Relevance of Mathematics in the Oil & Gas Industry

By

Gbenga Ajibua

WHAT IS MATHEMATICS?

- The abstract science of number, quantity and space, either as abstract concepts (pure mathematics), or as applied to other disciplines such as physics and engineering (applied mathematics)
- Pure Mathematics is studied for its intrinsic interest
- Applied Mathematics is directly applied to real world problems
- Discrete Mathematics is the study of mathematical structures that are fundamentally discrete rather than continuous
- Computational Mathematics involves mathematical research in areas of science where computing plays a central and essential role, emphasizing algorithms, numerical methods and symbolic methods.
- Mathematics is all around us in everything we do.

WHAT IS THE OIL AND GAS INDUSTRY ABOUT?

- Upstream: concerned with finding oil deposits (exploration) and getting the crude oil out of the ground (production)
- The Hydrocarbons requires the process of discovery and recovery
- Downstream: concerned with turning the crude oil into usable products (refining and petrochemicals) and delivering them to customers (distribution)

A CLOSER LOOK AT OIL AND GAS PRODUCTION

- As oil becomes more difficult to find and more expensive to extract, mathematical algorithms and simulations play an even more important role in the business.
- Inversion of seismic data (using seismic traces to map subsurface rock formations) has long been an important ingredient in oil prospecting. Advances in algorithms and computer hardware and software have brought 3 and 4 dimensional simulations within reach.
- Large scale basin models help International Oil Companies (IOC's) decide whether a rock formation is a promising candidate for drilling
- Dynamic simulations also enable oil companies to analyse and minimise the risk of accidents before a facility is certified for production. However, the need for better risk analysis and modelling was brought home by the BP oil spill. This shows clearly that faster models using real time data are needed to monitor conditions in a well and assess damage in the case of an unexpected event.

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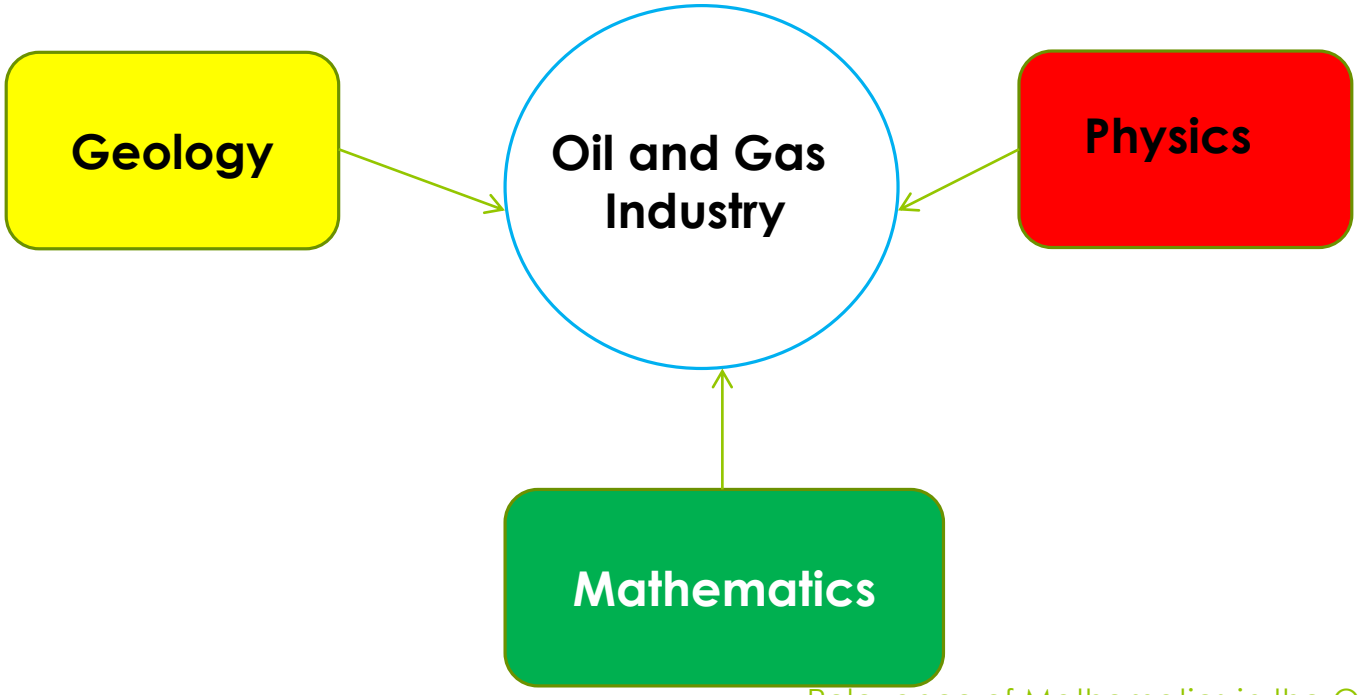
RELATIONSHIP BETWEEN MATHEMATICS AND THE OIL AND GAS INDUSTRY

- Mathematics is used for example to estimate the volumes of oil and gas in reservoirs to optimise performance of wells and pumps that get the oil and gas to the surface, to improve the quality of the fossil fuel projects, and to minimise vessel transportation and final delivery costs.
- Philip Emeagwali said ''my mathematics came from oilfields''. He further stated that ''I invented 36 partial derivatives and used them to reinvent nine partial differential equations that can be used by the petroleum industry to recover oil.
- His equations were the most advanced and the most useful form of calculus which he invented by borrowing the algebraic formula, force equals mass times acceleration (F=ma)

FEEDER PROPOSITION



USE OF MATHEMATICS IN DRILLING

- Mathematics is used for improvement in mathematical computer modelling, probability analysis, and new technologies like horizontal drilling and enhanced oil recovery, etc. All this has drastically improved the toolbox of the petroleum engineer
- Assess costs and estimate production capabilities and economic value of oil and gas wells
- Evaluate viability of potential drilling sites
- Develop plans for oil and gas field drilling.
- Direct and monitor the completion and evaluation of wells, well testing or well surveys

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USE OF MATHEMATICS IN DRILLING Contd.

- Specify and supervise well modification and stimulation programs to maximise oil and gas recovery
- Interpret drilling and testing information for personnel
- Assist engineering and other personnel to solve operating problems
- Confer with scientific, engineering and technical personnel to resolve design, research and testing problems
- Analyse data to recommend placement of wells and supplementary processes to enhance production.
- Monitor production rates, and plan rework processes to improve production

IMPORTANCE OF MATHEMATICS KNOWLEDGE IN THE OIL AND GAS INDUSTRY

- A required course for a certificate of technical studies in oil and gas production technology in Louisiana includes Math 129 - Applied Technical Mathematics and/or Math 102 – College Algebra
- Maths required by Petroleum Engineers are college algebra, geometry, Calculus I and II, linear algebra, differential equations and statistics

EMPLOYABILITY SKILLS: A FAST TRACK PROCESS

- Basic skills needed to get, keep and do a job well
- Employer's biggest concern is finding reliable employees and then training them.
- The difference between the skills an applicant has and the skills required for the job is referred to as the skills-gap. These are concerns for HR Managers and business owners looking to hire employees that are competent with employable skills.

PLEASE ANSWER THIS PERSONNALY

- What skills do you currently possess now?
- What skills are you looking at possessing after graduation?

INCREASE EMPLOYABILITY SKILLS

Engineering

- University of Aberdeen – Msc In Oil & Gas Engineering accepts applied mathematics degree for this course
- Heriot Watt University in Dubai- Msc in Petroleum Engineering accepts mathematics degree

HSE

- National Examination Board in Occupational Safety and Health (NEBOSH) –NGC and IGC
- NEBOSH International Oil and Gas Certificate

RESULTS OF INCREASED EMPLOYABILITY SKILLS

- Drilling Engineers: who analyse drilling performance and factors affecting cost and efficiency
- Facilities Engineers: focus on the support, management and execution of construction projects such as installation of oil, gas and water production, separation and injection facilities, etc that allow the exploration of new frontiers
- Geologists and Geophysicists: undertake survey and interpretation work and assess the prospects of production of oil and gas in new areas
- Petroleum Engineers: who apply the principles of mathematics, physics, chemistry and engineering to the recovery and separation of hydrocarbons
- Reservoirs Engineering: who estimate field reserves of oil and gas using mathematical models and computer programmes

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A MATHEMATICAL REVOLUTION

……it was a two part, mathematical formula and programming. In the mathematical formula I encoded the law of physics-a set of factual statements that describe reality-as nine new equations for 'seeing' inside an oilfield. Because my new equations incorporated inertia forces, they were more accurate. Oil has the disposition to remain inert and this inertia force must be overcome before extracting oil from a petroleum reservoir-----Emeagwali

FACTS TO NOTE

- The Oil industry is the largest single user of mathematical programming.
- Operations research branch of maths helps organise the production to maximise output or minimise cost.
- Emeagwali discovered a fundamental error in the equations used by oil companies like Exxon Mobil, Shell, etc, namely four forces exist inside every petroleum reservoir; yet Exxon Mobil equation had summed only three forces. He further created new mathematics by correctly summing all four forces, namely: pressure, viscosity, gravity, and inertia.
- Mobil later invited him in a letter dated March 19, 1990 to help the company in reservoir simulation. This is an important mathematical discovery that helps produce more oil (Phillip Emagwali, June 1996)

MATHEMATICS CAREER PATH IN THE OIL & GAS INDUSTRY

- Geophysicists
- Reservoir Engineer
- Drilling Engineer
- Wells, Reservoir & Facilities Management
- IT
- Finance
- Etc.

(You can be who you want to be in the Oil & Gas Industry)

MATHEMATICIANS STORIES SEE IT AND BELIEVE IT

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Courtney Stephens (BS Mathematics 2001 – Senior Commercial Analyst at Marathon Oil Company, USA.)

- After college, I wasn't quite sure what to do with my **mathematics degree**. I had chosen **mathematics** as a major because I love problem solving and always found the subject challenging. When I married a chemical engineer, I knew my future could likely end up in America's Energy Capital, Houston, Texas.
- **Without a clue of how mathematics can be applied in the energy industry**, I sent my resume off to a few recruiters in Houston and got several immediate responses. It turns out that math degrees are sought out in the energy industry for technical and analytical positions.
- **Mathematics can be applied in multiple sectors of the energy industry**. In addition to the big oil companies, there are also many software companies, oil and gas investment banks, energy lending firms, engineering consultancies, etc. that service the energy industry. **Companies need employees that can analyze data, model future growth, and calculate economics**. Most companies purchase commercial software for modelling future oil and gas production, but these sophisticated programs are best handled by mathematicians.
- **I started my career as a petroleum analyst** at an engineering consultancy. I worked as part of a multidisciplinary team that modelled future oil and gas reserves, production, and profit. The team included geologists, geophysicists, reservoir engineers, and petroleum analysts. **As the petroleum analyst, it was my job to analyze the historical cost, price, and production data to determine input parameters for the new models. I was also responsible for running the model, performing sensitivity analysis in conjunction with the reservoir engineer, and checking the model for errors and accuracy.**

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Courtney StephensContd.

- I then moved to an investment bank specializing in oil and gas transactions, sometimes called acquisition and divestiture firms. These boutique firms serve as the realtors of the oil and gas industry, helping companies to buy and sell oil and gas properties. Again part of a multidisciplinary team, as an engineering technologist one of my responsibilities was to locate synergies within the industry. For example, if Company ABC has one thousand gas wells in Texas and one oil well in California and Company XYZ has one thousand oil wells in California and one gas well in Texas, doesn't it makes sense to coordinate a trade? Worldwide, there are thousands of databases that one can mine and manipulate to find potential value.
- In 2005, I was hired as a senior level engineering technician at Marathon Oil Company. At Marathon, I have worked as part of the budget planning team, the exploration team, the production and operations group, and now the business development team. As part of the business development team, I am leveraging all of the skills that I have built thus far in my career, including stochastic modelling techniques, database manipulation, synergy identification, and more. More than ever before, oil and gas companies have a strong focus on safety and the environment. As new technologies develop to meet worldwide energy needs, mathematicians will continue to be in demand in the oil and gas industry. For mathematicians just starting their corporate careers, I highly recommend exploring the opportunities at Marathon Oil Company and in the energy industry.

ADEWALE BOLAJI (Head of Business Planning at Shell Nigeria)

- I am a **first class graduate of Mathematics** and a professional with over 20 years experience in the Oil and Gas and Banking Sectors; I possess leadership skills involving customer relations, managing, developing and motivating teams to achieve their objectives, able to work on own initiative and a team player. First-class analytical, communication, interpersonal and problem solving skills with flair for new challenges.

  As a systems analyst with the UBA banking group, I was able to resolved a major taxation related systems issue and ensured quick turnaround that prevented loss of revenue and industrial action that might have resulted from non-resolution of the said problem within the given time frame.
  In my role as Oil & Gas portfolio economist, I improved the company's audit rating to **GOOD by calculating the Economic Limit Test used in booking reserves for Shell Development Company in Nigeria in 2007.**

  Most recently as **Shell Oil & Gas Head of Business Planning**, I have the responsibility to analyse and propose the most viable options best suited the overall strategy and mission for the Royal Dutch Shell (RDS) Upstream, and Downstream operation in addition to ensuring implementation for business outcome.

VIANNET OKOUMA (Bsc Mathematics with Theoretical Physics

- **Assets Development Director**
- Gabon Oil Company
- June 2013 – Present (1 year 10 months)Libreville, Gabon
  - **FDP & Studies Team Lead**
- Shell Oil Company
- September 2012 – May 2013 (9 months)Greater Pittsburgh Area
- **Principal Reservoir Engineer**
- Shell Oil Company
- September 2011 – October 2012 (1 year 2 months)Calgary, Canada Area
  Technical Assurance (TA), Peers Assists, Discipline Assurance and Controls Framework (DCAF). Advise on workflows, capabilities, etc ...
- **Snr. Staff Reservoir Engineer**
- Shell Oil Company
- April 2009 – September 2011 (2 years 6 months)
- **Snr. Staff Reservoir Engineer**

VIANNET OKOUMA Contd.

- **Total Canada E&P**
- September 2008 – March 2009 (7 months)
- **Senior Reservoir Engineer/Gbaran Ubie Study Team Lead**
- **Shell Petroleum Development Company (SPDC)**
- August 2006 – August 2008 (2 years 1 month)
- **Senior Reservoir Engineer**
- **NAM, B.V (Assen)**
- September 2004 – August 2006 (2 years)
- **(VC) Reservoir Engineer**
- **NAM, B.V (Assen)**
- September 2002 – September 2004 (2 years 1 month)
- **Reservoir Engineer**
- **Shell Gabon, Gamba**
- October 1998 – September 2002 (4 years)

ANUSHA SEKAR (Bsc, Msc, Phd Mathematics as Research Geophysicist at Chevron San Ramon, California, USA.

- **Mathematician** and research scientist with a strong background in research and development, mathematics theory, computational skills, and data optimization. Currently employed as a Research Geophysicist with Chevron. Hold **Ph.D., M.S., and B.S. in Mathematics degrees, as well as an M.S. in Numerical Analysis.**

SAMPLES OF ADVERTISED JOB VACANCIES IN THE OIL & GAS INDUSTRY

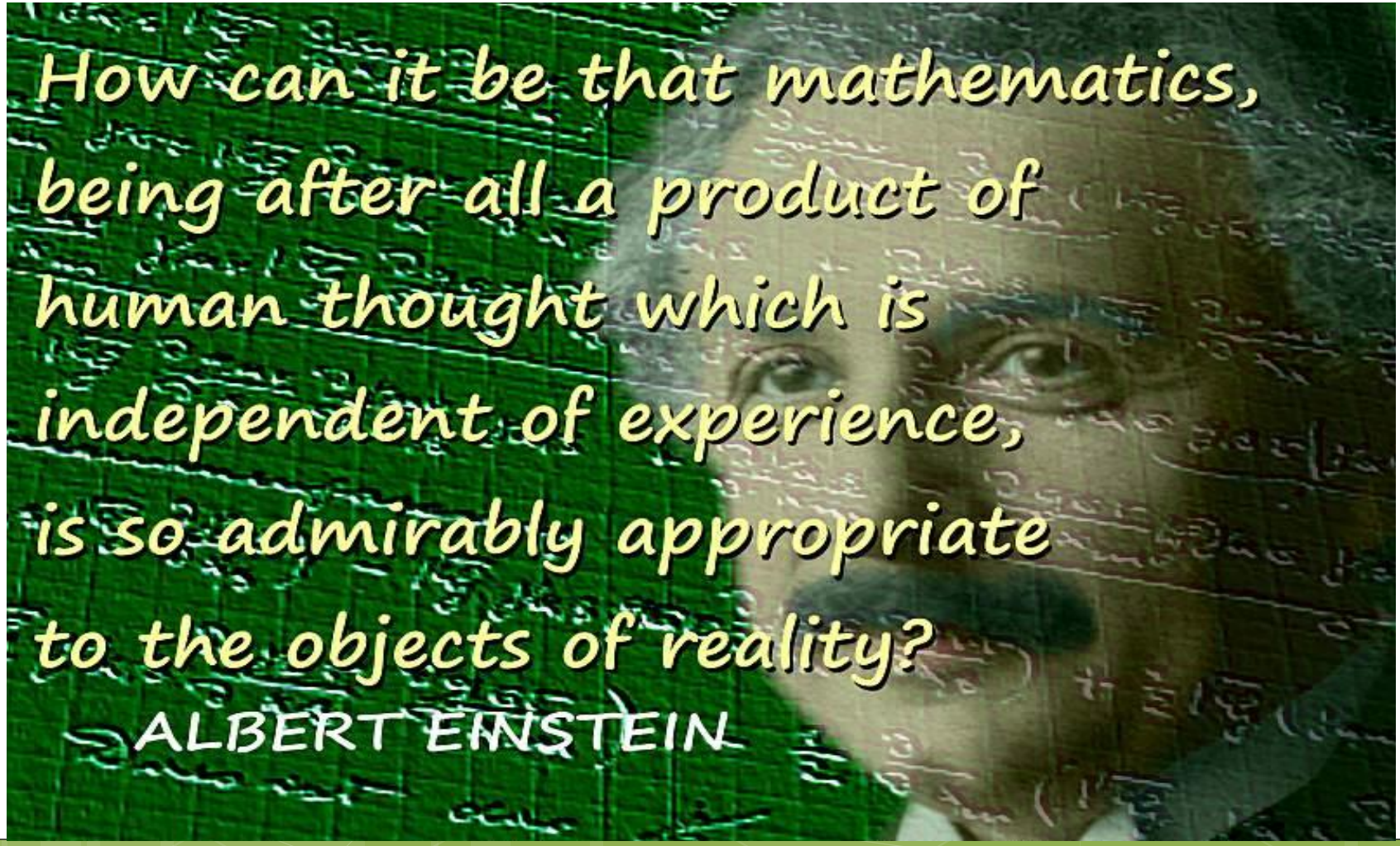
- **Job Title: BUSINESS ANALYST**
- **Job Reference No.**: 2012-IT-05
- **Job Description:**
- . Business Anlaysis of IT projects
- . Coordinate project initialization, prioritization and execution plans
- . Maintain optimum data quality levels
- **Required Qualifications:**
- Bachelor's degree with a minimum of Second Class Upper Division in Computer Science, Electrical/ Electronic Engineering, **Mathematics or Statistics**
- **Required Skills:**
- · Strong analytical, project management and business process skills
- · Good knowledge of software development
- · Strong end to end experience of Project lifecycle
- · Excellent interpersonal skills
- · Ability to document complex business processes
- · Effective communication skills

SAMPLES OF ADVERTISED JOB VACANCIES IN THE OIL & GAS INDUSTRY Contd.

- Chevron is one of the world's leading integrated energy companies, with subsidiaries that conduct business worldwide, including Nigeria. Chevron Nigeria Limited hereby invites applications from qualified candidates for employment. These positions will be initially located in Lagos, Abuja and Warri. The company also provides career opportunities to its workforce in other Chevron's worldwide operations. Chevron is committed to sound environmental and safety practices and exhibits cultural diversity. Our employees conduct their day-to-day work with the principles outlined in 'The Chevron Way' which expresses our vision "to be the global energy company most admired for its people, partnership and performance". If you are interested in becoming a valued employee of Chevron Nigeria Limited, a company that provides excellent career opportunities and welfare packages, this opportunity awaits you! Will you join us?
- Job Reference No.: 2012-IT-01
- Job Title: **INFRASTRUCTURE ANALYST - NETWORK SUPPORT**
- Job Description: . Install and maintain telecommunication equipment such as microwave radio, VSAT systems, PABX systems, Fiber Optics and Optical line equipment, routers, switches, DC power systems and cabling infrastructure. . Plan, co-ordinate and manage IT projects in all company locations. Prepare technical specifications and bid package for tendering out major telecommunication projects. . Participate in CPDEP process for IT projects. . Liaise with consultants, equipment manufacturers and vendors on project implementation and deployment of new technologies. . Contribute to long term technology deployment plan in the company . Participate in the evaluation of vendors and contractors tender proposals . Liaise with Nitel, Ministry of Communications, Nigeria Communications Commission on issues relating to government policies, permits and licenses
- **Required Qualifications**: Bachelor's degree with a minimum of Second Class Upper Division in Computer Science, Electrical/Electronic / Telecommunication Engineering, Physics/ Electronics, **Mathematics or Statistics plus relevant Cisco certifications Required Skills**

QUOTE OF THE DAY

One reason why mathematics enjoys special esteem, above all other sciences, is that its propositions are absolutely certain and indisputable….



FOOD FOR THOUGHT

- Emegwali's innovation lies in seeing what every physicist saw, but thinking what no geologist thought.
- Innovative ideas require unconventional thinking
- Think without boundaries
- Behind biology is chemistry; behind chemistry is physics; **behind physics is mathematics**; and **behind mathematics is God who created biology**
- Solve the problem, and not the formula

.....Emeagwali

CONCLUSION

- Petroleum Engineering is all about Mathematics and Physics.
- The Exploration and Production of Hydrocarbons is all about Physics, Mathematics and Geology.
- Everything in life is centered around Mathematics including the Oil and Gas Industry.
- As a Mathematician, you do not have a limitation except yourself.
- As Mathematicians, the Oil industry welcomes you on board.
- See you at the top!

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THANK YOU FOR LISTENING GREAT MATHEMATICIANS