in the industry, due to the age and retirement of very skilled and talented manpower. The human resource will drive the operations, technology, and funds. Critical decisions will be made that will impact on operations, choice of technology, funding strategy, and QHSSE (Quality Health, Safety, Security and Environment). Thus, the industry will desire key metrics, such as

- Creativity in the Human Resource.
  - Engineering professionals,
  - Geo-systems professionals,
  - Technical professionals, and
  - Allied professionals – legal, economics, sociology, etc.
- Sustained research & development, leading to Emerging new Technologies.
- Best practices in operations, with the emerging of New models for Financing Development Activities.

Will the local content be able to meet these metrics in the future? In this paper, we seek functional education in our tertiary institutions, to provide the local content, which will play a most important part in the success of the future petroleum industry in

Nigeria. We present solutions, such as centres of excellence in engineering education, for the training and capacity building of our future engineers, especially, petroleum engineers. Table 1 shows the basic areas, that the future oil & gas industry in Nigeria, will need smart work force, to drive operations. We believe that the tertiary institutions, well-endowed through functional education, will meet the metrics.

**The State of Petroleum Engineering Education in Nigeria**

Supposedly, petroleum engineering education is available in several universities in Nigeria, but mainly at:

- The University of Ibadan, Ibadan, Oyo State
- The University of Benin, Benin City, Edo State
- The University of Port Harcourt, Port Harcourt, Rivers State
- The Federal University of Technology, Owerri, Imo State

These universities run a five year curricula, in 100, 200, 300, 400, and 500 level programs. However, over the years, we have seen standards get below what the petroleum industry considers to be a minimum requirement for employment. We see companies such as SPDC and Total set up remedial training centres to facilitate the upgrading of first degree graduates to their minimum standards. What are the probable reasons for these low standards in the universities? We posit the following:

- Admission requirements (procedures for) of candidates
  - Quality of Candidates
- Emphasis on academic training, without regards to capacity building, of students
- Static curricula
- Quality of Teachers
  - Ethics, Best Practices

Table 1: Some Areas of Need for the Oil & Gas Industry in the Future

Core Engineering	Technical Services
Exploration Engineering <ul style="list-style-type: none"> <li>▪ Geo-sciences/systems</li> <li>▪ Well Construction</li> </ul>	<ul style="list-style-type: none"> <li>▪ Static Modeling</li> <li>▪ Drilling Activities: Designs, Well Construction, Logistics.</li> <li>▪ Project Management</li> </ul>
Reservoir Engineering <ul style="list-style-type: none"> <li>▪ Reservoir Identification</li> <li>▪ Reservoir Evaluation</li> <li>▪ Reservoir Management</li> </ul>	<ul style="list-style-type: none"> <li>▪ Dynamic Modeling: Reservoir Software, ICT</li> <li>▪ Interpretations, Best Practices</li> <li>▪ Preparation of Reports</li> </ul>
Production Engineering <ul style="list-style-type: none"> <li>▪ Facilities Engineering</li> <li>▪ Production Engineering</li> </ul>	<ul style="list-style-type: none"> <li>▪ Production Optimization and Management</li> <li>▪ Best practices</li> </ul>
Environment Engineering <ul style="list-style-type: none"> <li>▪ QHSSE: Quality Health, Safety and Security</li> </ul>	<ul style="list-style-type: none"> <li>▪ Impact Assessments and Audits of Projects</li> <li>▪ Community Relations</li> <li>▪ Best Practices</li> </ul>

We think the universities should offer petroleum engineering education, instead of petroleum engineering training. Training involves mainly classroom and laboratory instructions. Although, we have 400 level students sent on industrial training for six months, to supposedly, acquire skills, this process has not really fulfilled the desired capacity building of our students. Most often, the right spaces are not available for these students to participate in right skills acquisition. Thus, for the six months, many of these students are left in offices, or some don't even have places to do this program. The universities should provide internal places for the students to acquire the right skills, to complement the classroom instructions.

We define education as the upbringing of an individual having talents, to a desired (standard) competence, through impacting knowledge (training) and qualities (capacity building) that are expected to enhance the capability and usefulness of the individual, to society, as shown in Figure 1. We posit ethics as a basic quality. Ethics, the metrics, that

define the character – Quality of an individual, are the foundations on which education becomes functional. Functional education demands:

- Responsibility from all stakeholders
- Clear mandates and proper direction at all levels
- Workable and effective tools for teaching, learning, and capacity building
- Dynamic trends in mandates, from effective synergy with industry
- Best Practices – Creativity, Leadership, Critical decisions, Commitment, and Productivity

Best practices are in critical shortage in our tertiary institutions. Quality and functional petroleum engineering education must be re-introduced into tertiary institutions. This is particularly necessary now, as we see increasing critical shortage of skilled staff of relevant experiences, in the mid-level, and subsequently, top management positions, needed to effectively drive operations and grow assets, in the Petroleum Industry. Innovativeness and emerging

trends should be constantly available, as we believe this approach will be more cost effective and beneficial to all stakeholders – students, teachers, and the industry. Table 1 reminds us of the basic needs of the petroleum industry in the future, especially, as the industry goes into harsher and deeper marine environments, with high pressures and temperatures. Will our tertiary institutions deliver the human resource, which will drive the industry to success? The Federal Government and industry demand and expect safe and greener environment. Quality health, safe and secure environment must be available for the work force and host communities.

### **Challenges to Functional Petroleum Engineering Education**

We believe functional education for petroleum engineering can be attained in our tertiary institutions. However, four basic challenges confront petroleum engineering education, and will definitely impact on functional education in the future. We posit these challenges as:

- Low level of best practices
  - In teachers and students
- Static curricula
- Career dynamics – Definition and development
  - Capacity definition and development; Competency acquisition
- Tools and trends for functional education

At present, we see critical decisions that are impacting very negatively to petroleum engineering education, namely:

- Un-necessary requirement by the NUC, for all teachers to acquire the PhD degree, to teach petroleum engineering, without regard to quality of the teacher, to deliver on his responsibilities – training and capacity building of the student
- An ever increasing number of in-takes for entry level, not minding lack of space and infrastructure for these students
- Salary and promotion structure for the petroleum engineering teacher. Uniform structure for all university academics, will not attract the right (best) personnel to teach petroleum engineering. The best graduates are attracted to the industry, where he will make about five times what he will get at the entry level in the university system.

Creativity, innovativeness, leadership, and commitment, are best practices, which are urgently desired in our teachers and students. The industry needs a greater synergy with the universities, in the area of dynamic curricula, to reflect current and emerging trends in core engineering (Table 1). The

department of Petroleum and Geo-Systems Engineering, at the University of Texas, Texas, USA, reflects the importance of core petroleum engineering students, acquiring very good working knowledge in the geo-systems, especially, geology and geo-physics. We believe our universities should adopt this trend. Our graduates must be effective in assets teams, with working knowledge in the geo-systems. Proper admissions criteria remain key metrics, for creative students, into our tertiary institutions, for petroleum engineering education.

### **A Case Study of the University of Benin – Positive Trends**

Figure 2 shows the main paths for petroleum exploitation. As the industry goes into harsher and deeper marine environments for petroleum exploitation, these paths become highly dynamic in creativity, curricula, and technology. Each department of petroleum engineering is expected to address each path, to deliver quality education to the students. We ask basic questions, namely:

- Is the department of petroleum engineering at the University of Benin sufficiently positioned to do this? No.
- Are they new trends been evolved to drive petroleum engineering education to sustainable and quality growth in the department? Yes.

At present, sufficient geo-system courses are not taught in the department, to effectively position each graduating student, with proper working knowledge of geology and geo-physics. Asset teams are assembled in companies to effectively exploit petroleum reserves from geologic structures, the reservoirs. Very good knowledge of geology and geo-physics should be impacted to petroleum engineering students in the course of their education.

At the department of petroleum engineering, University of Benin, only one course, “Petroleum Geology”, is available to the students at 300 level, in their five year program, levels 100 to 500. We believe this is not sufficient to effectively acquire a good appreciation of “geology” in petroleum. As shown in Table 2, we call for a minimum of two courses in geology and geo-physics, for a good working knowledge of the role of geo-systems in petroleum exploitation. The departments of petroleum engineering, geology, and geo-physics, should synergize, to educate their students properly, in petroleum knowledge. By February 2014, no such synergy existed between these departments at the University of Benin, who are supposed to educate their students that will drive the asset teams in E & P companies.

However, we see three emerging and positive trends that are expected to impact on the quality training and

effective capacity building of petroleum engineering students at the University of Benin, namely:

- Greater use of ICT tools – PowerPoint, Software, etc., by Teachers to deliver lectures
- Better interaction among the stakeholders – Teachers and students
- Creativity gradually encouraged among graduating students – 500 level students

Table 2: Proposed Geo-System Courses at the Departments of Petroleum Engineering

Level of Study	Geology	Geo-physics
200	Geology of Petroleum	Elementary Geo-physics – Gravity, Acoustics, etc.
300	Depositional Processes and Environments	Introduction and Application of Software for Static Modeling of Reservoir Systems

Although, functional training of students is gradually been introduced, effective capacity building is still not available at the department of petroleum engineering, University of Benin, Benin City, Nigeria. The facilities needed for effective capacity building are either dysfunctional or simply not available. However, a computer laboratory has been installed, for training and research. We believe critical decisions should be urgently taken, to define:

- Future direction for the department, in both training and capacity building
- Needs for sustainable growth, and effective contribution(s) to industry
- Proper, sustainable and inclusive synergy for all stakeholders in petroleum engineering education, mainly industry, teachers, and students
- Proper admission requirements for entry level students.

Being a first generation university in petroleum engineering education, the University of Benin, must be positioned to provide the creativity, innovation, and leadership, to drive the E & P sector of the future oil & gas industry in Nigeria, to effective productivity and success.

**Lessons and Expectations from the Emerging Trends in Training**

Lessons are being learned from the emerging trends that we see at the department of petroleum engineering, University of Benin. ICT through PowerPoint presentations of course materials effectively motivates the students to investigate topics, and become more creative. This creativity is more evident in 500 level students who must also present their final year projects, through appropriate

research. The greater access to SPE library, allows the students to have information on trends in operations, technology, and thinking, in the industry. This knowledge allows faster and better understanding of courses and research topics by students.

We posit the following basic expectations, from the functional education of students, with the emerging trends effectively improved, and sustained:

- Dynamic curricula, to address trends and needs in the industry
- Excellence in petroleum engineering education
- Functional petroleum engineers, to drive the next generation of smart workforce (Idigbe and Onaiwu, 2013)

SPDC has recently opened a “Centre of Excellence in Geo-Sciences and Petroleum Engineering” at the University of Benin. This Centre is positioned to train candidates, chosen from the geo-sciences and engineering, in Master’s degree program. We see it as complimenting the SPDC Centre that enhances the quality of understanding of petroleum engineering, for recent graduates from our universities. We still emphasis that capacity building is very pertinent to any Centre for petroleum engineering. Training is a necessary, but not a sufficient condition, to functional education.

**Development Centres for Capacity Building**

Though they are some positive trends, to provide needed quality capacity for the petroleum industry, we believe “Centres for Capacity Enhancement”, in the main departments that offer petroleum engineering education, should evolve, with maximum synergy from the major stakeholders; PTDF and the industry. Figure 3 depicts our thinking for these centres, which will drive functional petroleum engineering education for the oil & gas industry of the future. We see very important positives in the industry in Nigeria, namely:

- Achieving 40 billion barrels of reserves of crude oil in the nearest future (Idigbe and Olafuyi, 2010)
- Delivering the volumes of natural gas to meet the generation capacity of PHCN and IPPs, and achieve other targets for natural gas based projects (Idigbe and Igbinoia, 2010; Ijevu et al., 2013)
- Emergence of more indigenous companies, in the E & P and service sectors of the industry, especially, those in the marginal fields, to
- Growing of more economic reserves for both crude oil and natural gas

At present, we see many graduates of petroleum engineering, not employed. Training without capacity building of these engineers, has left many, not having

the right skills and competences, to cope. The right capacity should be sourced, developed, encouraged and sustained. Defining and meeting mandates with clear timelines, is a major requirement to achieve and enhance performances, and should be effectively implemented. Talents must be recognized early, carefully nurtured and properly developed; skills should be effectively identified and impacted; competencies are developed on individuals with the right attributes. Best practices, such as responsibility, commitment, leadership, and discipline, in any synergy, are very vital metrics.

### **Benefits of Functional Education in Petroleum Engineering to Nigeria**

The petroleum industry of the future will be driven by creativity, innovation, smart workforce, smart technology, and QHSSE solutions. The main benefits of functional education in our universities to the economy in Nigeria, are:

- The availability of functional engineers for employment, with right tools and competencies, to drive operations
- The achievement of local content levels in human resource, services, and technology.
- The greater opportunity by local companies to aggressively contribute to the target of 40 billion barrels of crude oil reserves
- The sustainable growth of the petroleum industry, especially, in meeting targets in both conventional and non-conventional resources
- Better exploration and exploitation of our various sedimentary basins
- Centres of Excellence in training and capacity building.

We believe petroleum resources exploitation, has a great potential in the various basins in Nigeria. Functional education will play a critical role in the success of the future petroleum industry towards meeting targets.

### **LIMITATIONS OF STUDY**

The authors considered only the department of petroleum engineering, University of Benin, as the case study. However, the major challenges in petroleum engineering education, stated in this study, are also present in most other departments of petroleum engineering, in Nigeria. The authors are of the opinion that functional education in petroleum engineering, should be adopted by all departments.

### **CONCLUSIONS**

Petroleum resources form the main sources of income for the Federal Government of Nigeria. The future petroleum industry in Nigeria will operate in harsh and deeper marine environments, with severe conditions, such as high pressures and high temperatures (HPHT). Petroleum engineers are expected as core members of asset teams that will

drive the smart workforce, services, and technology for this future oil & gas industry in Nigeria.

In this paper, we posit functional education as the key to get the petroleum engineer to acquire the required levels of competence, dictated by the standards of the industry. The engineers must have good working knowledge and appreciation of geo-systems in petroleum; with effective knowledge in ICT, and best practices. The requirements to functional education in the departments of petroleum engineering in our universities are presented. Basic and urgent steps are needed to drive this, namely:

- Best practices in admission of entry level students
- Dynamic curricula in the departments, to be consistent with needs of the industry
- Building capacity in our students, through “Development Centres for Capacity Building”
- Creativity, leadership, and innovation, in training of the students

By delivering functional education in petroleum engineering, many benefits will impact on the economy of Nigeria. Functional engineers, that will drive productivity and bring excellence in operations, will be available for employment. Local content in the human resource, that will drive smart services and technology, will be met, with less foreign input.

### **NOMENCLATURE**

E & P – Exploration and Production; the Upstream Sector of the Petroleum Industry  
HPHT – High Pressure, High Temperature  
NUC – National Universities Commission  
QHSSE – Quality Health, Safety, Security, and Environment  
SPE – Society of Petroleum Engineers  
SPDC – Shell Petroleum Development Company  
PTDF – Petroleum Technology Development Fund

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**APPENDIX**

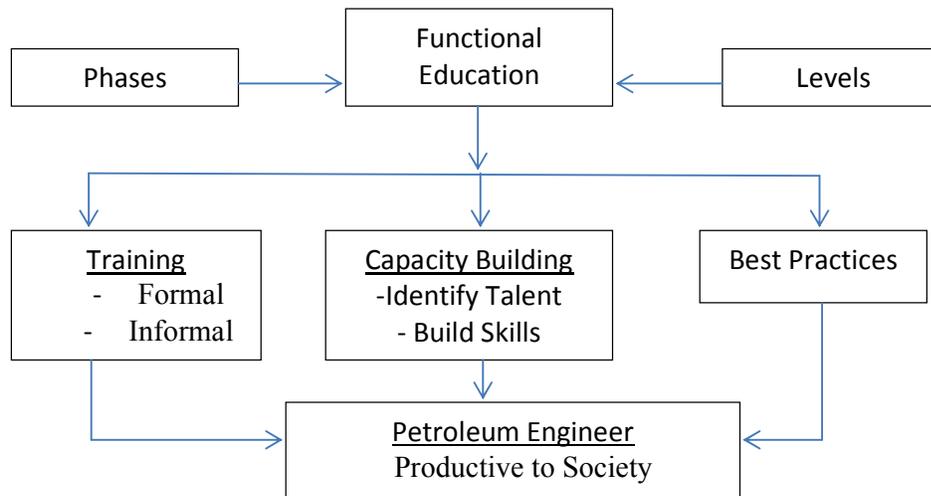


Figure 1: Schematic of Functional Petroleum Engineering Education

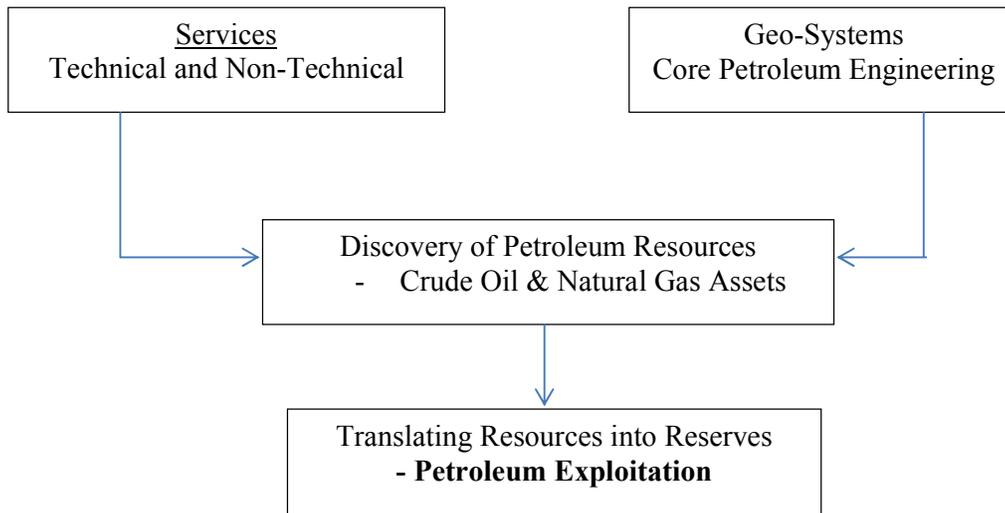


Figure 2: Schematic for Petroleum Exploitation

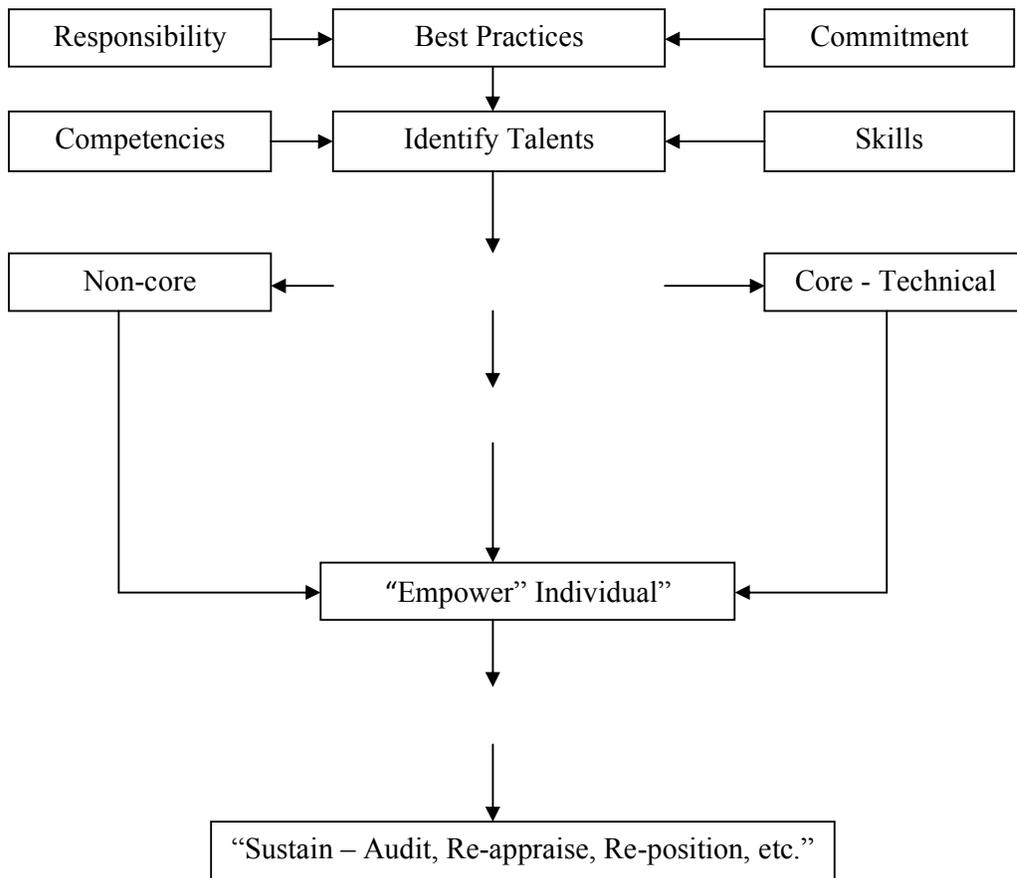


Figure 3: Proposed Schematic for Capacity Building to Drive Functional Petroleum Engineering Education