UNIVERSITY OF PORT HARCOURT

"THE PHILOSOPHY OF SANDING: A SUBSURFACE PRODUCTION ENGINEER'S PERSPECTIVE"

An Inaugural Lecture

By

PROFESSOR DULU APPAH

Dip. Educ., M.Sc, (Baku), Ph.D (UPH), MNSE, R. Eng.
Chi Ikoku Chair in Petroleum Engineering,
Department of Gas Engineering, Faculty of Process & Energy Systems Engineering, College of Engineering

INAUGURAL LECTURE SERIES

NO. 106

June 12, 2014

DEDICATION

This Lecture is dedicated to acher" (Mr E.O. Appah), with whom I had an intimate father son relationship. He pointed me to the highest warm, unconditional and eternally loving relationship. Everything happens when you define yourself, when you validate who you are. I found that, more than any citation or profile, Ezekiel 16: 4-14 testifies about me. **Dulu** means **Live**! This Scripture is today fulfilled in your eyes. I am, indeed, what I am by His grace. The only gift I have, in appreciation, is a thankful life. In many places I work pro-bono, purely from contributions.

ACKNOWLEDGEMENT

Mr. Vice Chancellor Sir, permit me to use this opportunity to publicly thank you (VC and Professor J.A. Ajienka) profoundly for approving this lecture, the time I joined you as office mate in Choba Park in 1990, the ideas we share as colleagues in the same specialisation (petroleum production engineering) and the development of the department, and for accepting me back in 2011 after being on leave-of absence-loan to PTDF for two years. The University of Port Harcourt has been good to me. I had a terminal degree here and was trained on the job in this university. I have been in and out on several research fellowships in advanced laboratories and world-class petroleum engineering departments. The University through the Mac Arthur Foundation sent me to University of Iowa (UI), Iowa to study university administration and fund raising. We enjoyed public goodwill, received immense external donations and management style was positively affected.

I would like to express my very special gratitude to my wife, Rose, a public health consultant doctor. It can be difficult to be a lecturer's wife: the frequent periods away for research, external examinations and accreditation exercises, academic work at home, grading of heaps of examination scripts to submit results in four weeks, etc. Indeed, a call-profession!

I acknowledge and thank Society of Petroleum Engineers (SPE), Department of Petroleum Resources (DPR), Nigerian Petroleum Corporation (NNPC), Institute of Petroleum & Chemistry in Baku, School of Geological and Petroleum Engineering at the University of Oklahoma in Norman, Institute of Petroleum Engineering (ITE) of the Technical University at Clausthal Germany, Petroleum Technology Development Fund (PTDF) and other individuals of the Petroleum family. They have graciously permitted me to use their data and published materials in this lecture. I fondly remember my PhD supervisor, Dr M.J.

Ichara. HRH (Dr) F.E. Eze's certificate of medical fitness enabled me to study in USSR. Prof G.K. Falade, my mentor, would always call to encourage me, out of passion for petroleum engineering in Nigeria.

I also thank my numerous guests, colleagues who have challenged my thoughts, students with whom I interact and learn from, friends and family members, the Ekpeye and Kalabari communities, who have come to honour this invitation. I express gratitude to one and all, because I am the reason we are gathered here today.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

"THE PHILOSOPHY OF SANDING:
A SUBSURFACE PRODUCTION ENGINEER'S PERSPECTIVE"

PREAMBLE

I am humbled and highly honoured to be invited to deliver this Inaugural Lecture to express my thoughts concerning subsurface engineering, specifically sand production. It is evident that I speak among people responsible for the educational, economic and social policies of our dear country. I have for about a decade reflected on development theories, more so human capital that can improve the economy. Success is only success if it can be passed on. Mentoring is the transference of wisdom. The human quest for success and money, money and the good life is a philosophical and also an economical question. Many accumulate without end and without purpose. What is happiness? How much is enough? Many underestimate the force of insatiability. Failure can be a backdoor for success. Greatness is what you do for others. Fame is what you do for yourself. Succession is passing the baton. We should prepare for the worst, but hope for the best. The pursuit of growth is always a misleading concept. What is growth for?

Presidents of countries and governors of states give inaugural speeches at the point they take oath of office. An Inaugural Lecture is the celebration of the elevation. It provides insight into knowledge, research efforts, concerns and contributions to national economy. The Lecture recognizes academic excellence and induces rigorous studies and research among scholars. Traditionally, the professor who has been introduced to a new rank, looks at the history of a discipline and/or profession or

expounds what is new, and looks forward to an articulated future or prospect. The professor applies to the Vice Chancellor to deliver the lecture, stating a topic and possible date, and upon approval delivers it. Most inaugural lectures come many years behind schedule, for so many reasons far beyond unwillingness or lack of enthusiasm. It is not surprising, therefore, that an inaugural lecture is viewed as a debt a professor owes the University Community which must be paid at some point in the career. My personal experience has shown that, within a time frame, the older the merrier. It can only be delayed, but it is never sour.

A problem is defined in the context of alternative potential solutions and comments on these solutions. It is an opportunity to tell the public, in a lay language, what a new professor professes. The purpose of this lecture, more than anything else, is to generate discussions on the problem in question, as we leave here. At the peak of the teaching profession, and rightly an elder in the academic community, the professor has something to say!

INTRODUCTION

Mr. Vice Chancellor Sir, I first heard the word philosophy in class three, when Nyemoni Grammar School wanted a president for the Debates Society and a teacher asked interested students to write an essay on ***The Philosophy of Yesteryears***. I wondered what the word and concept of philosophy were, and carried that thought-burden with me to the university. In Baku, I was to take a course in philosophy for two semesters. Here, in Dialectic Philosophy, philosophy was defined as the love of wisdom! I learned about truth, beauty, time, space, reason, morality among others. My curiosity was addressed and I became intensely interested in the strong desire for knowledge, truth and wisdom as I tried to find meaning to the issues of life. An analytical approach to life started and the seed for development theories was sown in the well-

designed programme of integrated courses in Historical Materialism, Ethics and Political Economy. Historiography taught me the culture, mindset and historical perspective of the people the engineer was to design for. Knowing the culture you seek to serve connects you to the people. I could differentiate private and public ownership of wealth. A future, as a researcher, was defined. It was now the philosophy of the society making the man: "Man is a product of his environment". My mind was, from the works in Marxism-Leninism and those of capitalist philosophers, set on how my rural Ozochi Community can be developed. This early acquaintance with Socrates, Plato, Aristotle, Hegel, and Freud awakened my worldview in philosophical thoughts, where Alexander Pope averred that the proper study of mankind is man. I was convinced that it must start from my personal commitment and the education of a "critical mass". Education is a passport to the future. I then became interested in engineering education, so I obtained a Diploma in Education in 1985. I see a reprint of the Holy Bible as I daily meditate on this life-giving book, draw on my rich rural upbringing and reflect on the term "true" or "truth". I met and embraced the Truth in 1977, through grace that found me. The day I was born, I cried and everybody smiled and now, the day I die, I smile and everybody cries. I hold a Doctor of Philosophy degree in Engineering so today, expanding my philosophical thoughts, I give the lecture with a title that starts with ***The Philosophy***. It is an attempt at giving a proper understanding of, and a reasoned approach to, sand production in wells. Philosophy is the queen of the arts, and the mother of the sciences and technology. The context is engineering education and development. It also adds depth to the *perspective* which is part of the title of this discussion.

In 2003, at a promotion interview for Readership, a Professor of Oral English (Professor Helen Chukwuma) asked: "What is sand? Why do we have sand production? How has your vast

research fellowship experience rubbed off on the University of Port Harcourt?" These questions provoked my thoughts in a problem I have researched on since 1983 when I first joined a Workover Team at Azizbebov Oil Company in Baku to clean wellbore sand from different wells: From a human doctor to a "'well' doctor". It was this same field experience that informed my choice of the PhD topic: **Aerated Wellbore Sand Cleanout in Oil Producing Wells**. Yes, 'tell me where you have been and I will tell you who you are'. The quality of my teaching/mentoring has been enriched and others have been placed. The frequent research trips brought back a *memorabilia* to contribute positively to the university and country.

There can be no meaningful understanding of the actual recovery of oil and gas from known structures that have hydrocarbons and conduits (subsurface) or surface facilities without a clear view or monitoring of downhole. Oil and gas wells/reservoirs performances are better when there is a proper 'window' to the depth of interest. This is also true when a hole is made and a drilled wellbore is converted into a safe & efficient production/injection system. Surface measurements are not necessarily diagnostic of wellbore related problems.

READING ENGINEERING

This sub-topic is adapted from "Reading Law" where a narrow and broad reading of law to inform judgement was x-rayed by Scalia, the longest serving U.S Supreme Court judge and only Italian-American there. The day I received my A/Level results with grades of B,B and C, for possible admission to read Medicine in Unilag, was when I received a *telegram* to proceed to Lagos for travel documents to the then USSR to read Petroleum Engineering. I already had a Rivers State Government scholarship to read Medicine in Nigeria. I weighed the options of my very modest

family background, the potentials even then of university unrest and the idea that I was to travel abroad.

Usually, I do not make decisions based on feelings and I am not defined by things or people. I quickly left for USSR in August 1979 and, as expected, I was admitted to Idi-Araba a month later.

No regrets at all! 1979 -1985 was "The Golden Age" of my life. My father, the bread-winner of the home, died in an auto accident exactly twelve months later. It is a lesson in flexibility, adaptation and determination. I cannot say if I would have still had a Masters with distinction and a CGPA of 4.95 out of 5.00.

Definitely, I would not have fluently spoken Russian or enjoyed the attendant advantages of the legendary Russian Culture and the best of my growing-up years. It was a privileged world that was very exclusive at the time. I understood cultural diversity, race relations and pondered on the Nigerian question and, minorities and women rights. The strong background helps me better cope with changing social, economic, and political conditions. Modestly framed: The best brains, from not so rich families, had Bureau for External Aids Scholarships. Engineering is expected to leap-frog socio-economic development in Nigeria.

Historically, in the thirteenth century, Marco Polo the great sailor travelling from Italy to China saw an "oil spring" at Baku (near the Caspian Sea). He exclaimed "rock oil" or petroleum! This was the Baku I studied in, the same first petroleum engineering institute (department) in Europe, established in 1920 I attended not by choice, but divinely posted. Petroleum is the generic name for crude oil and gas. Crude oil is a hybrid between slurry and emulsion, while natural gas is composed of lighter hydrocarbons of C_1 to C_4.

Engineering Education

I became the Chairman, Committee of Heads of Petroleum Engineering Departments in Nigeria in 2003. The position was

supposed to be for one year, but I was saddled with the responsibility for seven years, long after I was not an HOD. It was ***a call to duty.*** We rotated meetings to enable us assess facilities at younger departments, addressed their concerns and strengthened them. I was then involved in the activities of the Petroleum Engineering Education Committee (PEEC) set up by the then Permanent Secretary, Ministry of Petroleum Resources (Ms Ama Pepple) to improve petroleum engineering education.

Mr. Vice Chancellor, Distinguished Ladies and Gentlemen, please permit me to try to sketch a profile of the engineering educator.

Education is what remains after the information that has been taught has been forgotten. Ideas, methods, habits of mind are deposits left by education. Teaching is a service of life and to life. Education is the key to restructuring an economy towards an appreciable level of self-reliance and self-sustaining development. The state of the world is seen through healthcare and education. Education makes individuals not only independent and productive, but also, perhaps more importantly, relevant to the collective self-reliant and self-sustaining development of their societies. These two elements do not necessarily mean self-sufficiency, but a pattern of regeneration through one's efforts of fighting dominance.

We must revolutionise education through teaching and research. A good teacher is the most important of the three factors needed for it. Others are class size and curriculum. Measurement is the key in making a good teacher, being told what to work on and how to engage the class for an interactive and performance-oriented teaching. Observers, surveys and statistics are useful. I am very optimistic that measurements, students and teachers can fix education. People do not care what you know until they know you care. At current investment level to fix the Nigerian education, the trends are very scary. University rankings tell the complete

story. Nigeria is rich in history, resources and culture. Schools and universities train our workers. We must insist on hardwork and personal responsibilities. New job creation will favour university graduates more in the future than in the past.

Engineering education has been permeated with the sciences – natural sciences and engineering sciences. Engineering fundamentals are understood in depth by a solid mastering of the natural sciences. S*cientia* (knowledge in Latin translated as science) is built up with facts. The general laws of science are the laws of nature. Engineers operate in an "environment of rapid technological progress and major changes in marketplace". All large engineering projects are multidisciplinary, since new technologies have blurred the boundaries between engineering functions. The need for interdisciplinary exposure of our students and to encourage this positive trend, the Chi Ikoku Chair in Petroleum Engineering has drawn the rich experience of researchers to study Formation Damage. In the team are drilling, reservoir, production, chemical and geotechnical engineers, with a chemist and a geologist. There is a lot of greatness in Uniport.

The idea that university is for everyone has not worked. Potentials are unlocked through education, science and research. Employable graduates demonstrate technical competence, communication skills and knowledge of foreign language(s). The Colorado School of Mines defined "technical competence" as "a firm grasp of mathematics, science and engineering and the ability to apply them to one's chosen specialty". The engineering sciences are subject matters dealing with engineering systems, to which the laws of natural sciences were applied.

Most students are overworked, so they spend on each subject the minimum effort needed to get by, with no extra time on subjects of interest. The psychological reward is "the joy of learning" and maximum thinking, not moulded in the image of the professor. We should encourage deep individual study, intellectual

adaptability and student-teacher contacts. We have the notion that free time can lead to non-academic activities and end result of a deterioration of standards. The overburdened curriculum is counter-productive.

Engineering education should foster creative ways to strengthen skills in writing and speaking abilities in students. Improving communication skills is part of the career-long component of engineering education. Science revolution, fired up by computer technology, results in an "aristocratic" revolutionary process in engineering practice and education. Engineers treat quantitatively a large scope of "real" problems. Contents of mathematics, incorporated into the curriculum computer-aided design, taught to engineering students have been re-evaluated and repackaged as engineering mathematics. Engineers routinely use sophisticated engineering packages and develop programmes.

The key areas required for attention in improving engineering education in Nigeria have been identified as: provision of adequate resources, improvement of industry-university collaboration, pursuit of excellence and, capacity building and sustenance. The emphasis is on skills for self-actualisation. Objectives of engineering education, in our universities, should include providing educational opportunities for undergraduate and graduate study and research, encourage and develop large-scale multidisciplinary programmes in technology, serve as an interface between industry and government in specific areas of study or research, and disseminate research results for transfer to industry through seminars and lectures.

The objectives of laboratory instruction and experiments should be rethought. Cost-effective approaches, making use of modern information-processes and simulation, can be developed. Professional bodies should identify for their disciplines the laboratory experience and equipment required. The University has

made efforts in this regard through endowment management committees and industry advisory boards.

The number and quality of the upcoming students of engineering is crucially important to the nation. Programmes in mathematics and science sponsored by private and public agencies to help prepare and motivate youth to seek engineering career must be strengthened. PTDF has sponsored the national Catch Them Young Programme (CTYP), where there were debates, essay writing and quiz competitions. To increase interest in, and preparation for, careers in the Oil and Gas industry, winners were awarded scholarships and given laptops. Such model state-supported programmes that have successfully increased pre-university science achievements should be expanded. Mathematics is a tool for reasoning, a language plus logic.

Engineering and Technology

Technology is not just the "scientific study of industrial arts", the"application of science to industry", or "applied science" as defined by most dictionaries. Technology was practiced long before the concept of science and the scientific methods were invented. The men who crafted local guns and different masquerades practiced technology. "Where there is man, there is technology" (Tadmor, 2001) and I agree. Technology is for growth and an investment in the future. Technology, unlike science, could be successfully practiced without understanding the fundamental laws underlining its nature. Pottery and ceramics were practiced without an understanding of the chemistry, and rubber processing before the hypothesis on the structure of macromolecules or rheological behaviour of rubber (Fruensgaard, 1984). Science's main concern is analysis to discover laws of nature, while the identity of engineering or technology is synthesis or design. Design is the construction of artifacts that have a function and a purpose.

Engineering is development, but politics plays a role in accepting the contributions of engineering. It is the creative look into suggestions. The main concern of engineering is to practice technology. Technology is the domain of man-made, rooted in the sciences. It is a dominant factor that determines the nature of society. Humanists must study technology to understand social change, and engineers must study humanities to appreciate the complex interaction between society and the technology they help create. A specialist with no knowledge of the humanities, arts, and social sciences was rightfully considered uneducated and not useful to anybody. Mr. Vice Chancellor Sir that was my training. The individual with no knowledge of technology can also be considered uneducated.

Technology and innovation impact on human lives. The digital revolution is just at the beginning. We are going to surprise ourselves with innovation. Four sources of technology can be identified as academic and specialised research centres, national oil companies for self-reliance, multinational oil companies, and manufacturing and service companies.

Education of engineering technicians or engineering technologists in our university programmes contribute to the strength of the Nigerian technological workforce. These elements fit under the broad rubric of engineering education. Science Laboratory Technology Programme (SLTP) remodeled and transformed to Institute of Laboratory Technology is a step in the right direction. The entire engineering education programme should be organized around project work.

Engineers and engineering management must be capable of operating effectively in a global domain. An international perspective in all aspects of engineering education is important. The collaborations need to be broadened. We should, given our population, export manpower to the emerging markets in the Gulf of Guinea.

Technology-based industry, technology-dependent government agencies, and professional societies should recognise their shared responsibility to develop an integrated system for providing educational services to engineers throughout their professional careers.

Technology changes rapidly, so career-long education to improve performance is imperative for all engineers. Educational services must be time-effective and cost-effective. Individual schools of engineering, industrial companies, and professional societies need to combine their efforts for an adequate infrastructure to exist. Technology is the determinant for growth.

Technology must be driven by national needs. Technology policies should include development agenda and a road-map. The purpose of technology is to meet demand, maintain competitiveness and adapt to, as well as, mitigate adverse changes. The technology, partners and goal must be properly designed. Challenges of accessing technology include negotiation for licensing (ownership) and partnership for innovation. Issues regarding providers, transformation, field, auditors and regulators, and distribution/application must be addressed.

The implementation of these key recommendations will contribute directly to the vitality and well-being of the Nigerian engineering education system, and, by extension the nation itself will be strengthened. Implementation of some of the recommendations requires organisational and structural changes of the university. The implementation of significant changes in our engineering education would, understandably, be a slow, gradual, sometimes painful process. Unique Uniport has commenced such a process as the Faculty of Engineering transformed to a College of Engineering, with a take-off of three faculties: Process and Energy Systems, Infrastructure Systems, and Production, Power and Communication Engineering. Some of the issues raised in this lecture require much further study and deliberation. The need

therefore arises to initiate a series of invited international workshops, led by an international steering committee, to be held at different locations. We appreciate efforts by Professor A.O. Kuye who organized a National Workshop on New Learning in Engineering Education using Desktop Learning Modules (March 12, 2013) and Society of Petroleum Engineers's Oil & Gas Education Summit (2013) on Skills Gap. Appropriate technologies are required to realize economic growth.

Graduate Engineering Studies

To answer future needs, the School of Graduate Studies has been expanded and metamorphosed into the College of Graduate Studies. It initiates a host of interdisciplinary programmes in science, engineering, management and liberal arts.

Undergraduate education can at best provide only a sound basis on which to build for a lifetime. Continuing education is to acquire 'critical masses' of knowledge for self-study and done in formal classes and also to acquire specific skills for a defined job. Uniport has established itself as part of the solution. You cannot be in the training room, if you want to make the team. Engineers must be encouraged to spend time on continuing education. Resource allocation and difficulty in producing excellence side-by-side with the ordinary are the two dilemmas that engineering schools face. Industry needs both types of graduates. The philosophy and perception ought to stress elite engineers and mass of engineers to run the industry and economy. The recommendation to reduce the formal course load becomes valid.

Project-centred engineering education is a successful method for educating engineers than subject matter. New concepts are more easily introduced and the students work in teams, as they learn the art of research. For every course I teach at the graduate level, students work in small groups and have term paper oral

presentation. Project and project-related courses can be supported by study courses.

Professional practice-oriented MEng/MSc programmes have been developed in a variety of technological specialties to complement available research-oriented advanced degree programmes in engineering disciplines. This informed the establishment of the School of Advanced Engineering Technology (SAET). A majority of students should be encouraged to complete the programmes on full-time basis as the appropriate route to a working depth of knowledge and skills in engineering. The necessity of a lifetime education has made continuing education the accepted way of future engineers. SAET is expected to accomplish one or more of the following objectives: (a) bring students to the entry level of sophisticated engineering practices, (b) bring them to the frontiers of specific technological fields, and (c) provide them with basic management skills. The engineering community is recognising its responsibility to assist non-engineers. The University of Port Harcourt has accepted the responsibility to provide continuing education services to the community. The university has been progressively improving. Big doors open to you on small hinges and the greatest things in life are not things.

More highly qualified students must be attracted to seek the PhD and pursue a university teaching career. “Frontal teaching” should be replaced by self-study habits, free open-class discussions, small seminars and special projects at the graduate level. We should actively encourage the top third of Masters Student body to continue studies immediately for the PhD degree. Students with high intellectual ability should have funding from universities, with industry and government support. The graduates would remain and be retained in the continent. Judicious use of endowed professorial chairs would boost capacity development for the teaching pool. The pool is enriched by

knowledge, capacity and expertise. We should harness intelligence, creativity and power of our students.

Poor university funding, poor management of scarce human and material resources, and influx of careerists into the teaching profession have compromised graduate quality. Attracting the right quality of new lecturers is hard enough, keeping the ones you have got must be a priority. Graduate programme is supposed to be a tool for self-employment and human living.

The main players in education and training for the oil and gas industry in Nigeria are the Federal and State Governments, Ministry of Education and Government Agencies. The Agencies for training are PTDF, Tertiary Education Tax Fund and Professional Associations, such as Society of Petroleum Engineers (SPE), Nigerian Association of Petroleum Explorationists (NAPE), Nigerian Mining & Geosciences Society (NMGS). The professional bodies are platforms to collaborate, share knowledge and formulate strategic solutions, which would advance the Oil and Gas industry.

Mr. Vice Chancellor Sir, it was part of my passion at PTDF. More opportunities were given to university lecturers through PhD scholarships and the University Lecturers' Enhancement Programme (ULEP) in which they were sent for a three-month active teaching course and later a three-month teaching practice. In two years, two lecturers were sent for PhDs and three ULEP. A number of Uniport lecturers were/are either assessors/interviewers or direct beneficiaries. The goodwill persists. The split PhD programme, with bench work at advanced laboratories tried to address the fear of brain drain. PTDF sponsored students, under the local scholarship scheme for Masters Degree and instituted the research grant programme. Three lecturers of the Faculty of Engineering have so far received substantial two-year grants each. On leave of absence there, I spoke for the universities and professional bodies. I use PTDF as a

case study and hope that it would challenge individuals and other Agencies in finding a solution to the ailing education sector of our national development. The general picture may look bad, but there is hope and we are all stakeholders.

Professional development and career planning are part of a young lecturer's responsibility. The environment and opportunity to increase proficiency in technical field, teaching, and research should be provided by university administrators.

Dearth of Infrastructure

A key issue in the ranking of universities is funding. The problem is compounded by the recent economic meltdown and volatile oil prices. Universities can hardly maintain their laboratories and check brain drain let alone, hire qualified lecturers. Sadly, in spite of the subjectivity, there is no Nigerian university in the league table of even 100 in the world. More than 50 percent of the best universities are American schools (Nwogwugwu, 2010). There are no laboratories for basic research, no running water, electricity or proper learning environment (**Fig. 1**). While we focus on the good and bad, we must not dwell on the bad. The Nigerian educational system is characterized by decaying structures, uninspiring teachers and generally, non-chalant students. A university of growth and prosperity competes for investment and human capital.

Fig.1: The Learning Environment

CONCEPTS IN ECONOMIC DEVELOPMENT

Development involves human and material components. Human resource is the most fundamental thing, not the crass materialism, opportunism and corruption we experience today.

The problem with the economy starts with problem with education. Development involves change, transformation anchored on democracy, with the people included in decision-making. Development is the process of progression in society, politics, economics, science and technology. Economic growth does not equate economic development as noted in "Asian Drama" (Myrdal, 1968). From "Theory of Economic Growth" (Lewis, 1955) and "Wealth of Nations" (Smith, 1776), wealth creation and well-being are achieved in development. The three major goals of development are economic, political and social empowerment

(Okowa, 2005). Infrastructural development (roads, electricity, etc) is key to economic growth. Family instills respect for authority and learning. Science and technology are important tools in education, health, research, transportation, communication and industry. They can, then, be considered the vehicle for development. We cannot continue the same pattern of development over the next decade. For development, we need the sweat of our *hoi polloi* and the thoughts of the middle class. Economic growth is always work-in-progress.

Development decisions are investment decisions of people and resources. Pressure and conflict are widely used for development. Development paths utilise the necessary local human resources produced by education. The philosophical basis for transformation is growth from our resources. Three essential elements of economic growth are capital, labour and knowledge. Knowledge is key to poverty, science and technology challenges' solution. S. Korea underscores this by having a Knowledge Economy Minister. Innovation must be developed through freedom and free-thinking. It outweighs capital and labour interplay (**Fig. 2**). Innovation and human resources come before fund as enablers of growth. Foreign aids do not get you growth or development. They are a waste, though could result in some improvement. You need capital to have capitalism, but capital was destroyed by the capital market. Labour market becomes robust when there is increase of demand for goods and services.

Economic growth results in increased job growth. Labour movement is structural, depending on science and engineering as opposed to other disciplines. We must claim the promise of new technology. There is gap in the orientation of principal skills. Development is enhanced by policy, values, institution, leadership and financial market. Market forces are interested in profit, not people. Market does not deliver everything.

Fig. 2: Developing Culture of Innovation

In Singapore, a third of the country's GDP comes from manufacturing which is the backbone of the economy. There is investment and backing of government, advanced computer technology and advanced engineering technology. Value-added specialist product, not labour-intensive consumer product. China succeeded in preventing its one-fifth of the world's population from becoming a burden of the world. China's charge forward, poverty reduction from 43% in 1981 to 13% in 2010, is proof that the path to poverty alleviation is capitalist-led growth. The world has never been in a better shape as middle class grows. Asia has 500 million living in middle class standards and this expected to grow to 1.75 billion by 2020 (three times in seven years). All the future markets are in Asia, though the political sphere is uncertain. In the last decade, every emerging market (Brazil, Russia, India, China and South Africa) is slowing down. The questions are: Are emerging markets (BRICS) ...submerging? Is the West's rise, a blip in history? Will the East eclipse the West? The West needs to

demonstrate wisdom and manage the rise of Asia. China is on the road to democracy, with steady growth.
The only question is route and timing. Chinese feeling that they will soon be number one is a powerful driving force and puts them together. The OECD forecast is that China would overtake the U.S by 2016. China is being drawn into a global economy, like U.S 200 years ago. China has always been just as interesting in the rest of the world as every major player. Until 2007, China spent $1 to generate $1, but it accumulates a debt of $3 to generate $1 in the last five years. The policy is to keep fast growth. There is red ink on China's balance sheet and its total debt is the highest for any developing country in the world today. The U.S since 2003 has a growth rate that is at the world average. It is the best house in a bad neighbourhood. The American dream is rooted in equal opportunities. India is a bottom-up story, not top-bottom, where all the billion people count. Western policy of weakening multilateral organizations (e.g. Security Council of the U.N) is one of the saddest Western policies in the last 30 years. Innovation has global impact, so new American inventions spread round the world. Spending more on R&D ensures competitiveness. The U.S is still at the leading edge. It is the largest economy and spends a lot on R&D, so at the cutting edge of innovation and it spends money on the right things. Picking best practices does not mean being less national. We need a working private sector that can create wealth and spread (not redistribute) it around, which relates to social justice.

People keep on moving for more money. Higher taxes drive millionaires away, from State to State in the U.S and now from France to Russia, resulting in a new phenomenon: millionaire migration. Six critical sets of variables that determine prosperity are human capacity, policy choice, institutional strengths, entrepreneurship, culture and leadership. A period of strong stimulus can grow and reverse the economic crisis. Not spending

is extremely disruptive. Growth can be created while dealing with the deficit. Jobs will be created and the economy expanded by spending to spur growth, not squeezing budget. You have to have deficit to run the economy. Primitive accumulation of money by the business elite and rapacious greed of the selfish politicians is at the root of Africa's underdevelopment.

The "import culture" and debtor nation tag need not be so. It is imperative to look inward to find what can be produced. In harnessing all our relevant human and material resources technology needs be acquired and domesticated. The three institutions in the country that must be held responsible for the nation's advancement are government, the industries (broadly defined to include agriculture and the service industries) and universities (including for the purpose of this lecture, polytechnics and research institutes). The activity which cuts across – or should cut across – the three institutions is **research (Fig. 3)**. They have, because of received conventional wisdom and old habits, tended to look differently on research activities.

Conventional wisdom has it that the proper role of the university is to preserve existing knowledge by teaching it to generations of students and publishing books to make that knowledge available. The recipients may not pass through their portals. Universities are to seek and disseminate new knowledge by constantly laboring at the frontiers of knowledge. University is a place of learning, character development and research centre. To achieve this, universities cherish an atmosphere of free inquiry in which both staff and students are allowed to challenge old knowledge with new knowledge until a new "truth" is established. Research, therefore, is seen as the handmaiden of teaching, and any line of inquiry may be pursued "for its own sake", that is as a contribution to knowledge.

On the other hand, industries are motivated by the desire to make profit by providing useful products and services to society.

Industry support research that leads to propriatable good or service, and a profit. Industry guards research results so as to be the first in the market with the resultant goods. In the circumstance, there can be no freedom to publish, or freedom to pursue any study "for its own sake". Government should encourage industry/university cooperation, which is a strategic necessity.

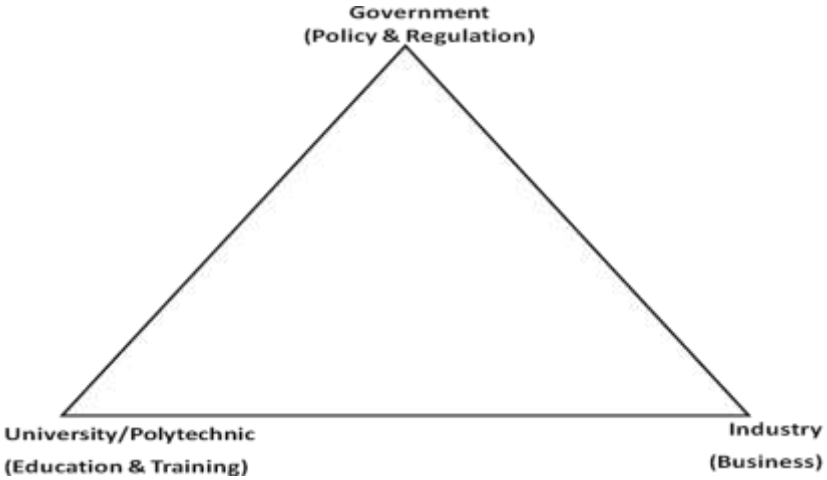

Fig. 3: Drivers of Development

Universities and polytechnics contributions to research and development of technology are only a part of their role in economic development. A radical restructuring is needed because a situation where major industrial and subsectors and universities belong to the public service cannot lead to the desired growth. The key roles of higher educational institutions are human resources development, policy analysis and research, capacity building, technical assistance, basic and applied research, technology transfer. Intellectual assets are made up of three components: structural capital (practices, models and methodologies), human capital (talent, skills and knowledge) and

relational capital (communications, alliances and agreements). An asset is every resource that adds value to an organization. For the petroleum industry, other assets are physical (reservoirs, wells, facilities, hardware, materials and naturals) and financial (capital, equity, stocks and cash).

The Diaspora is an important reservoir of technology, talent, capital and resources. It represents wealth and experience. They should be involved in our development. The African University of Science and Technology (AUST), as part of the Nelson Mandela Institute is a classic example of using the brain-gain in the university sector on short-term visit basis. The trickling return of highly educated migrants is encouraging. We are separated by the Atlantic Ocean, but information technology has bridged the divide. The remittances from them are more than the foreign aids. Somalia has 50% of its GDP from the Diaspora. Our diplomacy should be refocused to integrate African Diaspora concerns.

Nigeria's population of over 150 million out of Africa's 1 billion provides a large market of human talent. In 1975, the world population was 4.07 billion, but today, about 7 billion. The U.S has a population of 350 million people and Britain is about 1/5 of U.S.A (62 million) and Italy is 60 million people populated and Ghana, 25 million. Steadily declining population of Japan's working-age adults is a real problem. The Institute of Petroleum Studies, Uniport is an effort at investing in the best and brightest to create a critical mass of excellent engineers. The critical mass drives the economy. In the big companies (International Oil Companies), educational institutions and specialised institutions tripod, the last is a third party because they cannot fund research. Knowledge created should be pursued to commercialization.

In Nigeria today, the basic need of industry are skilled work force, access to relevant technology, access to top quality staff and resources in the universities for consultation, technical assistance in solving technical problems and good managers. The industry

players drive the economy, not the laws and government creates the environment. Nigeria needs to go back to a situation where we are self-sufficient in food, where in addition to oil, we can produce cash crops at competitive prices for export. We must do this selectively concentrating in the areas of comparative advantage, such as refined petroleum products, chemicals, tropical agriculture and agro-industries. Consistently, over a number of years, we have to alter the climate of rewards and penalties in our economic and social system, especially export activities. At some point, we should make import and trading less attractive. We need also to improve the quality of life for people in rural areas to attract more people back from the towns and cities.

Throughout the process, it is essential that universities and technical colleges produce the cadre of good applied scientists and engineers who can join in the national development. Imported technology should be adapted in order to serve our national needs. It would save on original research funding and prototype development.

Government, industry and university should foster a co-operative relationship in a meaningful manner. We need a nationally coordinated application-oriented programme for solving a national economic problem and it would have multiplier effects on the economy and generate copy creativity. Research is the modus operandi. The public and private sectors should fund research in targeted areas of need on a continuous and predictable basis. The means is **consultancy**. Universities and research institutes should each develop a well structured consultancy organization with enough flexibility to permit innovation and adaptation.

A new strategy for growth is reform and investment for the future. There should be preference for the future over our present, our children over our own interests, individual rights above popular participation, evolution over revolution, and constitution

takes precedence over elections and democratization before liberalisation. Young entrepreneurs under the age of 30 should be allowed credit holiday, they should get credits and soft loans provided to business.

There is a trust-deficit. There must be transparency and accountability. Unemployment, a culture of impunity and corruption are issues that have long plagued the country. Young people must be validated by some kind of economic activity. Good governance, empowerment of people at the grassroots and synergy between socio-economic sectors and communities are the panacea for poverty in most rural communities and achieving the MDG by 2015. Religious tolerance, enlightened leadership and good governance are things to live by these days. Despite the huge human and material resources, political differences and over-concentration of basic amenities in the urban areas hamper efforts of poverty reduction strategies and initiatives. Trickle-down policy from urban infrastructure and development cannot stimulate growth in the rural areas. Communities, individuals, faith-based and community-based organizations should be involved in planning effort to ensure rapid transformation and mobilize funds. Wealth can be created, by retirees, based on experience and contacts gathered while in office. It contributes directly to improving the material well-being of individuals in society. The deprived life in the rural areas can, at best for lack of a better expression, be described as tough. There are no roads to open up the hinterland, so we would not even think of electricity or pipe borne water. The people in the rural areas should be given a sense of belonging, in our development efforts, through the principles of inclusion and contributionism. Their achievements and contributions towards civilization and history must be recognized. Culture is no longer song and dance, but an active economic activity. Civilisations rise and fall, but the people's arts survive. Art is talent, imagination and power of expression. The more we wait,

the higher the cost of fixing or averting the worse. The worse can be nearer than we think.

The key drivers of economic development are resource extraction, population with the right skills to manage the resources and infrastructure to sustain the economy. Engineering creates the infrastructure required for sustainable economic and social development. Sustainable development meets the needs of the present, without compromising the ability of future generations to meet their own needs. It involves physical, resources and costs/benefits distribution. Development progressively transforms the economy, politics and society. Infrastructure spending is the most effective way to create jobs. People in future should look back, with pride, on what we build today. We need to unlock private spending, clarify on corporate tax reform debate, and make both growth and fiscal deficits a priority to create jobs. Investors invest more on innovation as the economy grows. Innovation becomes just what you do. Surprisingly, the world's innovative city is not Seoul, not Tel Aviv but Medellin in Columbia. It transformed from being the drug-war capital to creating opportunities of people from all walks of life. A healthy government can pay attention to long-term fiscal deficit reduction, which is wildly insufficient, and growth deficit.

Nigeria is endowed with a large population, so a large market, oil and gas resources, mineral resources, coastal areas and vast agricultural land. We should embrace diversity, as strength. It is true that where you are and who your neighbours are affect your destiny. There is the need to create a development knowledge-driven society and a workable development agenda. We have a country imbued with potential to be a great nation. Growth is fueled by innovation, productivity, education and research, not just hard work. Entrepreneurship is thinking creatively in business. An entrepreneur organizes, manages and assumes the

risk of a business or enterprise. He or she discovers new ways of combining resources.

Life improvements do not necessarily show up in GDP figures (**Fig. 4**). GDP per capita may not express much, as high GDP may be among few hands. China with a population of 1.3 billion in 2012 has a high GDP, but per capita numbers are low (18% that of America). The best performing stock market in 2012 was Greece, not Germany! Greece has the highest unemployment in Europe and 161% debt of GDP. The lesson from Europe is that austerity can cause social explosion. Reforms and less austerity are needed. There is the need to cut down bureaucracy, cut down lack of transparency, cut down corruption and waste. The rich do not pay taxes and they get away with it. We should think long and hard about it. There must be accountability.

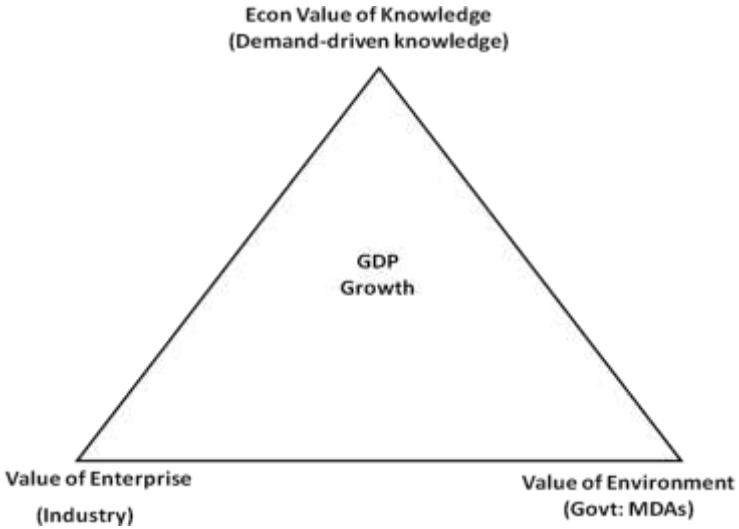

Fig. 4: Factors affecting GDP Growth

We must develop a new economic model for jobs, not just growth. We should allow more flexibility in exchange rates, export

agricultural products to Europe and diversify the economy. The question is always: how do we get revenue? Revenue is unlocked in fresh talents and ideas, lessons from our past, building relations, narrowing the agenda, a new style in being ready to deal (tough but compromise and be clear to the electorate) and expecting the unexpected. Politicians must stand on the side of the people. History teaches us about the prospects and pitfalls. Those who do not remember the past are doomed to repeat it. Our past should be our identity, social responsibility and now part of our culture. Class remains a major obstacle to economic growth. A combination of special interest and money corrupt politics, especially when politicians beg rich people and corporations to give them money. Campaign finances, big money and anonymous donors put our future at risk. Rich natural resources can only be meaningful, when there is a thriving industry and a skilled workforce. Consumption is an engine for growth and we must balance economic development with environmental sanity. Power supply remains the single and most important incubator to economic growth in Nigeria (in terms of people's businesses). Electricity is a major contributor to social economic development, poverty reduction, job creation, capacity building and entrepreneurship. The key to growth is a vibrant economy and political system. There must be structural reform and investment in the economy. The case of infrastructure investment is urgent. There is a declining human capital, so we must spend for the next generation of growth.

The only way to succeed is to have opportunity and the first essential of success is to create it. Opportunity comes in basically two ways, creativity (a new product) and innovation (an improved product). Every opportunity has a difficulty and every difficulty has an opportunity. Opportunities, sometimes, masquerade as challenges. Be great at what you are doing now, for the next opportunity. Entrepreneurship increases economic wealth and

human well-being, and it is rewarded with profits, social recognition and approval. Information technology-driven entrepreneurship would fast-track our development efforts and check cyber attacks. Hack attack is a form of economic warfare and an industrial espionage, where trade secrets are stolen and companies destroyed.

It is time to constitute self-reliance and self-sustainment into the main pillars of our development strategy, to transform them from political slogans such as Visions, Development Plans and Millennium Development Goals into a framework for policy action. The uncompromisingly fragile economy, as it relates to Nigeria's heavy dependence on external aid, throws us out of balance. Development budgets funded on external inflows militate against any policy aimed at providing environment for the stakeholder. The conditions of the donors that must be met and limit the power for political and socio-economic transformation. Bilateral or multilateral aid should complement, supplement or catalyse local development goals. Development aid should be seen to promote self-reliance, must represent national effort for development and promote sustainability in all sectors. Aid kills entrepreneurship and foreign investment. Foreign investors cannot build our market. Competitive domestic firms drive economic diversification. We have issues with high cost of fund, weak infrastructure, corruption, dumping, smuggling and other unethical practices. Growth is the best way to solve deficit. Quality infrastructure and institutions are crucial in fixing the economy.

The Place of Education in National Development

Economies develop based on natural resources, critical mass of a teeming population and infrastructure. The examples of Japan's industrial development and France that exports technology and manpower in the extractive industry without a drop of oil are very instructive.

The main players in education and training for the oil and gas industry in Nigeria are the Federal and State Governments, Ministry of Education and Government Agencies. The Agencies for training are PTDF, Education Tax Fund and Professional Associations, such as Society of Petroleum Engineers, Nigerian Association of Petroleum Explorationists, Nigerian Mining & Geosciences Society.

Our most precious natural resource is our young people. Education is the bedrock for development, a social service, an economic issue, a human rights and a national security issue. It is the soul of the nation and higher education its brain, as it equips people to serve. Basic education makes people literate, while higher education gives them skills to be productive. The key issues in education are skills in communication, critical thinking, work culture and ethics, as well as technical knowledge (Appah, 2008). Educating the mind plays a key role in matters of peace and war. Education is an investment in people to empower them with skills and knowledge for sustainable development. It has three empowering goals: training (teaching and skills to make a living), education (thinking beyond just making a living) and celebration (enjoying life). Quality of decisions and innovation are high through education. New skills should be learnt and knowledge acquired as conditions change. Developing human capacity starts with education.

When capitalism was born, capital was the most important resource, but today talent is the most important. What is at stake is the future of our youth and, by extension, the collective good of the people. There is the need to rise up to the challenge of developing a sound education. In Nigeria, economic mobility is still low and few poor people even become upper middle class. Educational research shows that children who have early education do better in their professional lives. The next generation will be defined by high-quality human capital. Educational

facilities are often absent, posing a problem for both the government and the people. Education is the best infrastructure we can build for our people. The educated understand the benefits of democratic governance, transparency and integrity in governance.

We should recognise the need to expand access to education and deliver the facilities. Post-graduate education is a gateway to human knowledge and understanding. It is an essential part of the scholarly life of the department. Post-graduate students are the university teachers and researchers of tomorrow. I, therefore, enjoin you to leave the University with a product: knowledge and valued skill. The goal of excellence in learning and research should be upheld.

Research

Value of research is when research is for development. Most successful economies and societies in the 21st century will be creative ones. This will be based on individual creativity, skill and talent, with the potential to create wealth and jobs through intellectual property. Research is a painstaking venture. There is a huge reward, so let us be patient for the reward. R&D cannot come by mere persuasion. There should be a deliberate government policy. R&D deals with the needs of the private sector, translating words into action. Sadly, people look at research with dignified ignorance. Research is not only a development programme, but it is also business. It contributes to new knowledge, innovation, new methodologies, tools and equipment. Research in Africa is still a plant of tender growth, so urgently needs care and strengthening. Getting the right hand to work is a major challenge. You really cannot run a research establishment without support from other scholars.

Academic research in engineering is an integral part of the educational process and would keep our engineering education in

a global competitiveness position. Current policies, practices and trends, as witnessed in our entrepreneurial Uniport, are encouraging. However, academic engineering research needs to be strengthened by making federal agency, state governments and other external support less oriented to specific goals selected in advance.

Moribund research centres liter around the country because of programmes that are not thought-through, policy somersaults, R&D process coordination, stewardship, regulatory affairs management, facilitating access to input and output markets and poor funding. Some of the problems with research funding are International and local oil companies (IOCs & LOCs) competitiveness, individual companies collaboration, track commitment and monitoring, gestation period and motivation.

Other issues with research are results of public Research should be for private sector-led economic growth, not research for research sake (publications). R&D activities access and use by local industry, links/cooperation/synergy between industry and technology (research centres & end-users) are weak. Funding and more resources are needed. Politics can affect the dissemination of technologies.

Five roles of government in developing research area:

1. Government must have a positive research climate in Nigeria.
2. Develop a strong research infrastructure.
3. Provide an educational infrastructure where enterprise and business education is incorporated in the study of engineering.
4. Use tax-incentives and other fiscal arrangements to draw creative and research talents to stay in the country.
5. Create clear objectives, set targets for the industry.

Everybody has a role to play: the legislators, the judiciary for understanding and protecting intellectual property, the private sector and researchers. Human capital is important for recovery.
Challenges that hinder the sustenance of research efforts are poor infrastructure, poor skills, lack of access to capital, low adaptation of information technology and lack of access to markets among others.

In the petroleum industry, research interests and development include depwater (≥ 4 000 m) technology, gas utilisation (gas value chain), technology for marginal fields, subsurface (precise software development) facilities, environmental impact assessment (EIA) and upstream & distribution operations.

Government

Government is a collective institution of the people and represents the interest of the people. It is a public affair, an enabler, a facilitator and promoter of business. Government provides and caters. Government plays a role in the economy, in creating a business climate and in society by providing a safety nest. It should provide public goods to the people. The people demand accountability and only the people can be the guardians of democracy. Governance is not sharing the fruits of conquest, but an all inclusive administration. Government cannot be the all time big spender and everybody leeches on it. It is not the cash cow that must be milked dry. Government cannot dispense favours whether merited or unmerited: people should look elsewhere. Power is about good governance. Governance is about sacrifice and service. We must consider philosophical issues on ethical principles in government and business.

Contemporary experience shows that opposition strengthens democracy. Democracy is not viable without a virile opposition.

The cornerstone of democracy is good governance and popular participation. Good governance involves transparency,

accountability, due process, respect for human rights, and observance of rule of laws. Good governance is primarily about fulfilled, not failed, promises. The act of governance is about common good, communal togetherness, empowerment (not pauperism), pursuit of justice, rule of law and quest for peace. Political, economic and corporate policies must be predictable, open and enlightened.

Welfare and security of people, as enshrined in the 1999 Constitution, Section 14, is a major role of government. Government is about building minds, the spiritual and cultural wealth of the people. The people will then build the roads and hospitals. Government creates the environment for brands to develop, builds human and institutional capacity through technology, fiscal regime (economy and investment climate) for business. Alexei Gorky, the Russian writer stated that poverty is not created by the poor, but by the system. Regulations are incredibly important. You cannot get free market without regulation. Reinforce the rules and boundaries. Policies deeply matter and it precedes law. Government is in charge of policy and regulation.

Many in government do not understand the philosophy of governance or modern governance dynamics. This has serious implications for *soc*ial welfare and public interest. Proper investment should result in social and economic returns. The issue of transparency and corruption, where it is largely alleged that eighty percent of the country's oil revenue benefit only one percent of the population hold cannot support an economy. The Mo Ibrahim African Governance Index (2012) placed Nigeria 14th out of 16 West African countries and 43rd out of a total 52 countries on governance (Emenanjo, 2013). The African Peer Review Mechanism, a part of New Partnership for African Development (NEPAD), and Human Rights Commission are measures to ensure good governance. Corruption is more a political than an economic

problem. There is a form of distrust and it is a "cancerous" growth. There are lots of money in the hands of public officials and weak institutional strength, resulting in enormous frustration. People are impatient and there is a tremendous force from the grassroots level. Investors confidence is eroded and direct foreign investments are affected.

There should be urgent initiatives to clean up, through political reforms. The Obama phenomenon lesson is that Nigerian middle class and intelligentsia no longer have any excuses for shying away from the call to serve. The middle class should apply itself and allow itself to "hope", to reclaim leadership and transform culture and our society. The other class is ill-prepared for the challenges of governance and lacks the moral will to change status quo. Leadership and style are important and budgets reflect choices.

AN OVERVIEW OF OIL AND GAS OPERATIONS IN NIGERIA

Nigeria is the crown jewel and hub of activities in the Gulf of Guinea. The petroleum industry is the dominant and successful industrial sector in Nigeria. The country has several basins of varying levels of prospectivity. There has been growth in capacity and reserve base, contribution to GDP, foreign earning, and Liquefied Natural Gas (LNG). In 2008, petroleum and petroleum products exported totaled 50% of Nigeria's Gross Domestic Product (GDP), up from 29% in 1980, earning about 99% of foreign exchange and about 85% of budgetary revenues.

Nigeria's GDP grew systematically from 4.5 in 2005 to 6.4 percent in 2007. There is a GDP growth forecast of about 6.6 percent because of non-oil GDP rate (25 percent from agricultural sector). The low-lights in the petroleum industry are low level of local content, gas flaring, and environmental degradation and community problems. Expatriate domination of the operational activities of the Nigerian Oil and Gas industry results in low value

addition in the Nigerian economy and limited diversification of the industrial base of the country.

The local content initiative of the Federal Government of Nigeria is formally called The Local Content Development (Popoola, 2009). Local content initiative is a domiciliation and indigenous resources utilisation programme. It involves finance, technology, people, manufacture and infrastructure and competitiveness.

Nigeria's energy resources, especially gas, are enormous. Nigeria's gas is rich in natural gas liquids. Nigeria is next on track to becoming next to Qatar in liquefied natural gas (LNG) supplies in the world. There are increasing proposals from investors in GTL plants in-country and the power sector reforms. Of the five main uses of natural gas: re-injection, gas sales, power generation, syngas and LNG, Nigeria commercialises only LNG at international level. The petroleum industry is the dominant and successful industrial sector in Nigeria.

The petroleum industry is the engine of growth. Petroleum is mankind's best friend (Ikoku, 2000). It is no exaggeration to say that the modern world, that takes oil for granted, turns on petroleum. Petroleum comprises not only liquid components, but also 'natural gas' – sometimes found with oil, sometimes alone – and even solids and semi-solids like bitumen. The petroleum industry, since 1859 when the first well was drilled in the U.S.A and 1958 in Oloibiri, Nigeria, is the major determinant of global finance, industry and economy. The story of petroleum begins with a search for oil and gas on both land and sea and ends in petrochemicals and environmental conservation (**Figs. 5-7**).

Fig. 5: Oil and Gas Field Operations

Fig. 6: Gathering Plant and Processing Complex

Fig. 7: Onshore Facilities - Summary

Most of Nigeria's petroleum finds are located in the Niger Delta and the continental shelf, in dry land, swamp and superficial offshore areas. They are generally between eight and twelve thousand feet (about 2.5 and 3.7 m) in the formation. New areas are the highly prospective deep offshore, up to a sea depth of 200 metres, the Dahomey blocks, and the inland basins, notably the Chad Basin and the Benue Trough. Nigeria appears likely to remain a producer and, may be, a net exporter of oil for another 30 to 40 years. There are seven prospective basins and, of the over 900 fields already discovered, only about 200 have been developed and are contributing to national petroleum production.

With an estimated 187 TCF of proven natural gas reserves, the 7th largest natural gas reserve holder in the world and 1st in Africa, Nigeria will produce gas for an even much longer period. The Nigerian gas is high grade quality, with zero per cent sulphur and rich in natural gas liquids.

The Niger Delta is very vast, covering an area of about 20 000 square kilometers, with four ecological zones, viz: coastal islands, mangroves, freshwater swamp forest and lowland rainforest. The region is poor in the midst of plenty. Large deposits are discovered in wetlands and deltas, so they are of great importance for development theorists, practitioners, activists, politicians and the international communities.

Exploration and Production

Exploring for petroleum started in Nigeria in 1908 by the Nigerian Bitumen Company, and was resumed by Shell D'Arcy in 1937. Shell found oil in commercial quantity in 1956.

Petroleum production is from three formations: Benin, Agbada and the marine-shale Akata. Oil production gradually rose as more companies (1955 -1963) joined the original sole concessionaire, Shell. Oil production rose steadily from 5 100 bbl/d in 1958 to 415 000 bbl/d in 1966. The outbreak of the Nigerian Civil War in 1967 drastically reduced exploration activities. Production peaked at 2.3 million barrels per day in 1979/80 and then fell off with the reduction in upstream investments, following the collapse of oil price of 1982. Since 1986, production has been creeping up again. The boom and bust cycles (1973 – 1980, 1980 – 1999 and 1999 – Date) have affected national economic development. The Organisation of Petroleum Exporting Countries (OPEC) introduces a production quota system to arrest sliding market situation and exercise greater control over resources exploitation. Nigeria joined OPEC in July 1971, as its 11th member.

Splendid internationalism is manifested in Nigeria in the upstream sector. Almost all the world's big players are there – Shell, Chevron-Texaco, Exxon-Mobil, Elf and Agip. The older companies have a participatory agreement in which Government owns 60 per cent and the company 40 per cent. Contracts are production sharing types, principally to reduce the burden of

upfront expenditure on Government. There are also service contracts. Funding has been to the Nigerian National Petroleum Company (NNPC), joint ventures and marginal field operators. Exploration risks are usually high with an equally high return on investment. Indigenous Independent Explorers and Producers are located acreages on the basis of sole risk ventures. Government was to always acquire an interest in any acreage, as stipulated by law. With increased oil production came the emergence of the vital service sector responsible for the technical and ancillary services for the petroleum industry.

Nigerian oil is classified as light sweet crude. The country imports heavy crude for processing to obtain products like bitumen, lubricants, and some petrochemicals. There are large deposits of tar sands in Ondo State, which are very expensive to develop, especially when compared with the economics and common sense of harnessing associated gas. However, several attempts have been made by government and private individuals to develop the tar sands. At the other end of the spectrum, are condensate deposits which exist in at least one large field in the South Eastern Shelf of the country.

Until recently, legal and fiscal framework for the petroleum industry was geared towards oil production and utilization with little focus on gas. Oil and gas project management is essential (**Fig. 8**). Stable gas means stable power which translates to more activities in the industry.

Government's strategic goals are to grow reserves to 40 billion barrels of and 187 trillion cubic feet of gas and productivity of 4 million barrels of oil per day. Our potential crude production capacity is 3 million barrels of oil per day (mbopd) and the current Nigerian OPEC quota is 1.7 mbopd. Damages, challenging situations in the Niger Delta, operational reasons and market which do not support higher production led to loss of oil

production. Our natural resources abundance should lead to economic growth.

Fig. 8: Downhole Measurements to Calibrate Surface Data

Government's aspirations are, in 2015, to produce 200 000 barrels of oil per day (bbl/day) from the current 75 000 bbl/day, produce 60 million standard cubic feet of gas per day (MMSCFD), ensure good governance in the industry and grow reserves in shallow and deep waters, as well as deep planes (below 15 000 metres). Nigeria produced over 100 billion barrels of crude oil in the last 53 years. Government is committed to opening up new areas to international investment. Oil terminals have been built in Bonny, Qua Iboe, Brass, Forcados, Escravos, Pennington and Warri.

State Participation in the Oil and Gas Industry

Government started to directly acquire participating interests in assets and operations of multinational companies in 1971. It was driven by economic desires, national security and the need for

petroleum technology transfer to Nigerians. The Nigerian National Oil Corporation (NNOC) was established the same year to carry out upstream activities (exploration, prospecting, pipeline, tank farms and managing government investment in oil companies).

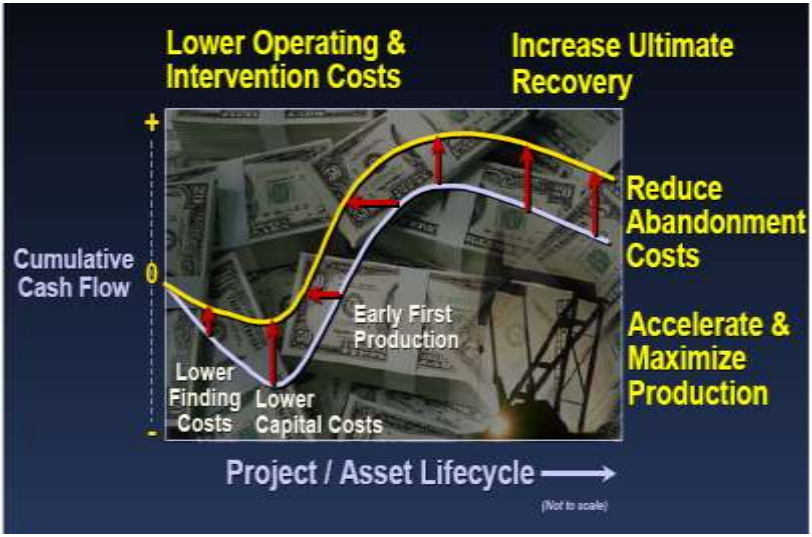

Fig. 9: Oil & Gas Fields Project Management (NEXT, 2007)

In 1975 The Ministry of Petroleum and Mineral Resources was created, from the Department of Petroleum Resources (DPR) desk of the Ministry of Mines and Power. The Ministry was restructured and designated Ministry of Petroleum Resources in 1995. It was to, among other things, ensure companies compliance with petroleum law and regulation; process applications for permits, licenses, and leases; prepare aggregated returns and reports on operations, ensure safety and pollution regulations, and supervise production processes to conserve the nation's petroleum resources (Appah and Ekiye, 2010).

The Nigerian National Petroleum Corporation (NNPC) is the government agency charged with responsibility for public sector involvement in Nigerian oil and gas industry. Its history dates back to1958, as hydrocarbon section in the Mines Division of the then Ministry of Lagos Affairs. The section was upgraded to a Division in 1963 and offices were opened to cover field operations in Port Harcourt and Warri in 1962 and 1967, respectively. The level of statutory responsibility increased and in 1970, the Division was upgraded into a Department in the same Ministry. Oil production phenomenally increased from mere 5 000 barrels in 1958 to 1.78 million barrels per year in 1975.

The Ministry of Petroleum Resources and Energy, in 1976, became the Ministry of Petroleum Resources (MPR). The establishment of NNPC in April 1977 saw the merger of NNOC and MPR to eliminate overlapping functions between them and totally involve government in the oil industry. NNPC was empowered to refine, treat, process and handle petroleum for manufacture; carry out research; effect government's contractual agreements and enhance the petroleum industry. The Corporation has, over the years, undergone several restructuring and organizational changes geared towards commercialisation. NNPC subsidiaries are The Nigerian Petroleum Development Company (NPDC), Integrated Data Services limited (IDSL), Warri and Kaduna Refinery and Petrochemiclas Companies Limited WRPC, KRPC), Port Harcourt Refinery Company Limited (PHRC), Pipelines and Products Marketing Company (PPMC), Nigerian Gas Development Company (NGC), Eleme Petrochemical Company Limited (EPCL), National Engineering and Technical Company (NETCO) – JV and Nigerian Liquefied Natural Gas Company (NLNG) (JV). The NNPC Board of Directors is responsible for policy objectives and compliance. The new direction is to turn NNPC to pure business operations, not policy and regulation.

Department of Petroleum Resources (DPR), that replaced the Petroleum Inspectorate, has wide regulatory powers. It is responsible for award of Oil Prospecting Licenses (OPL), administering the conversion of OPL to Oil Mining Leases (OML), approving field development plans (FDPs), setting production allowable, monitoring of liftings and exports of oil at terminals.

Government's aspirations for the oil and gas industry

Government's aspirations are to grow reserves, increase local content and government revenue, from oil and gas, from $ 14 to $ 20 billion per annum, eliminate flaring of associated gas and use gas as domestic fuel (Daukoru, 2005). Uncompetitive practices, low exploration shares of global Exploration & Production (E & P) budgets and outsourcing of 'core' business are observed shortcomings to the aspirations. Advances in technology are adding significant deepwater reserves (**Figs. 10 and 11**).

The Federal Government issued 23 short-term directives to stakeholders, indicating the scope of work on all E&P projects, pending the full effects of the Nigerian Content Bill that would be signed into law (NNPC, 2004). Government's 45 and 70% target for Nigerian content, in the oil and gas industry, by the year 2006 and 2010, respectively were not and would not be met for a number of reasons. Engineering and fabrication jobs are to be domiciled in Nigeria. The issue of capacity building, production cuts because of insecurity in the oil producing Niger Delta area, NCD contrarians who never really accepted the initiative are challenges that crimp Local Content, slow trend in the initiative's implementation. Sadly, it is widely believed that the Nigerian oil industry is a model of what not to do. There is the need to create a conducive operating environment for the locals, put in place proper machineries to enhance policy formulation and compliance monitoring (Salau, 2009).

Fig. 10: Offshore Operations

Fig. 11: Offshore Facilities

Local Content in Nigeria

Local content is a performance indicator in the industry. Local content adds value through materials and human resources. It

grows and deepens indigenous participation beyond the traditional approach (**Fig. 12**). Nigerian Content Development initiative requires assessment of local content levels, identification of bottlenecks, and development of clear policies and processes to stimulate growth. This would result in economic empowerment through increase in the percentage of local materials, personnel, goods and services for the industry. It is nothing, but active participation of Nigerians. We must tap into our local talents by developing in-country capabilities. A significant portion of the economic derivatives from the industry would be domesticated. Local content involves local training, local technology and knowledge transfer. The answer lies in combining international best practices and home-grown solutions. Enablers of capacity building are free market; stable fiscal and regulatory environment; strong National Oil Company, International Oil Companies and Government, as well as long-term goals. There must be practical application of learning, because skills create jobs. Big companies should buy into the needed training and head competence.

Fig. 12: The Industry: Local Content?

Nigerian Content Development initiative requires assessment of local content levels, identification of bottlenecks, and development of clear policies and processes to stimulate growth. This would result in economic empowerment through increase in the percentage of local materials, personnel, goods and services for the industry. It is not Nigerianisation of the industry, but active participation of Nigerians. A significant portion of the economic derivatives from the industry would be domesticated.

Most of prospecting jobs will be domesticated and only companies qualified by NNPC will enjoy contract patronage in the E&P segment. Companies would offer specialised services, modules fabrication and front-end design. The process will create employment. The need, therefore, arises to separate policy issues from operations, empower DPR for better pre-shipment inspection, visit other countries in the Gulf of Guinea to exchange ideas on local content and expand market network (Tolkein, 2009). There is the need for private-public partnership, as well as regulatory and legal framework.

An estimated $ 12 billion is spent annually in the upstream sector but about 70% by value of work is carried out abroad, so there is unrest in the oil producing region and contribution to Gross Domestic Product (GDP) is low. Local content is an endurance race, not a short distance race.

There is the need to create a conducive operating environment for the locals, put in place proper machineries to enhance policy formulation and compliance monitoring. We should re-strategise for a more realisable target date, other than 2010 when it may be 45 per cent. The need, therefore, arises to separate policy issues from operations, empower DPR for better pre-shipment inspection, visit other countries in the Gulf of Guinea to exchange ideas on local content and expand market network. Reserves and

production aspirations, as well as continuous flow of projects are fundamental to growing local content. We must learn how the top 20 economies made it and sustain their ranking. We need to drive domestication of technology through development of new resources, long-term government, academia, national and international companies partnerships and policy consistency. Local content in 2004 was about 13%, but today it revolves around 35%.

The Petroleum Industry Bill is about increased revenues and Nigerian Content. The industry is being reformed and NNPC is restructured towards commercialization. The Nigerian Content Act is a bold and commendable step. A Nigerian Content Development and Monitoring Board, with an Acting Executive Secretary, was set up in April 2010.

Impact of Industry Activities on the Environment: The Niger Delta Scenario

Mr. Chairman, in Germany the mantra was ***Denk an die Umwelt*** (think of the environment), unlike Russia and Nigeria that have the unenviable positions of being the worst and second worst gas flaring countries, respectively. Oil business does not only generate financial returns, but also health and environment hazards. Major environmental challenges in Nigeria are oil/gas and industrial pollution, refuse disposal and management, desert/sea encroachment and deforestation. Environmental degradation is mainly caused by unplanned and uncontrolled activities of man (**Fig. 13**). In 1989, the first National Policy on the Environment was launched, with special emphasis on Sustainable Development, to raise public awareness and promote understanding, secure a quality of environment for health and well-being, restore and enhance the ecosystem and preserve biological diversity. The Niger Delta Basin has four ecological zones: coastal islands, mangroves, freshwater swamp forest and lowland rainforest. The

Niger Delta region can be described by degradation (**Fig. 13**) and deprivation.

Fig. 13a: What a Legacy?

Fig. 13b: What a Legacy? Health, Safety and Environment Issues

The prevention and control of oil pollution have become politically sensitive. This is due to the possible environmental devastation of land, coastline and important fishing industry. The 1969 Petroleum Act had provision for the prevention of pollution.

Four major areas of activities, the so-called "value chain", in the industry are exploration, drilling and production, transportation and refining. They impact on the atmosphere, biosphere, geosphere and hydrosphere. The ecosystem, animal and plant species is distorted during exploration by cutting

through forests, farmlands and swamps. Explosive devices affect physical structures and aquatic lives. Drilling wastes such as drilling fluids, cuttings and harmful gases from blowouts, production wastes (waste water and emitted gases) pollute the environment. Spillages occur from failed equipment, human error, sabotage and theft. Ozone layer depletion and acid rain occur because of carbon saturation.

The scale of land, water and air pollution in Nigeria is considerable. The extent of pollution depends on frequency and severity. Crude oil and oil product spills which are toxic to life, in the Niger Delta, enter the seas, estuaries, harbours, swamps and rivers. Waste gases are flared in production fields and operations of the refineries. Flares interfere with plant growth and diminish agricultural productivity through their effects on soil temperature. Federal Environmental Protection Agency (FEPA) established environmental criteria, guidelines, specifications and standards. The Niger Delta Environmental Survey (NDES) carries out a comprehensive scientific survey for adequate data and information, to manage resource development for ecosystem and human population sustenance. The whole aim is to manage degradation, conserve, resolve conflicts and sustain development of the communities. The Ministry of Environment, created from the Ministry of Housing and Environment, has eliminated inconsistencies in different work practices.

In 1997, 98% of associated gas was flared. Flaring partly accounts for carbon dioxide emission, leading to global warming, damages to local environment, flooding, severe irritation for people with asthma and other respiratory ailments. This wasteful flaring statistics: 1977 (98% flare), 2007 (37%; 16.3 bn cm), 2010 (14.6 bn cm), 2012 (1.3 cuft/d), 20... (?). Today, 45% of total gas production is flared in the fields and 55% gainfully used. It is reported that Nigeria loses about $5.1 billion annually to environmental degradation. Individual, public and industrial

organizations awareness of the environment can be increased through information, education and training. Those denying climate change are, literally, whistling past the grave yard. The 2012 flood in Nigeria is a taste of things to come. We must build infrastructure with the future in mind, thinking for the long-term. The sea level is rising exponentially high. The Niger Delta is two (2) metres above sea level. With global warming, it is projected that in 2057 water level may rise 1.2 m above sea level.

Global warming scenarios are sea level rise and shoreline loss.

Governments, industry, research institutes and non-governmental organizations (NGOs) join efforts to preserve the environment.

The reasons for continued flaring range from historical to will power: "absence" of large gas market and poor commercial framework particularly for domestic gas, lack of basic infrastructure for processing and storage because of oligopolistic structure of incumbents and export bias, lack of political will by government (legislation and regulation problems) and over-dependence on FGN for funding.

Human capacity building plays key roles in pollution control, containment and related activities in the industry. Environmental preservation, confidence building in host communities, peace and security would lead to sustainable development. The Nigerian petroleum industry contributes over 90 per cent of the country's GNP. Sustainable development entails improving quality of life and making the world a better place. The government, industry and host communities are key stakeholders in minimizing oil and gas pollution. Research efforts would provide a systematic approach to solving pollution problems. There are training needs of people in inter-disciplinary studies to build capacities, capabilities and competencies for a balance between petroleum activities and the environment. It is to promote optimal value creation in the economy and retention to stimulate the

development of indigenous capabilities, hence effective participation in the Oil and Gas industry.

Conflict and Security Issues in Nigeria Oil and Gas Industry

There is a direct nexus between security and the economy. The Niger Delta conflict has been attributed to rural development issues and environmental degradation of the region. Problems of development can be narrowed to capacity and governance. There is a complex inter-play of the environment, social and economic development and the impact of the resources to be used. The Federal Government is the sole trustee of the Nigerian environment. The Niger Delta people are generally poor, a situation worsened by environmental degradation. The social indicators of development, such as access to education, clean water, healthcare and life expectancy, have deteriorated. Niger Delta like Northern Niger, Northern Mali, Northern Ghana and the Casamance region of Senegal, is a conflict spot traceable to natural resources management or perceived lack of inclusiveness. Discontent about compensation and perceived lack of commitment on the part of government and oil companies to develop the region have led to series of crisis and social unrest in the Niger Delta. The people felt neglected by government, pressured by demands of subsistence, expectations from family and community several communities dismissed by flood with properties worth millions destroyed. Security of lives and property has been threatened. What are justifiable reimbursements for both economic losses suffered and restoration or replacement of injured natural resources? Violence and other such acts are inimical to rapid development. Environmental Impact Assessment (EIA) is a tool for forecast and assessment of physical, ecological and sociological changes to better control and management. EIA helps to incorporate environmental considerations into decision-making for sound development.

In 2008, The Ministry of Niger Delta Affairs was created to cover the nine (9) oil-producing states. The departments of Infrastructural Development, Environmental Issues, Finance and Administration were created to fast-track infrastructural and rural development of the area. The Petroleum Sector Reforms (April, 2000 and re-visited in 2008) are aimed at addressing some of the grievances. The Niger Delta Development Commission (NDDC) has been strengthened for faster development of the region and there is a master plan.

Conflict resolution is usually through a process of reconciliation, mediation, negotiation or a mutually agreed way forward. The process of negotiation, compensation payment and regenerating the environment is costly. Educational programmes for communities should involve available technologies, statements of the adverse effects of pollution and that an efficient cleanup to spills minimize adverse effects to the environment.

Resolution of the Niger Delta problem could add up to 3-4% to the Gross Domestic Product (GDP). Oil production picked up from 1 million barrels per day (mbbl/d) to 2.4 mbbl/d. Loss of revenue due to spillages and bunkering, in the first nine months of 2008, was about $20.7 billion. Priority is given to economic policies that support human capacity development in the Niger Delta. With the amnesty and arms' surrender, there will be dividends from the chanelling of resources from war to peace and productive ventures. Host oil producing communities are being granted 10% equity in the Oil and Gas business which is even more than the 13% derivation. Stakeholders in the peace process are the three tiers of government, oil and gas companies, host communities, traditional rulers, organized youth groups, community development committees, NGOs, women groups, civil rights organizations and media. Development is enhanced by policy, values, institution, leadership and financial market.

Peace engenders security. Conspiracy theories play out because of insecurity. Sustainable peace involves eliminating suspicions, vandalism and hostility. The long-term approach is to create jobs, mobilize youth to embrace peace, discover community needs, factor people into the infrastructural and general development. Quality education, employment, entrepreneurship and skills acquisition for indigenes of Niger Delta are being handled by The Ministry of Niger Delta Affairs.

Role of Financial Institutions

Adequate funding and investment are necessary for growth and repositioning Nigeria in the global energy dynamics. There are concerted efforts to consolidate the banking industry to strengthen upstream funding. Foreign credit lines increased because of larger asset base of Nigerian banks: bonus and guarantees and Naira worth. Many indigenous companies can partner with foreign companies, to attract needed funds.

Nigerian banks are in downstream funding. With higher productivity, GDP is growing but inflation still remains a problem. Potentials are great and the industry can leverage some of our equity. A lot of money stays in the system and banks are uniquely positioned to make a win-win situation. The problem with banks was two-fold: poor asset quality and insecurity because of distress. The major limitation is how much loan a bank can give to a single company. Insurance sector and service companies involved in transportation can take advantage of business that is opening up in the three sectors of the industry: up-, mid- and down-stream. There is need for workshops to sensitise banks on the opportunities, project financing and the chain of indemnities. The industry is a high risk and capital intensive venture, with high technology base, but the return on investment is good. Banks can grow the economy through interactions with E&P companies, creating E&P desks in the bank and devoting about 50 per cent of

portfolios to fund the Naira portions of E&P projects and enhancing knowledge base of the banks.

The way forward includes improved research and development (R&D) funding, greater cooperation and partnership amongst local banks, structured finance (not an individual or competitive approach) and support for local content development. Investment scenarios need to be improved because the cost of borrowing is high. There is the risk component of borrowing, given the corruption image of Nigeria.

The Nigerian Petroleum Exchange (NIPEX), the body charged with procurement and contracting, should reduce contracting cycles. Tendering and approval process should to be between 6 and 9 months from the current 18-24 months.

Capacity Building Dynamics and PTDF's Interventions

PTDF started off as the Gulf Oil Company Training Fund (Administration) of 1964, became the Petroleum Technology Development (Act) of 1973 (as a desk under DPR), and was finally reconstituted in 2000 as a fully functional agency of government.

The Mandate: Development of capacities and capabilities in the oil and gas sector towards the effective participation of Nigerians in activities related thereto. Effective collaboration and partnership, with relevant stakeholders, are important for PTDF to deliver on its mandate.

Petroleum Technology Development Fund (PTDF) is the Government's catalyst for development of indigenous capacities and capabilities for the Oil and Gas industry. The aim is to positively impact on Government's economic vision through Oil and Gas activity reforms. The Fund is the vehicle for development of human capabilities, institutional capacities and acquisition of technologies for the oil and gas industry. It is to promote optimal value creation in the economy and retention to stimulate the development of indigenous capabilities, hence effective

participation in the Oil and Gas industry. PTDF's strategic alliances and collaborations, as well as interventions, as efforts aimed at improving local skills development and in-country value retention are presented (Darma, 2009).

PTDF is charged with the responsibilities of human capacity development, development of systems and institutions such as professional associations, and development of materials and manufacturing processes. It is the singular agency of government to develop capacity for the oil and gas industry. It recognizes the need to create an interface between the public sector and stakeholders, recognises that science, engineering and technology play an important role in national growth and recognizes the need to take our destiny in our hands. The vision and passion are to run an organization, a public institution for sustainable development.

The main stakeholders are the industry, academia and government. The capacity programmes and projects would help develop skills and competencies for Nigerians to participate in the Oil and Gas industry. Several Nigerian Content (NC) programmes are developed and jointly executed with the Nigerian National Petroleum Company (NNPC).

PTDF intervenes to create the critical mass of engineers, welders, artisans for active participation in the petroleum industry. It is through training, scholarships and research grants, facilities upgrade and professorial chairs endowment, etc. PTDF develops indigenous capabilities and competencies for Nigerians to actively participate in the industry in Nigeria and the Gulf of Guinea. PTDF's strategic alliances and collaborations have improved local skills development and in-country value retention. Monitoring of deliverables of programmes, through impact assessment, are continuously improved.

Nigerian or local content involves domiciliation, domestication, technology transfer, job creation, training, value addition and value creation. Focal elements of Nigerian content

development in the oil and gas are human capital development, mandatory use of Nigerian resources, specific programmes to transfer technology and employment generation, procurement centre facilities and infrastructure in Nigeria support contracts/projects, increasing the value of work/services for execution, and indigenous companies working alone, or as leading partners in a consortium (Wabote, 2010).

Challenges of local content in Nigeria include capacity building, regulatory bodies' role conflicts, production cut as a result of insecurity in the Niger Delta and Nigerian content contrarians. The critical mass of Nigerians with world-class competencies qualifies to participate in the petroleum sector of the economy. The petroleum industry grows faster than human resources. The Fund, in 2003 and 2010, commissioned two industry-wide skills gap audit to identify skills inadequacies in the Oil and Gas industry. The 2004 report identified areas of human resources needs as technology transfer, training of skills, mentoring and apprenticeship for design engineering works, fabrication, construction, service, maintenance and upgrade of existing organizational and educational facilities. Effective collaboration and partnership, with relevant stakeholders, are important for PTDF to deliver on its mandate. The main stakeholders are the industry, academia and government. Several Nigerian Content (NC) programmes are developed and jointly executed with the Nigerian National Petroleum Company (NNPC).

From the year 2000 to date, PTDF has embarked on the following activities:

1. Project Execution: Petroleum training Institute, Effurun and Universities' Upgrade, Information and Communication Technology (ICT) Centres, Government Technical college, Bonny and Oil & Gas Polytechnic, Ekowe.

2. Scholarship Schemes: Overseas and Local scholarship Schemes (OSS & LSS).
3. Universities' Endowment Programme (Table 1).
4. Nigerian Content Development, and
5. Strategic Support and Collaboration with Stakeholders. The collaboration involves sponsoring publications, annual local/ international conferences and disseminating information relating to geosciences, mathematics and oil and gas-related programmes. The Fund now owns a journal: Petroleum Technology Development Fund Research & Training Journal.
6. Skills Development and Training Centre, Port Harcourt.
7. Welders Training for International Welders Institute (IWI) certification.
8. Research Grant and Technology Knowledge Sharing Programmes.
9. Catch Them Young Competitions in essay writing, quiz and debate for senior secondary schools students.

Physical facilities, curricula and staff development are usually upgraded. The Fund is involved in the following projects: Engineering Design Training Programme (EDTP), EDTP Post-Training Attachment Programme (EDPTAP), Interventions towards Enhancing Fabrication Capabilities of Nigerian Oil and Gas Industry (EFCN), Institutional Capacity development and Coaching, Mentoring and Competency development programmes. About 60% of the EDPAP have secured jobs. EDTP consists of training in various engineering design software packages such as HYSIS, PDMS, INTOOLS, PROJECTWISE, PLANT DESIGN PRO. The EDTP addresses skills shortage in the area of engineering design. The Government's NC directive was to fully domicile all front-end and detailed engineering design projects from 2006. Participants, at the end of their training, are attached for six

months experience to Engineering Design Companies through the EDPTAP. Notable fabrication yards are being upgraded through the EFCN project and welders are to be trained for certification, especially International (IWC). Institutional interventions are for human, institutional and material development. Capacity is built by optimally utilizing these aspects of the intervention. The total number of university intervention projects is sixteen (16). Professorial Chairs have been endowed to conduct research and train, in eight (8) universities that were upgraded (Table 1).

Educational upgrade in technical university departments and polytechnics includes curriculum development, staff development and training, academic quality development, and organization, organogram and systems development.

Table 1: University Upgrade Phase 1 and Endowed Chairs (Darma, 2009)

S/No.	UNIVERSITY	DEPARTMENT
1.	University of Port Harcourt	Petroleum & Gas Eng'g (Gas Eng'g)
2.	University of Maiduguri	Geology
3.	University of Ibadan	Petroleum Engineering
4.	University of Nsukka	Geology
5.	University of Benin	Chemical Eng'g (Renewable Energy)
6.	Ahmadu Bello University	Chemical Engineering
7.	Usman Dan Fodio University	Chemistry (Petroleum Chemistry)
8.	University of Jos	Geology and Mining (Geology)

Eight (8) departments in Nigerian universities, within PTDF's mandate, have been selected for the second phase of facilities upgrade. The Federal Universities, which are at different stages of completion, are given in Table 2.

Table 2: Phase 2 Departmental Upgrade Projects in Universities (Darma, 2009)

S/No	UNIVERSITY	DEPARTMENT
1.	University of Uyo (Commissioned)	Chemical/Petroleum Eng'g
2.	Bayero University, Kano (Commissioned)	Electrical Engineering
3.	University of Calabar	Chemistry (Applied Chem.)
4.	Federal U. of Technology, Owerri	Petroleum Engineering
5.	Obafemi Awolowo Univ., Ile-Ife	Geology
6.	Abubakar Tafawa Balewa U., Bauchi	Petroleum Engineering
7.	Federal U. of Technology, Minna	Chemical Engineering
8.	University of Ilorin	Geology & Mineral Science

Facilities at Bayero University, Kano and University of Uyo were commissioned in February and April, 2009, respectively. Components of the University upgrade project include infrastructure, laboratory equipment, books, Information Technology facilities, linkage facilitation, etc. Table 3 shows Phase 3 of the University Upgrade, that commenced in 2009, is for five (5) Federal and State universities each.

Table 3: University Upgrade Phase 3 (Darma, 2009)

S/No.	UNIVERSITY	DEPARTMENT
1.	University of Lagos	Chemical Engineering
2.	Nnamdi Azikiwe University	Mechanical/Production
3.	Federal Univ. of Technology, Yola	Mechanical Engineering

4.	Nigerian Defence academy	Mechanical Engineering
5.	University of Abuja	Physics
6.	Rivers State University of Science & Technology	Chemical/Petrochemical Engineering
7.	Enugu State University of Science & Technology	Metallurgical/Materials Engineering
8.	Niger Delta University, Bayelsa	Mechanical Engineering
9.	Umaru Musa Yar'Adua University, Katsina	Renewable Energy Centre
10.	Benue State University	Chemistry

The objective of the Overseas Scholarship Scheme (OSS) is to provide skilled human resource in related fields to man the oil and gas industry, in line with the local content policy. It is run in ten (10) top U.K universities. Results obtained are given in Table 4. The PhD programmes train Nigerians at the doctoral level and enables them partake in high level research towards problem solving skill. It upgrades research skills of lecturers. Between 2006 and 2009, 192 Nigerians have obtained their PhDs.

Table 4: MSc Scholars Produced by PTDF (Darma, 2009)

N	Subject Area	2002	2003	2004	2005	2006	2007	2008	2009
1	Engineering	48	39	29	38	46	53	151	140
2	Geological Science	5	12	35	27	22	15	28	47
3	Environmental Sciences	8	13	31	16	24	13	11	36

4	Offshore Related Courses	9	4	8	2	6	6	14	24
5	Energy Courses	12	5	8	7	6	8	12	47
6	Information Technology	16	10	4	10	8	2	13	58
7	Others	21	33	6	13	16	14	66	57
	Total	119	116	121	113	120	111	295	409

Table 5: PhD Scholars Produced by PTDF (Darma, 2009)

S/N	YEAR	No. OF SCHOLARS
1.	2003 (Pilot year)	15
2.	2004/2005	25
3.	2005/2006	18
4.	2006/2007	28
5.	2007/2008	39
6.	2008/2009	47
7.	2009/2010	78
	TOTAL	250

From the year 2000 to date, PTDF has produced over 1700 combination of MSc and PhD scholars. Details of the areas of specialization of the candidates are presented in Table 4, while Table 5 shows yearly statistics of awardees. Having sponsored around 1700 scholars in the pursuit of its mandate, PTDF embarked on an impact assessment survey to ascertain the percentage of the sponsored candidates that are currently working in the oil and gas sector. Although, by its mandate, the Fund does not have any enforcement right to ensure that the industry absorbs its products, but believe that the data acquired will provide insight into how the programme can be properly streamlined to address the supposed looming skills gap in the oil

and gas sector. The survey results may also serve as a tool to enable the enforcing bodies make informed decisions.

National College of Petroleum Studies and Central Analytical Laboratories

PTDF is in the process of establishing a National College of Petroleum Studies in Kaduna to train higher level of technical and senior management personnel in the Oil and Gas industry (PTDF, 2009). The College is to enhance personnel skills and competencies and evolve qualifications and certificated programmes.

A state-of-the-art and world-class central analytical laboratory is to be set up to assist researchers in Oil and Gas, as well as clientele in the industry.

The Millennium Development Goals

The Millennium Development Goals (MDG) seek to address the problems of poverty and promote sustainable development by 2015. The aim is to increase capacity of people to have control over material assets, intellectual resources and ideology. People's choices, freedom and dignity would then be expanded to improve their lives. The United Nations Millennium Declaration to eradicate poverty, promote human dignity and equality; and achieve peace, democracy, environmental stability and develop a global partnership for development, was adopted in September 2000.

Nigeria is the sixth largest exporter of crude oil. It was one of the richest 50 countries in the early 1970's, but today hosts the third largest number of poor people after China and India. It is among the 20 countries in the world with the widest gap between the rich and the poor.

The eight (8) main MDG targets, using the 1990 as a baseline, are: Eradicate extreme poverty and hunger; Ensure environmental

sustainability; Achieve Universal Basic Education; Promote gender equality; Reduce child mortality; Improve mental health; Combat AIDS, malaria and other diseases; and develop a global partnership for development.

Limitations for using the MDGs as a framework for measuring development have been advanced, but we would stay focused on their strengths.

The Nigerian Petroleum Industry and Vision 2020

The objectives of the vision are creating jobs and wealth, increasing Gross Domestic Product (GDP), alleviating poverty and growing external reserves. Important elements required for the nation to achieve the 2020 economic vision are human capacity development, maximised natural resources and raw materials transformed into finished products. Versatile and adaptable right skills and good governance are prerequisites, beyond resource extraction, for national development. Energy security is threatened by population explosion, growth in energy demand and consumption, scale of production and cost of renewable energy. The youth are the greatest resource. The scientist or engineer must fit into the market place in a rapidly changing and challenging socio-economic world. Technological skills must be transformed into money. Three factors required for production to be enhanced are critical mass of population, skills to manage the resources and favourable or peaceful and secure environment.

There was a quest, in 2008, for an estimated $40 billion infrastructural life-line to finance the vision outside the yearly national budget. There is the need for private-public partnership, as well as regulatory and legal framework. It is necessary, like Malaysia and Singapore at par with us in the early 1970s, to look at what constitutes sustainable development. Poor micro-economic planning and implementation, leadership problem, mono-

economy and consumption patterns distorted our growth, unlike these Pacific Rim nations.

The aims of the vision are creating jobs and wealth, increasing Gross Domestic Product (GDP), alleviating poverty and growing external reserves. Important elements required for the nation to achieve the 2020 economic vision are human capacity development, maximised natural resources and raw materials transformed into finished products. There was a quest, in 2008, for an estimated $40 billion infrastructural life-line to finance the vision outside the yearly national budget.

The following conclusions can be drawn:

1. PTDF builds capabilities, capacity and competencies in petroleum activities and research.
2. A platform has been set up for constant interaction, among organisations.
3. A road-map with clear and measurable milestones to guide the partnership is developed.
4. Local Content has increased from 13 to 35% in 5 years, because of the Federal Government's policies and PTDF's efforts.
5. Lecturers are trained at MSc, PhD levels and a University Lecturers Enhancement Programme is now in place.
6. Petroleum Technology Development Fund (PTDF) intervenes to create the critical mass of engineers, welders, artisans for active participation in the petroleum industry. It is through training, scholarships and research grants, facilities upgrade and professorial chairs endowment, etc.
7. PTDF's strategic alliances and collaborations have improved local skills development and in-country value retention.
8. The challenges can be turned to opportunities for both the Government and investors. The future looks good.

THE PHILOSOPHY OF SANDING

Philosophy is a way of life, the pursuit of knowledge, love of wisdom, "Ideas we act upon" Adler (Six Great Ideas) and the way people think. I recognise that there is political philosophy, legal philosophy (jurisprudence), and we have our own engineering philosophy and philosophical engineering.

Philosophy is about thinking. In philosophy you think your way out and in engineering, you invent your way out. All great things were started by thinkers, otherwise known as philosophers. Logic is a key ingredient of philosophy. The advancement of science, leading to discoveries and inventions, is because of the search by some deep thinkers. Political ideologies are put together by extraordinary thinkers. National development is lead by leaders who are capable of thinking through difficult problems. The crucial term of the roots and the routes of what I have called The Philosophy of Sanding is engineering education.

Areas of major problems include the U.S Gulf Coast, California, Canada, Venezuela, Trinidad, West Africa (Nigeria) and Indonesia (**Fig.** 14). Several oil reservoirs in the Niger Delta show fines migration behavior under water drive.

Unconsolidated sand formations are subject to structural (shear) failure. Strength of sandstone is controlled by amount and type of cementation material holding individual grains together, frictional forces between grains, fluid pressure within the pores of the rock and capillary forces. Sand particles move in 3 ways: individual particles suspended in well effluent, a viscous fluid like quicksand and in large chunks due to sloughing.

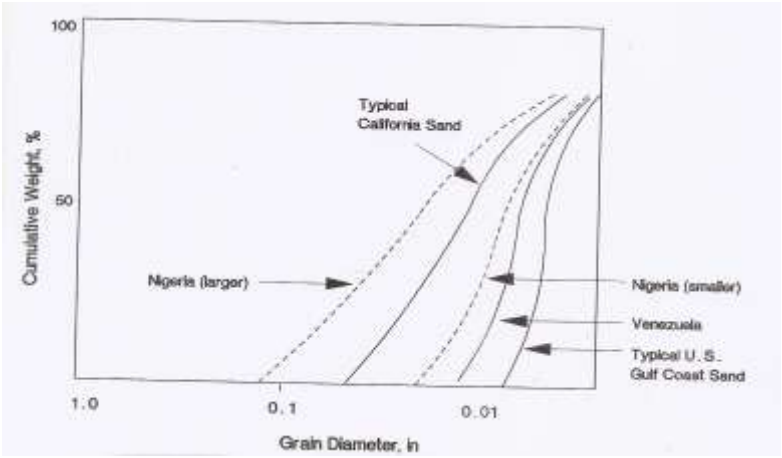

Fig. 14: Formation Sand Grain Size Distribution Curve

Fig. 15 shows the reservoir-well system. Sand is a non-carbonate sedimentary rock with grain size of 2 – 1/16 mm diameter (very big to very fine grains of average diameter in the range of 0.5 - 0.3 mm) as illustrated in **Fig. 16**. The rock type is sandstone and usually spherical in shape. Sand production carried by reservoir fluids from poorly consolidated strata is a major worldwide problem which has plagued the petroleum industry. Grains in different lithologies are given in **Fig. 17**.

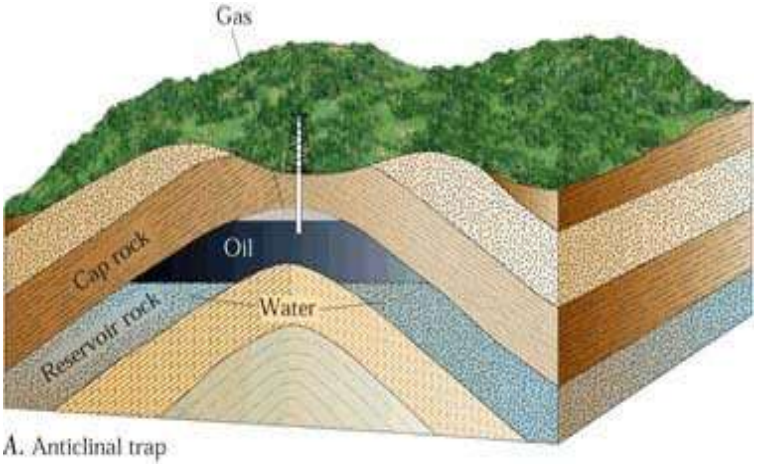

Fig. 15: The Reservoir-Well System

Fig. 16a: Sand Grain Size

Fig. 16b: Sand Production

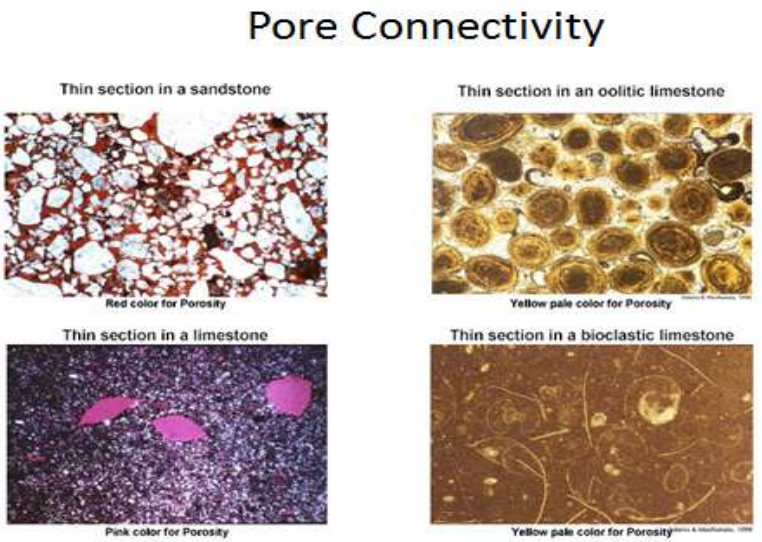

Fig. 17: Grains in Different Lithologies/Pore Connectivity

Formation compressive strength indicates sand production potential. Unchecked sand production is very expensive in terms of additional operating expenses, lost revenues, and creation of potentially hazardous situations. We either control or dispose of produced sand. Predictive tools such as log and core analyses are used with varied degrees of success (Musa, Temisanren, and Appah, 2005). Sand monitoring techniques include wellhead sampling, in-line sand trap, erosion probes, sonic probes and flowline erosion. Sanding potential is predicted to evaluate the necessity of sand control and techniques, for economic reasons because of completion cost and well productivity, as a safety measure (personnel and equipment), due to environmental concerns and operational expense. Predictive tools are statistical (core studies) models, numerical models (special well tests), mechanical properties (sand strength) logs and analogy from offset wells data. Results from recommended sand control

methods are not satisfactory. Gravel-pack filters fail because it is difficult to get chemicals into the pack, optimize penetration and rate, and challenges of tool placement. Chemical binders applications have the problems in shaly formations, long intervals and when there is high water-cut. Incomplete coating of some sand grains (grain-to-grain cementation), and low mechanical strength of the formation are among reasons for failure (Appah and Ichara, 1994a). Sand still accumulates at the lower end of the production tubing, sometimes covering the perforated zone and reducing productivity (Appah *et al*,, 1997). The implication shows up both as cleaning and deferred production costs.

Causes of sanding can be broadly classified as rock strength effects and fluid flow effects. Sand production occurs when the stresses on the formation exceed the strength of the formation (Appah and Ichara, 1994a). The formation strength is primarily derived from natural cementing material holding the sand grains together, but the sand grains are also held together by cohesive forces due to the immobile formation water. The stress on the formation sand grains is due to tectonic actions, overburden pressures, pore pressures, stress changes from drilling, and the drag forces of the producing fluids (Appah, 1994). Depth of the pay zone may affect sand production and sand problems are also encountered because of the geologic age of the rock. Sand production is rate sensitive and formation sands will produce with fluid movement.

The operator is concerned with the question: Is sand control required? Rock failure test answers this question. The rock's compressive stress is determined. A drawdown pressure that is about 1.7 times more than the compressive strength indicates sanding (Appah, 1994). If porosity is greater than 30%, sand consolidation would be needed, 21-30% is an uncertainty limit. Long transit time (≥ 90 μsec) indicates a soft, low density and high porosity rock, while a transit time of 50 μsec is for hard rock with

low porosity (Davies, 2001; Appah, 1998). The Niger Delta region is made up of shallow, geologically younger tertiary sedimentary formation. There is little cementation, it is unconsolidated and the compressive strength is less than 1 000 psi, hence sand-prone.
Early sand control philosophy was based on the bridging or jamming theory. Particle sizes for fluid loss control agents were selected using this principle. Modern methods use ***sieve analysis*** (grain size distribution). The most characteristic feature of sand is the diameter of its grains. They are represented after filtration by a curve called "Gravimetric Curve". It is obtained by plotting percentage of cumulative weight of sand retained as a function of sizes of sieves. The effective diameter of sand can then be defined as the dimension of the sieve mesh which passes 10% in weight of sand being considered. This corresponds to 90% on the gravimeter curve which is plotted on percentage of weight of the sand retained. Sand is monitored by wellhead sampling, in-line sand trap, erosion probes, sonic probes and flowline erosion.

Sand control is physically preventing sand entry into wellbore. It is based on well completion, preceded by study. Sand control types are shown in **Fig. 18**. Gravel pack installation in a gas well depends on reservoir, while best practice for sand consolidation is achieved by proper candidate selection and upgrade on facilities.
Specific problems associated with sand production (Appah, 2004) are:

1. Sand fill-up and bridging inside the hole-casing, or tubing which reduces or shuts off production.
2. Erosion damage to downhole tubular and equipment (Safety valves, chokes and artificial lift equipment.
3. Sand accumulation in surface lines and equipment.
4. Casing buckling or collapse caused by void spaces behind casing.
5. Erosion or jam of surface safety valves.

Water production worsens sand production problem because of the following reasons:

1. Increased total fluid production to maintain oil or gas producing rates increase the drag forces across the sand.
2. Disturbance of cohesive forces tending to hold the sand grains together as the water phase becomes mobile.
3. Increased drag forces due to two phase flow and mobility of the wetting phase.
4. Dissolving or softening of the natural cementing material.

How much of sand is enough? The solution is set up a sand management system. The philosophy of sand production management, where no sand is produced, involves monitoring and control of well pressures, fluid rates and sand influx. A sand cut-off (5-10 pptb for oilwells and 0.5 -1 lb/MMscf for gas wells) should be designed. The decision must be made early at the field development stage. Incorrect omission leads to production loss and unnecessary inclusion results in extra capital expenditure (CAPEX), loss of future workover flexibility, reduced well production and reserves increased lifting costs. The technology for sand control must be great for the economy and good for the environment. The choice of a sand control method is dictated by a number of factors that should be carefully examined. These include initial sand control cost, expected reliability, effect on productivity, completion repair cost, formation sand quality, history of sand production, level of reservoir depletion and presence of multiple thin productive sections (Appah, 1999).

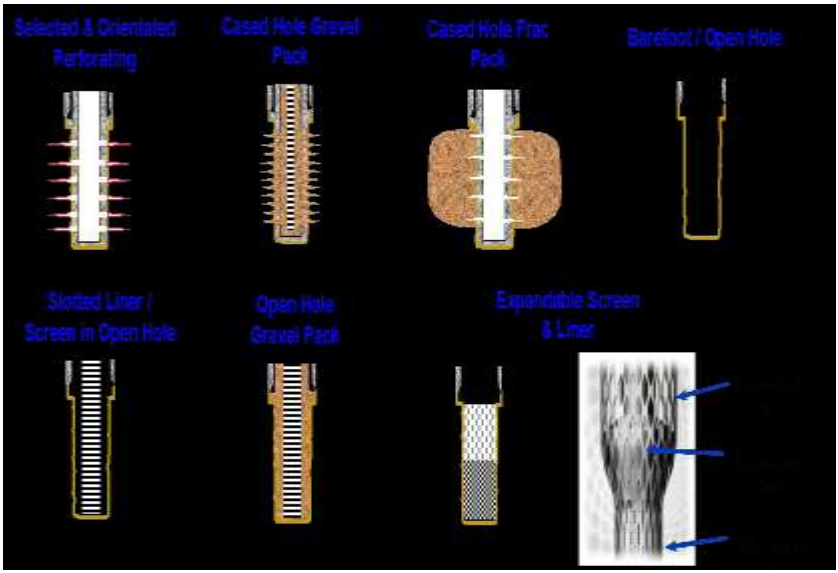

Fig. 18: Sand Control Types

Sand control mechanisms can be broadly classified into production control, mechanical, chemical and a combination of these methods. The governing factors causing sand production and formation damage can only be understood and appropriate measure put in place, if the mechanics of fines movement and flow into the wellbore are studied and understood (Appah and Ichara, 1994b). In-situ sand consolidation (SCON) methods convert loose sands into sandstone using chemical binders for grain-to-grain cementation, while allowing fluid flow. Phenol resin, phenol formaldehyde, epoxy, furan and phenol-furfuryl are commonly used. They are sensitive to placement techniques.

Consolidation, as a method of sand control, is often used in short intervals where for reasons of small pipe diameter, abnormal pressure which make through tubing operation advisable, top zone of a dual completion, offshore or isolated locations where

tubing hoist is not available, gravel pack cannot be applied (Appah, 2001). SCON, unlike the mechanical method (gravel pack), frees the wellbore of obstruction (Bouhroum; Bai; Appah and Ghofrani, 1995).

Fig. 19: Gravel for Gravel pack

Sand control types are given in **Figs. 18 and 20** and gravel for packs **(Fig. 19)**. The system works best in newly completed wells because the formation is least disturbed. Clean perforations, stabilized formations and sufficient pump pressures to ensure proper mixing of chemicals with formation sand are necessary (Appah, 2003). Our experience in the Niger Delta shows that most chemical treatments do not tolerate water and may fail at water-cuts higher than 50%, shaly sands (> 20%) and downhole temperature in excess of 45°C. Deviated wells give better results because the tubing is very close to the top perforations. Chemical

treatments can be performed using coiled tubing (rigless locations) or on tubing conveyed packer (TCP) string, where perforation and consolidation are done in one trip.

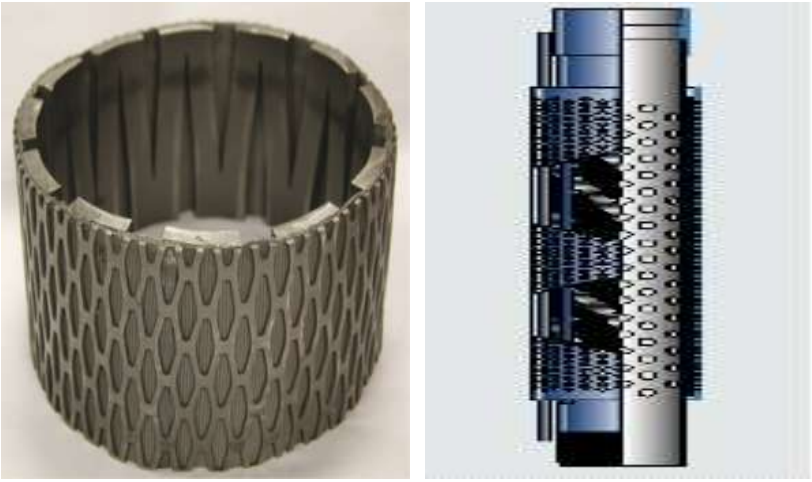

Fig. 20: Sand Control Screens

In spite of improvement on sand prediction (Appah, 1998; Appah and Benson, 1997) and control techniques, such as gravel packing (Appah, 2001; Chukwuezi; Appah, and Onodu, 2005), sand consolidation (Appah, 2003) and a combination of these, field results are unsatisfactory (**Fig.21**).

Fig. 21: Nothing Lasts (Petroleum Expertise Ltd., 2010)

Sand accumulates at the wellbore and impairs productivity, requiring cleanouts (**Fig. 22**). Downhole deposits impede productivity. Jetting tools have been recommended for economic removal of downhole deposits. Speed control is used to optimize ''cyclic stress'' for improved deposit removal efficiency. There is no damage to completion equipment or tubular, it has a 360° coverage of wellbore regardless of geometry, withstands temperatures of 400 °F (204 °C), fully compatible with all common oilfield fluids and 45-90° nozzle configuration is available. Hydraulic wellbore sand cleanout models were developed to determine energy required (Appah and Ichara, 1994). The need then arises for wellbore sand cleaning. An economic fluid system for proper wellbore cleanout was then designed (Appah, Ichara, and Bouhroum, 1997). The work finds wide field applications in pressure-depleted fields with sand problems (Appah, 2004).

Different laboratory sand columns were washed using aerated fluid of varying qualities (**Fig. 23**). The mesh size of loose reservoir sand used in the work was 0.25 mm and porosity of 30%. Equipment parameters were scaled to field dimensions and injection rates. The choice of preformed fluid, at the surface, was dictated by the need to better control contamination than in-situ fluid at injection point. Downhole mixing does not ensure comingling of air and water and liquid phase recovery cannot be minimized. Rate adjustment reduced fluid reflux into the wash-pipe. Proper pump and compressor selections solved the problem of high injection rates.

Cleanout time and fluid loss were compared with conventional techniques for both direct and conventional circulation methods. Sand cleanout is with coil tubing (CT) or rig-intervention. The issue with CT application for screen cleaning is the subsurface valve (SSV) section. The success of CT depends on the withdrawal speed. Sand is bypassed when it is fast and sand builds up, with sticking, if too slowly withdrawn.

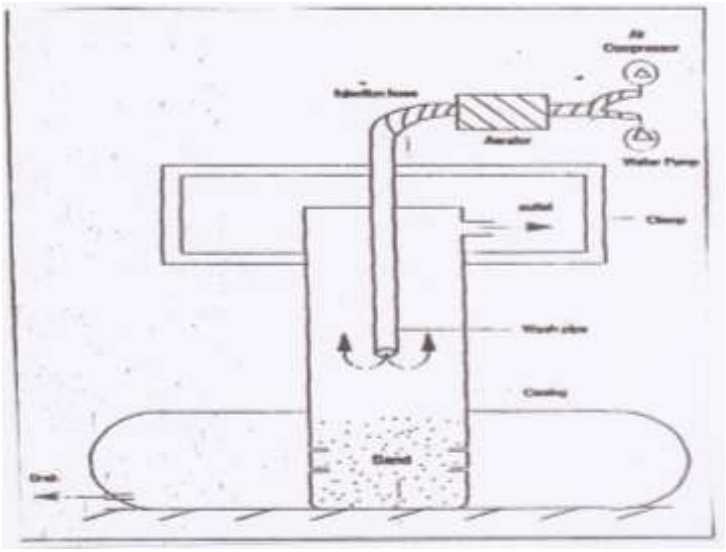

Fig. 22: Schematic of Aerated Sandwash

Results showed that 50 -60% preformed aeration improved the carrying capacity of water by about twice, thereby reducing well downtime for cleaning and rig cost. Aeration quality depends on reservoir drainage volume, near-wellbore reservoir permeability and formation pressure. The flow of this light fluid is steady state and fully developed laminar. The aeration increases rock stability and reduces adsorption and back pressure, thereby suspends sand and maintains lifting. A positive choke on the flowline is used to maintain a sufficiently high fluid velocity in the tubular goods to prevent erosion. The dominant transport mechanism is particle re-suspension, provided by inertial lifting force. Aerated fluid is light and energized. High visco-elastic water hinders particle mobilization. Lost circulation was minimized, resulting in reduced start-up production time after sand cleanup, increased water-free production period and reduced adverse effect of corrosion. Direct method is about five times slower than reverse (conventional) circulation. In the forward (direct), fluid is pumped down the

string and take returns up the annulus, while maintaining constant bottomhole pressure (BHP). A plug is set at the last nipple before circulation, if there is a high risk of formation damage owing to fluid loss. Bottoms-up time is long, annular pressure is high and casing corrosion occurs with sour crude. Oil and gas can mix with annulus fluid due to gravitation. In reverse circulation, the well sees pressure in the tubing. Cleanout fluid is pumped down the annulus at const BHP and takes returns up the tubing. Lower pressures, with lower risk of formation damage are encountered and circulation pressure in annulus is lower. The problem of the conventional method of circulation is that In small tubulars e.g. CT, there is lost circulation due to high friction pressure.

The mechanism of aeration are preformed or downhole mixing of air and water. Aeration quality can be controlled at the surface before injection and air expands downhole. Candidate selection sequence for aeration is rock and properties, geological information, description and structural/isopach maps, well information, logs, completion, production and workover history, downhole remedial treatment and analysis in simulators. Wells are usually killed before the intervention. Pre-kill activities involve inspecting and servicing the Christmas tree, checking if downhole safety valves need to be locked, open or pulled, isolating the well from production, rigging up and testing intervention equipment, and selecting appropriate brine weight and type. Data required for killing a well are wellhead and bottomhole pressures, fracture pressure, wellhead working pressure, fluid level in well, casing and tubing sizes, casing and tubing strengths.

Aerated fluid cleaned the length of tubing below the perforated zone, thereby increasing period between workovers. Aerated fluid is applicable in wells that produce by artificial lift method and pressure depleted fields. Traditional types of fluids might cause formation damage. Wells that are on water-free

production should not be sand-washed with just water, but aerated fluid. Fluid injection rate needs to be regulated to avoid prolonged sand washout. Unlike borehole cleanout during drilling, particle shape and sorting have no significant effect on cleanout. Sand is a granular material with uniform particle size range of 2 to 0.0625 mm in diameter, spherical shape and usually quartz with fixed porosity.

THE WORLD ENERGY QUESTION

Energy is a major index of human development. Yes, energy can indeed transform economy, lives and continents. Energy consumption should be correlated with economic development.

It is expected that energy demand will grow by 6 percent by 2030 and gas will even grow faster, doubling in the next 20 years. As more countries move up the economic ladder, more energy will be required. In the entire energy industry, oil and natural gas account for more than 75 per cent of total energy mix and would continue to be prominent for the next couple of decades. There is the perception that the Oil and Gas industry is a sunset industry, with declining production. There is rather a long-term career in the industry and compensation is competitive. The quest for energy self-sufficiency will require the appropriate technology for it to be realized. The main challenges for increasing conventional oil and gas supplies are improving resource discovery, accessing resources in harsh environments and optimising total recovery (Cassian, 2008). In Nigeria, the major problems are energy crisis, security challenges and infrastructure decay. Oil business does not only generate financial returns, but also health and environment hazards. Large oil and gas deposits are discovered in wetlands and deltas, so they are of great interests for development theorists, practitioners, activists, politicians and the international communities. Sustainable energy security can be achieved through competency-based training, education and learning for the energy

industry in Nigeria. Government and industry will need to mobilize unprecedented large scale investments ($bn/yr). Advances in technology are adding significant deepwater reserves (**Fig. 23**) and production optimization techniques have been used to recover more oil (**Fig. 24**). The energy challenges will be met in a holistic manner. The days of cheap oil are over. In the Gulf of Mexico (GoM) it takes 100 days to drill to depth and it is very slow. Oil is found at 1000 to 1200 m of depth of water. PEMEX in Mexico explores an area of 500 000 square metres. We should promote knowledge for national development.

Fig. 23: Floating Production Vessel

Fig. 24: Production Optimisation

Fossil fuel provides a great portion of the world's growing energy need and the situation is likely to remain so in the next decade. Nigerian oil industry covers both on-land and offshore fields. Energy growth is expected to be stable at a level of 2.2% between 2004 and 2015 and a further 1% annually up to 2030. All available energy resources are to be exploited in an optimal manner, for now and the future. Alternate or renewable energy sources such as wind, solar, geothermal, biofuels and biomas present a different set of technical and environmental challenges from fossil fuels. Energy must be made available, affordable, safe and sustainable. Cost of developing alternate energy is high, scale of operation limited and supporting infrastructure is lacking. Power and infrastructural needs must be home-grown, with planning as a critical component.

Federal Government electricity generation target was 6,000 megawatts by December, 2009 based on gas production target and supply to power the National Integrated Power Projects (NIIPP).

The International Oil Companies are the major players in this concern. About 830 MMSCF was to enable government generate the 6,000 mw to meet the December deadline. Gas must be made available to meet the target. Gas-condensing technology has been advocated as a solution to Nigerian flare issues. Nuclear power will guarantee a long-time energy security for future generation. The Nigerian Atomic Energy Commission is the operational agency responsible for developing technical capacity and expertise for exploiting and utilizing atomic energy. Manpower training, research & development and nuclear technology centres are the vehicle to achieving its mandate. The energy industry must be placed in the hands of fit and proper persons who should be trained and re-trained. Important elements for the Vision 2020 are human capital development, maximized natural resources and raw materials transformed into finished products.

Oil and gas pollution has come to the front burner of national concern because of the resulting socio-economic effects. Governments, industry, research institutes and non-governmental organizations (NGOs) join efforts to preserve the environment. Human capacity building plays key roles in pollution control, containment and related activities in the industry. Environmental preservation, confidence building in host communities, peace and security would lead to sustainable development. The Nigerian petroleum industry contributes over 90 per cent of the country's GNP. Sustainable development entails improving quality of life and making the world a better place. The government, industry and host communities are key stakeholders in minimizing oil and gas pollution. Research efforts would provide a systematic approach to solving pollution problems. Petroleum Technology Development Fund (PTDF) trains people in inter-disciplinary studies to build capacities, capabilities and competencies for a balance between petroleum activities and the environment.

Engineering creates infrastructure that is required for sustainable economic and social development. Energy security was one of the Seven-Point Agenda of the Federal Government. Energy security is threatened by population explosion, growth in energy demand/consumption, scale of production and cost of renewable energy, etc. We should have a long-term view of the country to map out strategies and monitor workability. We live in an increasingly inter-dependent world that is becoming more complex. We need to prepare for uncertainties.

We now live in a world where energy needs grow astronomically because of the emerging economies of Asia, especially China and India, and it is becoming increasingly difficult to discover fossil fuel finds of large deposits. Consumption need in 2060 is expected to be three times the energy use today. Global cross-over in oil discovery trend matched against production was in 1990. Production today is an opportunity cost. It is a later foregone value of production. Production optimization involves reducing costs, increasing productivity and production. Resource value chain (input-output-delivery) is aimed at enhancing economic value of the final product. There issue is that of filling the gap between production and consumption. Exploration and Production (E&P) industry development requires developing more multidisciplinary work environments, incorporating cross-cultural ingredients in the training and development of industry personnel, and encouraging industry managers and leaders to take development training in sustainable development and corporate responsibility concepts.

Gas is energy of today and the future. Gas is the fastest growing fossil fuel. Nigeria is a gas province with pockets of oil. Petroleum Technology Development Fund (PTDF), recognised this very early and endowed a Professorial Chair in Gas Engineering at the University of Port Harcourt to conduct research and build capacity to meet the local content aspirations

of government. The focus is on gas utilization and gas monetization, and it represents progress.

The key drivers of development are resource extraction, population with the right skills to manage the resources and infrastructure to sustain the economy. Engineering creates the infrastructure required for sustainable economic and social development. Government's aspirations are to grow reserves, increase local content and government revenue, from oil and gas, from $ 14 to $ 20 billion per annum, eliminate flaring of associated gas and use gas as domestic fuel. Uncompetitive practices, low exploration shares of global Exploration & Production (E&P) budgets and outsourcing of 'core' business are observed shortcomings to the aspirations. Oil recovery factor stands at 0.35. Subsidy removal is not a decision to be taken in a hurry, marketed in a rush and implemented in haste. Fuel prices hurt disposable income.

We need a new future based on renewable energy, not coal and oil. Alternate or renewable energy sources are wind, solar, geothermal, biofuels and biomass present a different set of technical and environmental challenges. Cost of developing alternate energy is high, scale of operations is limited and supporting infrastructure is lacking. While commercial alternate energy operations are rapidly growing, these sources are expected to provide only a small share of the energy supply needs for decades to come and will heavily depend on some form of subsidy. It is important for our industry to pay attention to, but not focus on, other sources of energy. It is only because we can develop technology for exploitation just as for petroleum and related energy resources. West Africa, situated near the Equator receives maximum sun energy intensity, is well suited to solar energy. Its diversification, as at the Energy Centre in Uthman Dan Fodio University, Sokoto, should be pursued in that regard. Electricity consumption in the U.S from nuclear energy is 19%, wind 3% and

solar 1%. Current market forces challenge the economic viability of existing nuclear power plants, while new reactors represent an extremely unattractive investment prospect. In Germany, there is a government-led nuclear exit. The Fukushima disaster in Japan has pushed countries around the world to ask: Should nuclear power be part of the energy future?

Frontier or unconventional oil and gas resources are tight gas, heavy oil, shale gas and shale oil. Major technology development needs are new and improved/enhanced recovery methods. Deepwater operations with high pressure-high temperature (HPHT) environments. They require better quality assurance technologies to manage and optimize our production operations. We need to describe and characterize reservoirs to aid better reservoir management. Tar sands, heavy oil and bitumen, are found in the Ondo area (Nigerian Benin Basin). They have the following characteristics: average bitumen content is 10%; ^{o}API, 14.6–5.3 (Average = 9.4); specific gravity between 0.204 and 1.837 (Average = 0.968); sulphur content, 1.3%; breaking point, 10 ^{o}C; flash point, 89 ^{o}F and pour point of 20 ^{o}F

The Federal Government recognises power plants as critical infrastructure to grow the economy. Saudi Arabia with 10.6 million bbl/d is second to Russia, the top producer, with 11.1 mn bbl/d. U.S oil boom, in the Gulf of Mexico, is expected to lead to energy sufficiency by 2035 and less dependence on import. The U.S is the highest consumer of petroleum products, with 42% of its demand imported. Jordan, in 2013, imports 96% of its energy need, so price hike is fueled and fuel subsidy issues are exasperated.

Global energy demand is to increase by a third in 2035. The U.S will still depend on oil imports. Fracturing of oil shale is great for the economy, but bad for the environment. The U.S has had frack since 1947, but there are so many unanswered questions about the effect on ground water, emission and air pollution, methane leak into water supplies. Regulations are incredibly important. Energy

demand will grow in India and China. Demand for regional natural gas is rising. Coal is much dirtier than natural gas. The solution of carbon emission is renewable energy. The World Bank forecast of economic growth in 2013 in developed countries is 2.4% (previous forecast is 3.3%) and developing countries 5.5%, with bright spot in Africa. China's growth is to slow gradually from 8.4% to 7.9%.

New oil and gas are discoveries in Africa. Ghana, like Kenya, Uganda, Sudan, Sierra Leone, Angola and Equatorial Guinea, has just discovered the joy of oil exploitation. The fresh challenges thrown up must be seen as an opportunity. We must look at the oil future with tremendous concern and take a systematic approach in developing renewable energy. Like Martin Luther King stated, "the fierce urgency of now" is to export manpower in the short term to build capacities in these emerging markets.

The Role of Gas in the Development of Nigeria

Mr. Vice Chancellor Sir, I would have been silent on gas. Necessity is placed upon me, because I am a Professor of Petroleum & Gas Engineering. Nigeria is transiting from oil to oil and gas industry. The petroleum industry is both capital and knowledge intensive. Demand for skilled staff outstrips supply. Companies depend on the quality of employees' vision, innovation and technical excellence for competitive advantage.

Natural gas is one of the cleanest fuel sources for electricity generation or in automotive fuel. Nigeria is the hub of activities in the Gulf of Guinea. Nigeria is a gas province that holds great promise for the county and investors. Gas reserves are in excess of 187 trillion cubic feet, making Nigeria the 7th largest natural gas reserve holder and 1st in Africa. In the long term, we are transiting to a gas OPEC.

Nigeria's energy resources, especially gas, are enormous. Nigeria produced over 100 billion barrels of crude oil in the last 52

years. The Exploration and Production (E&P) business attracted massive revenue (80% export earnings), with a virtually non-existent industry base and minimal Nigerian participation.

Gas was underutilized and mainly for export and 2 billion cubic feet of associated gas daily flared. Gas volumes were "incidental". The gas business is not as mature as oil. It is more capital intensive and technologically very challenging, requiring sufficient time and plan (LNG: 20-25 years). The more we pump in money into the oil sector and do not flare out, the longer the transition from oil to oil and gas will be delayed and suppressed.
Government is committed to opening up new areas to international investment. Nigeria's gas is sweet and rich in natural gas liquids. Gas utilization projects cover power generation, chemicals production, natural gas liquids, liquefied natural gas extraction and liquefied natural gas (LNG). Nigeria is on track to becoming next to Qatar in LNG supplies in the world. LNG business in Nigeria has a promising outlook. There are increasing proposals from investors in Gas-to-Liquid (GTL) plants in-country and the power sector reforms. Of the five main uses of natural gas: re-injection, gas sales, power generation, syngas and LNG, Nigeria commercialises only LNG at international level. There are endless opportunities to use gas and exponential value from LNG waiting to be harnessed.

Nigeria LNG started in 1965. Today, it has six trains, supplies 10% of global LNG, contributes 7% of Nigerian GDP, produces 150 000 tones/year domestic gas and has over 1000 highly trained Nigerian workforce. The Trans Saharan gas pipeline project was initiated in 2002 and a 630 km pipeline has been built to deliver gas to Benin, Ghana and Togo. The Gas Master Plan is an effort to accelerate gas development, given the uncertainties around crude oil and quantity of gas deposits in Nigeria. An active gas sector will increase foreign exchange earnings, boost job opportunities and other multiplier effects. Eight percent (8%) is lost during

transportation (gas shrinkage), 25% flared, 38% LNG and 20% is used in re-injection projects. We should promptly eliminate routine gas flaring. Nigerian gas is moving from demand to supply constraints. Natural gas is more readily available, relatively cheap and has extensive value chain. In the gas business, you sell first and then invest but for oil, you invest before you sell. We should not produce gas that is not being used. The petroleum industry is the dominant and successful industrial sector in Nigeria. Investment opportunities abound in the upstream (marginal fields), midstream (engineering, procurement and construction, fabrication) and downstream (service providers, gas network – SCADA). The plan is for gas transmission lines and processing facilities.

Critical success factors are reliability of gas supply source, balancing domestic and export gas requirements, security situation in the Niger Delta, and impact of proposed Petroleum Industry Bill (PIB), impact of Nigerian Content Bill, local content business environment and global LNG market. Critical areas of focus are assured funding of gas supply development projects, continued funding for all critical pipeline projects, electricity tariff increase to accommodate gas price and accelerated passage of the PIB. Incentives should include tax-free holiday of 3-5 years and 10 years for LNG and reduced tax. The challenges are pricing and market structure, limited infrastructure (pipeline, gas gathering system), gas supply constraints (accessing gas reserves), project funding (government and public private partnership), fiscal/commercial and regulatory issues, current industrial cost escalation and inadequate legislative framework (harmonise national and international practices). We should implement new gas policy and gas master-plan, and focus on domestic use. The enablers to enhance and protect investments are integrated "one stop shop" solutions, maximizing system availability (timely project approvals and adequate payments, transparent regulatory

structure and legislative framework), commercially attractive investment framework (pricing), changing contracting strategy, security of construction, peace and security. Enormous private sector investments supported by enabling environment of government, policies and legislations are required. The terms must not be overly generous but fair.

Drivers of growth are the rising gas prices in the West, increasing proposal from investors in fertilizer and methanol, and power sector reforms. Market rule-making should be separated from market participation.

The Petroleum Industry Bill (PIB) requires inputs from all stakeholders with outcome of huge inflow of foreign direct investment (FDI), private upstream and downstream involvement, and good investment climate. PIB will restructure the sector and increase proficiency, financial reward, production, reserve and accountability, create incentives and build confidence, arrest loss of revenue. It removes climate bottlenecks and sets principles (benchmark margins) and includes host communities. The strategy is to create institutions and governance structure, enact new regulatory fiscal and legal regimes to govern the sector that are realistic and investment friendly. The 1990 Petroleum Profit Tax (PPT) was very high, so did not encourage gas utilization incentives. PIB is public-driven with no oversight appropriation, self-financed by international joint ventures (no cash call). Separate oil and gas licenses will lower taxes for gas. The concerns with respect to PIB are overlap of responsibilities (Ministry and Directorate of Petroleum Resources), little competition and it being more regulatory than creative.

The University of Port Harcourt is sitting right inside the gas business in Nigeria. The Department of Petroleum Engineering, University of Port Harcourt, was established at the inception of the University in 1976. It was transformed to Department of Petroleum & Gas Engineering and subsequently a PTDF Chair in

Gas Research, and Centre of Excellence, endowed to harness and utilize the new source of energy. The Gas Engineering programme started, as a separate option, in 2002. A good number of the staff of the College of Natural and Applied Sciences have expertise in Gas Technology and carry out practical industrial research. The university's teaching staff should be augmented with industrial and government expertise. Gas engineering, like petroleum, is the practical application of basic sciences of chemistry, geology, mathematics and physics, all the engineering sciences to the development, recovery and field processing.

THE NIGERIAN YOUTHS

Our most precious natural resource is our young people. They drive power, politics and enterprise. You should commit to the future with the right thinking and meeting the right people. An era may have ended, but the destiny is not completed. This gathering is yet another confirmation that despite many disappointments, Nigerian youths are genuinely interested in Nigeria. Here is another opportunity to discuss the need for change and change we need. Most of our youths have been left despondent, hopeless and helpless. They are unemployed, unemployable, defenceless, frustrated and used for all that is negative in their theatre of war called election. The bludgeoning unemployment and vulgar opulence in the midst of acute poverty cannot curb the downward spiral into moral and social ruination. These are the consequences of failed leadership and national economic misfortunes. The instinct now is how to survive in a jungle. Youths now live with the psyche that life itself is meaningless. Violence is entrenched as a normal way of life. The unthinkable can become the inevitable. The alternative to education is too dangerous to contemplate. The mostly recycled leaders must stop and listen. The status quo must be questioned in what is termed the "crisis of education", for the society to move

forward and chart a new pathway. The market is over. The youths are angry, so we cannot continue to dictate the pace and the tune.

Our post-independence history is one of general elite irresponsibility. I refuse to give up hope about Nigeria. Prepare for the worst, hope for the best. Look for a career, not a job. Education is important, but gets skills. It takes more than dreaming to land your dream job. Failure can be a backdoor to success. Learn to acknowledge failures, repeal and profit from them. It is dream and work, not dream and wish. Your choice steers the course of your final destination. Do the right things for the right reasons. A reader today is a leader tomorrow. Ideas should be written down. Never undermine the power of ink in memory.

Your generation needs to build on what the generations built on. If you spend your time criticizing what you want, you would not get it. Wisdom is seldom possessed by the young. Every generation needs regeneration. Do not have an opinion where you do not have responsibility. People are tempted to major on the minor and minor on the major. Life is dreams of yesterday, realities of today and hopes of tomorrow. Life has a purpose, so there is something worth living for. Nothing replaces hard work.

Do not stumble through life, prepare (plan) for your future. Life is made up of the choices we make and we live with the consequences. Choice is driven by purpose and overriding public interest should inform it. Your future rests on decisions, not destiny! Your identity is wrapped up with what you are identified with. Identity is a part of a whole and sameness of different things. I would reemphasize that success without a successor is failure. Your best days are ahead, so look for the good in everything. The paradox of life is that when you are young, you use your health to pursue wealth and when you have the wealth, you try to use your wealth to seek the fading health. Health, like petroleum, is a wasting asset. The return on investment is sadly very small.

The use of money is part of your education in life. Riches are given for use, not storage (so that you do not worship riches). The seed that leaves your hands never leaves your life. Never ask how little you can do, but how much? Never be intoxicated by success or be paralysed by failure. Promote happiness in others, for wealth is kept sweet and sound by liberal distribution.
Complete your dream never let time defeat you. One day, you will look back and miss the season you are hurrying to go through. Do something about a problem you identify. Every day is a gift, unique and irreplaceable. Think success. Be convinced, but tolerate other people's convictions. You have to be strong to be humble, for insecure people need constant validation. You create a habit and the habit makes you. Choose to do better in the future. Be concerned with your future potential than the present circumstance, living the now. Trouble is inevitable, but misery is optional. Bad things happen to good people and good people also overcome bad things. "If only" is a sad expression. Look for the good in everything. Your best days are ahead. The most charm against poverty is knowledge. Your future rests on decision, not destiny.

Enablers of capacity building are free market; stable fiscal and regulatory environment; strong National Oil Company, International Oil Companies and Government, as well as long-term goals. There must be practical application of learning, because skills create jobs (**Fig. 25**). Big companies should buy into the needed training and head competence. Please listen to me with your ears and hear with your minds, in getting get skills. Take charge of your life! Education is an important tool in driving the job market. Education is the soul of the nation and higher education its brain. Unlock your potential through the human mind and skills. Skill is what you love doing. Low and middle skill manpower such as artisans, craftsmen and technicians, can be

acquired through vocational training. Behind every great person, there is another waiting to be great.

Fig. 25: Shortage of Skills (Petroleum Expertise Ltd., 2010)

CONCLUDING REMARKS

Mr. Chairman, ladies and gentlemen, education enlightens the mind, creates jobs and training develops skills. There is prospect for erosion control in many parts of the country (coastline & hinterland; Bar-beach), articulate studies and chemical placement aid selection of candidates which is key for success in sand control. The Petroleum Industry is the engine of growth, with the commodity for economic value. The age of "reasonably priced oil" is behind us and technology is the game changer. Today's expensive oil can be turned into tomorrow's cheap oil. Aeration quality of 50-60% is required for wellbore sand cleaning in

depleted reservoirs, private/public - University research collaboration is important in addressing sand production and control problems. Swelling cements can control sanding and improve quality of well cementing.
Engineering education and research must be multidisciplinary involving science and technology, especially chemical engineering, soil science, petroleum engineering, rock mechanics and engineering physics. We must revolutionise education through teaching and research. Education is an economic development, human rights and national security issue. A good teacher, class size and curriculum are important for quality education. Skills must be for self-actualisation.

Objectives of engineering education, in our universities, should include providing educational opportunities for undergraduate and graduate study and research, encourage and develop large-scale multidisciplinary programmes in technology, serve as an interface between industry and government in specific areas of study or research, and disseminate research results for transfer to industry through seminars and lectures.

Research interest are in deepwater (≥ 4 000 m) technology, gas utilisation (gas value chain), technology for marginal fields, subsurface (precise software development) facilities, environmental impact assessment (EIA), upstream and distribution operations. We should explore to discover and improve technology (innovation). Research contributes to new knowledge, innovation, new methodologies, tools and equipment.

Large amount of gas is now available to deliver an energy future. There is the need for industry restructuring, legislation, review of fiscal terms, transparent access to new E&P opportunities and advances in technology (add deepwater reserves). Policies for effective gas production are right pricing, develop fiscal terms, full-cycle economics for gas monetisation

projects, end subsidies for gas projects and infrastructure on tariff basis.

Four years down the road, with lessons learnt, our university should gradually transit from an Entrepreneurial University to an "IT-driven entrepreneurial Uniport". This would result in a big leap in its development and greater community service. Nigeria should be an exporter of manpower well above petroleum or any other mineral resource.

REFERENCES

Appah D. (1994): Application of the Theory of Diffuse Set to Optimise Hydraulic Fracturing, Petroleum Science & Engineering, Vol. 11, pp. 335-340. The Netherland.

Appah, D. (1998): Pore Pressure Prediction in Abnormally Pressured Wells, 33rd Ann. Conf., Nig. Mining and Geosciences Soc. (NMGS), Ile-Ife, March.

Appah D. (1999): An Assessment of Sanding Wells at Kirovneft, J. Institution of Engineers (India), Ch-417, Vol. 78, March, pp. 39-43, India.

Appah D. (2001): New Gravel-Pack Technique Reduces Sand Production in Niger Delta Wells, Oil & Gas Journal (OGJ), July 2, pp. 44-46, U.S.A.

Appah D. (2003): Sand Consolidation Experience in the Niger Delta. J. Institution of Engineers (India), Ch 7, Vol. 84, September, pp. 1-4, India.

Appah, D. (2004): Aerated Wellbore Sandwash Experience in Binagadi Field, J. KSU (Engineering Series), Vol. 17, No. 1, pp. 123-130, Saudi Arabia.

Appah, D. (2008): The Ekpeye Nation: Past, Present and Future, The First Ekpeye National Convention on the Bane of Underdevelopment in Ekpeye, Dec. 27, Ahoada, Nigeria.

Appah, D. (2008): UZUGBANI EKPEYE: An Instrument of Development. Ekpeye Ethnic Nationality: The Way Forward, National Congress, Dec. 29, Ahoada.

Appah, D. and Benson, O.G. (1997): Prediction of Formation Compacting from Compressibility Data, 33rd Annual Conference, Nigerian Mining and Geosciences Society (NMGS), Jos, Nigeria. March 2-7.

Appah, D. and Ichara, M. (1994a): Empirical Model determines Energy required to Clean Sand from Wellbore, Oil and Gas Journal, February, pp. 36-38, U.S.A.

Appah D. and Ichara, M. (1994b): Analytical Model Evaluates Sand Inflow Impact on Production, Petroleum Engineering International, July, pp. 42-44, U.S.A.

Appah D., Ichara, M. and Bouhroum, A. (1997): Aerated Washover Technique in Sand Producing Wells, Oil Gas, Vol. 4, pp. 29-33, Germany.

Appah, D. and Ekiye, S. (2010): Nigeria at 50: Accomplishments, Challenges and Prospects – Chapter on ***Oil and Gas***, Nigerian Institute of Social and Economic Research, Nigeria.

Appah, D. and Kalu O.U. (1999): Improving Natural Gas Reserves through Derivatives, Annual Conference of the Nigerian Society of Chemical Engineers (NSChE), Port Harcourt, pp. 157-167.

Asante, K.B. (2012). Education as Key to Sustainable Development, Daily Graphic Newspaper, Ghana, p.26.

Bouhroum, A.; Bai, M.; Appah D. and Ghofrani, R. (1995): Experimental Investigations and Modelling of Gravel Pack Damage (Part: Investigations Regarding Gravel Pack Damage), Erdol, Erdgas, Kohle (EEK) (English Translation: Journal of Crude Oil, Natural Gas and Coal), Vol. 111, No. 2, pp. 61-66, Germany.

Cassian, S. (2008): SPE's Talent and Technology, Soc. Of Pet E. Journal, Vol. 1, No. 3.

Chukwuezi, M.N.; Appah, D. and Onodu, N. (2005): Optimization of Well Productivity through Sand Control (Gravel Packing). Ninth Annual Offshore West Africa, International Conference & Exhibition, Abuja, Nigeria. March 21-23.

Darma, M.R. (2009): Capacity and Capability: Exploration and Production Business Aspirations and The Nigeria Vision 2020, SPE Nigeria Ann. Int'l Conf. & Exhibition, August 2-5, Abuja.

Daukoru, E. (2005): Enhancing Local Content: Policy, Plans and Practices, A Key Note Address to Nigeria Oil & Gas Summit, April 18-19, Abuja.

Davies, D.R. (2001): Sand Control, Schlumberger DPT Course, Chapter 7, July 5-8.

Elsentrout, B., Wintercorn, S. and Weber, B. ((2008): Six Re-Gasification Systems Present Options to LNG Importers, LNG Technical Review, LNG Journal Publication.

Emenanjo, E.N. (2013): About Language: Can Confucius be Right?, Valedictory Lecture Series No. 4, University of Port Harcort, 4 April, 107 pp.

Fruensgaard, N.O. (1984). Project Work as a Study Technique at the University of Aalburg, World Conf. on Education Technology, Cologne, April 16-19.

Ibrahim, M.M. (2009): Oil and Gas Reform: The Role of PTDF, In-House Capacity Building Workshop, Petroleum Technology Fund, September, Abuja.

Ikoku, C.U. (2000): Petroleum: Mankind's Best Friend, Inaugural Lecture Series No. 26, University of Port Harcourt, July 19, 91 pp.

Imomoh, E. (2007): Panel Discussion: 50 years of Oil Production in Nigeria, Ann. Conf, Society of Petroleum Engineers, NAICE, Aug 2-5.

Isichei, A.O. and Sanford, W.W. (1976): The Effects of Waste Gas Flares on Surrounding Vegetation in South-Eastern Nigeria, J. Appl. Ecol., 13, pp. 177 – 187.

Lear, W.E. (1986). *Quality of Engineering Education*. ASEE, Washington, D.C

Lewis, W.A. (1954): Theory of Economic Growth, London, George Allen & Unwin.

Musa, L., Temisanren, T.A. and Appah, D. (2005): Establishing Actual Quantity of Sand Using an Ultrasonic Sand Detector: The Niger Delta Experience, Society of Petroleum Engineers, Nigeria Council J. (SPENCJ) Paper 98820, Nigeria.

Myrdal, G. (1968): The Asian Drama: An Inquiry into the Poverty of Nations, New York, Pantheon.

National Oil and Gas Industry Outlook (2004): Evolution of the Oil and Gas Industry in Nigeria, 412 pp., PL Consulting, SIL Publishers.
NExT (2007): Well Performance and Productivity Enhancement, Modules 1 and 2.
NNPC (2004): Nigerian Content Development Policy Guidelines, Short Term Directives, Revision 2.
Nwaogwugwu, I. (2010): Reforming the University System, ThisDay, November 15, p.80.
Okowa, W.J. (2005): Oil, "Babylonian" "Matthewnomics" and Nigerian Development, Inaugural Lecture Series No. 40, U. of Port Harcourt, Feb. 10, 107 pp.
Popoola, N. (2009): Local Content, A Challenge for Insurance Capacity Building, Sunday Punch, May 17, p. 22.
PTDF (2004): Industry-Wide Skills Gap Audit Report, Petroleum Technology Development Fund.
PTDF (2009): Enhancing Education and Training for Upstream Oil & Gas Business in Nigeria.
Salau, S. (2009): Nigeria may not meet 2010 Local Content Target, The Guardian (Wed) May 27, p. 55.
Sote, K. (1993): Beyond the Crude Oil and Gas Reserves, Jeromelaiho & Associates, 516 pp.
SPE (2009): Nigeria Annual International Conference & Exhibition Communique, 33rd Society of Petroleum Engineers Conference, Abuja.
Smith, A. (1776): The Wealth of Nations, Penguin, Andrew Skinner Edition.
Petroleum Expertise Ltd. (2010): Strategic Management of Oil & Gas Resources, Dubai, UAE.
Tadmor, Z. (2001). Engineering Education. Interim report of the Working Committee on Engineering Education and Technion-Israel Policy.
Tolkein, J. (2009): How Gas Obligation Can Crimp Local Content, Africa Oil + Gas Report, Vol. 3, March, pp. 11-12.
Wabote, S. (2010): The Highs and Lows of Nigerian Content, Africa Oil + Gas Report, Vol. 11, March, pp. 16-17.

A CITATION ON
PROFESSOR DULU APPAH

Dulu Appah, Professor of Petroleum & Gas Engineering, ***lives*** to most willingly offer his professional services to many universities in Nigeria, Germany and Ghana. He was born, to Mr. and Mrs. Edwin Appah, in Ozochi, Ahoada-East LGA and attended primary and secondary schools in Abonnema. At St. Joseph's (RCM) School, Abonnema, he was given double promotion from Elementary 4 to 6, but his father asked him to go through all the classes for a very good First School Leaving Certificate. In Elementary 5, the Head Master, Mr Awoyesuku, gave him an

entrance examination form for secondary school. He passed the examination from Elementary 5 and proceeded to Nyemoni Grammar School. Dulu passed the West African School Certificate with Grade 1 at Kalabari National College, Buguma. He was a Humboldt guest researcher, on Fines Migration and Swelling Cements Design for Deep Wells, at the Institute of Petroleum Engineering (ITE, Germany); a Fulbright scholar, on Wellbore Sand Production, at the University of Oklahoma, Norman, U.S.A. Professor Appah holds an M.Sc (with distinction) in Petroleum Engineering (1985) and a Diploma in Education (1985), as a Bureau for External Aid fellow, from the then Azizbekov Institute of Oil and Gas (now Petroleum Academy), Baku, Azerbaijan, and a PhD in Petroleum Engineering (1996) from the University of Port-Harcourt, Nigeria. The doctorate programme was sponsored by the School of Graduate Studies, University of Port Harcourt through Research/Teaching Assistantship award (1988-1990), Society of Petroleum Engineers (SPE) Region XII (Africa & Middle East) International Graduate Fellowship (1991/92), a position open to one candidate per region in a year and Fulbright Fellowship (1993/94). Research gave him a chance to travel all over the world and fulfill a dream. Distinguished Ladies and Gentlemen, I have told you where he has been, so you know who he is.

Professor Appah joined the University in 1990 as Lecturer II and has been external examiner to Universities of Benin, Uyo, Lagos, Maiduguri; Federal University of Technology, Owerri and Rivers State University of Science and Technology; and member of programmes accreditation teams. He is a called-teacher, born to a teacher and born to be a teacher, who seeks to expose students to the many complex problems of petroleum and gas production engineering. Professor Appah shows them destiny and destination, making decisions based on foresight. Previously, He was HOD (2002 – 2006) and Dean (2008 – 2009).

He is a man who does more with less, he turns a place around for good as seen at the PTDF building that houses the department he moved in there, as HOD in 2006; the Faculty Quadrangle beautification and accreditation of all programmes during his short stint as Dean. We were not totally surprised, but delighted at the electrifying and energizing moment of the pyrrhic victory of this man with a broad appeal. He came off the bench to be lifted up the apogee of his career as Pioneer Provost, College of Engineering, on April 3, 2013, to secure its future. The man with a large sense of humour makes it so pleasant to be around him. He consults widely on issues, he is open to ideas, and treats matters with an amazing simplicity and friendliness.

Dulu Appah was Laboratory Prefect in secondary school; President, Nigerian Students Union, Baku (1983/84) and Chairman, Committee of Heads of Petroleum Engineering Departments in Nigeria (2003-2007). He has robust leadership credentials, experienced in public office and understands current trends in management, politics and public policy having been HOD, Hall Warden, Chairman (University Time-Table Committee), Director, Coordinator, Member (IPS Governing Board), Associate Editor of Technical Journal, Dean, Manager and now Provost.

Professor Appah is a man of the people in many ways: a man with a human heart, endearingly humble to the core and does not raise himself above the poor but works for the poor and lives by the poor. He is a charismatic figure, amiable with a lively carriage and liberal in his politics with a cause much greater than self. Professor Appah is a good-man and a God-man, a man with whom I have an enormously respectful relationship, over three decades, that never waivers. He is very reliable, a team player who believes that the young shall grow and plays by the rule with the principle of inclusiveness. He tells the Ekpeye story in a variety of ways: “We look out for one another” speaks of his generosity with finances,

experience and knowledge. Professor Appah never paid for education, being on scholarships at local and foreign public expenses. He gives back to the university system through Annual Prizes instituted, from October 2009 to Date, to stimulate interest and encourage research in the specialisation:
Professor Dulu Appah Prize in Petroleum Production Engineering : ₦20,000.00

a. University of Port Harcourt, Port Harcourt (2009).
b. Niger Delta University, Wilberforce Island, Bayelsa State (2009).
c. Abubakar Tafawa Balewa University, Bauchi (2009).
d. University of Mines & Technology, Tarkwa, Ghana: $250/yr (2012).

Poached by the Petroleum Technology Development Fund (PTDF), he was persuaded to accept an invitation to take up the position of Manager (Planning, Research and Statistics) from 2009 to 2011. At PTDF, he planned the Fund's programmes and interfaced with different universities; government ministries, departments and agencies (MDAs); national assembly and professional associations. He attended technical and management courses such as Fund Raising for University Administrators, University of Iowa, U.S.A (2003); Problem Solving and Decision Making for Managers at Lagos Business School, Pan African University (2009); Financial Modelling;

Petroleum Project Economics and Risk Analysis at International Human Resources Development Company (IHRDC), Boston, U.S.A (2010), Arbitration, Mediation and Dispute Resolution in Oil & Gas Industry by Petroleum Expertise, Dubai, United Arab Emirate (2010).

Dr. Appah worked briefly, on long vacations, in Work-over Operations at Azikbekov Oil Company in Baku (1983-1985). This informed his choice of PhD in Wellbore Sand Production. He is a

registered Engineer and a member of many professional societies: Society of Petroleum Engineers (SPE), Council for the Regulation of Engineering in Nigeria (COREN), New york Academy of Sciences (NYAS), Institute of Petroleum (London), DGMK, Nigerian Mining and Geosciences Society (NMGS), Solar Energy Society of Nigeria, New York Academy of Sciences, among others. He is a consultant to many multinational oil companies in Nigeria, in Problem Wells Analyses. He conducts short courses on Sand Control and Well Stimulation, and has given many institutional talks, as well as social engineering lectures. He has received several academic, cultural and religious awards.

Engineer Appah has authored and co-authored over 70 journal papers in Petroleum Production and Reservoir Engineering. He is a regular panel discussant on Oil & Gas Policies, Education Management, Financing and Capacity Building. He is the Chi Ikoku Chair in Petroleum Engineering, since January 2013, heading a multi-disciplinary research group that investigates Formation Damage. His research Interests include Wellbore Sand Cleanout, Cement Slurry Design for HP/HT Wells, Fines Migration/Formation Damage, Produced Water Management, Hydrate/Emulsion Control, and Artificial Lift Optimisation, with emphasis on training tomorrow's university teachers and researchers.

Special Skills

Extensive technical authorship and publications. Completely fluent in English and Russian (Ekpeye and Kalabari as local languages) and very competent in German with a working knowledge of French and a number of Nigerian indigenous languages/dialects. Professor Appah is gifted with languages, easily picks up languages and thinks in the language he speaks.

Prof's research experience spans over 30 years. His key skills include technical problem solving using extensive engineering

background; establishing and supervising multidisciplinary teams; clear and concise presentation of complex proposals and study results; multi-cultural and multi-lingual, with comprehensive government and international contacts.
The pages of this Inaugural Lecture, with word-play, make an interesting reading.

Mr Vice Chancellor Sir, I present to you a gentle, friendly, good and God-man, family man and husband of Rose – a public health consultant medical doctor, university administrator and Provost, College of Engineering, practical researcher and laboratory man, polyglot, philosopher, word-smith, engineering educator, a church and community leader, Unique Uniport alumnus, Fulbrighter and Humboldtian, friend of students and the Book King, Professor Dulu Appah.

Professor Ebiokpo Amakoromo
ORATOR