Incorporating oil and gas software into petroleum engineering education curriculum

Okafor Henry Elochukwu
Universiti Technology Malaysia, Skudai, Johor Bahru.

Mohammad Joukarborazjany
Universiti Technology Malaysia, Skudai. Johor Bahru.

Farshid Attarhamed
Universiti Technology Malaysia, Skudai, Johor Bahru.

***Abstract*—Petroleum engineering education is important in training petroleum engineers and the integration of oil and gas softwares into academic syllabus will produce a digital petroleum engineer. Different softwares are in use in the oil and gas industry today, this paper suggests how these softwares can be integrated into academic coursework of students undergoing training in petroleum engineering. On this basis it is necessary to start inculcating the knowledge of computer programming and software development in teaching petroleum engineering in schools. Petroleum engineering students should be introduced to the basics of programming at the early stages, encouraged to solve canned programs and at the later stages practice with industry-based software to expose the students to field problems and how it is solved. The major objective is to improve student's sense of engineering judgments and ability to interpret data and results. This paper highlights two major approaches by which oil and gas software can be integrated into academic coursework. The first approach illustrates a scenario where by students undergoing petroleum engineering training at the university level (undergraduates or postgraduates) are introduced to programming language. The second approach has to do with the use of industry-based oil and gas software. In this paper it is clearly explained how this industry-based softwares can be incorporated into academic coursework and with its expected outcome.**

Keywords- Petroleum Engineering Education; Oil and Gas Softwares; computer programming; Petroleum Engineering Academic Coursework; canned programs.

I. INTRODUCTION

The oil and gas industry is dynamic and it requires dynamic individuals to match up with its technological revolution. Computing in the oil and gas industry has shifted from the crude slide rule to a hand calculator and presently to a modern, sophisticated and state-of-the art computing systems. The industry requires that this sophisticated computing system would be manned by highly trained and well learned individuals. Now, the question is where will this individual come from? Where will they gain basic knowledge of how the system works? The ultimate answer is an improved petroleum engineering education adequately inculcating the use of oil and gas software.

More so, the search for oil and gas is becoming tedious, which led to innovations such as smart fields, e-fields, intelligent wells using latest technology. These innovations are the combine ideas of industry professionals and experts from the academia. Thus, petroleum engineering education is greatly appreciated in these innovations and the role played by petroleum engineering education cannot be relegated to the background. Petroleum engineering education is foremost in modeling a perfect digital petroleum engineer for the future [1] and a digital petroleum engineering student should be able to integrate and use of oil and gas software with academic course work. A qualified petroleum engineer should be able to use, analyze, integrate some oil and gas software.

Petroleum engineering is offered in higher tertiary education center such as university, college and polytechnic. At the universities, colleges and polytechnics petroleum engineering education are well structured with a standard curriculum. Merging the already stringent curriculum with the practice of oil and gas software looks too difficult. This author disagrees and believes that the usage of software alongside the petroleum engineering education curriculum is achievable. This can be achieved by including oil and gas software or canned computer programs from the rudimentary stage of petroleum engineering education.

II. Computing as it was before

Some five decades ago, industry professionals and students undergoing training in petroleum engineering used tools such as slide rule to carry out computational task. The slide rule gave way to now primitive hand calculators which was used to achieve similar task. The hand calculator at least eliminated the time spent on processing data, displaying results and also increased accuracy of result.
With the emergency of DOS based programming language such as FORTRAN, BASIC and personal computers, computing for petroleum engineering courses cannot only use but also develop programs to solve problems relating to their studies [2].

III. Computing at present

With the advent of miniature processor built for fast processing and alongside a gamut of computer programs. This is how the oil and gas industry have advanced technologically with the aid of these computing devices. The present day computer is built for multi-purpose tasks and complex computational procedure. This attribute is needed for application in the oil and gas industry.

Oil and gas software are developed to solve petroleum engineering problems, this software are able not only help to analyze but also give information about well and reservoir performance. Now, the question is what kind of software should be used for petroleum engineering education? Should undergraduate in petroleum engineering start off with canned programs alongside academic course work? Should undergraduate learn how to develop his or her own program to solve problems? Should petroleum engineering curriculum include oil and gas software training?

IV. Curriculum of petroleum engineering education

The course content of petroleum engineering education is designed to enable the student acquire knowledge to practice in the oil and gas industry [3]. Employers of labour in the oil and gas industry are always satisfied by the understanding of the profession as demonstrated by university graduates but this is only applicable to the theoretical understanding of the profession. Employers are shocked to find out that these same university graduates show little or no appreciation for the use of computers to solve petroleum engineering problems. Though, these cannot be concluded for all university graduates in the discipline.

This can be tackled by taking a good look at how the curriculum for training of a petroleum engineer is structured. The syllabus for each course is designed at each level of training to impact the basic knowledge and teach pre-quisite courses for the understanding of other courses. If the courses are ladened with computational procedures, then the use of computers and available computer programs will be appreciated for student understanding. More so, if the course content is majorly theoretical and require little or no computational, then the course should be structured in such a way that explanation will suffice. But on the other hand, if the course requires difficult computational procedures to solve problems or explain the course, then computer applications (software) will be required. This software can range from canned computer programs developed by students themselves to solve problems to industry based software.
To further explain this point, two approaches will be adopted to show that petroleum engineering can be improved if the use of software is integrated into academic course work.

V. Method of integration of computer programs into academic course work

A. Approach 1

This approach divides the curriculum into two major divisions which includes junior level for the undergraduate and senior level for the postgraduate students.

B. Junior level

Undergraduates should be made to take courses on programming alongside their academic coursework. Programming language such as FORTRAN, BASIC should be introduced at this rudimentary stage. The purpose of introducing this programming language to petroleum engineering to petroleum is to make them become familiar at their level how to develop simple programs to solve problems. Also, up till now some oil and gas softwares still run on DOS environment. If undergraduate at this level can write programs using FORTRAN or BASIC this will eventually lead to them appreciating windows based programming because they are already familiar with the syntax involved in programming.

In addition, the programs developed by the undergraduate students should be in line with the coursework they are taking. Thus, assignments, class works, test which involves lengthy manual computational procedures can be done using computer programs to solve it and this computer programs will be developed by the students. Inculcating the use of computer program for student is paramount for the overall success of building a perfect petroleum engineer ready to face the challenges of the dynamic oil and gas industry.

Standard canned programs should be made available for undergraduate students to also assist them in learning the course. These canned programs will contain rudimentary programs to support the coursework being undertaken by the undergraduates. These canned programs can be either developed by the students under the supervision of the course instructor.

C. Senior level

Postgraduate student at this level, it is believed that they are already knowledgeable on how to develop computer programs to solve problems. Postgraduate student without knowledge of programming are expected to take courses in programming to understand and develop their own programs.

But at this level of education, postgraduate student should not only dwell on developing programs to solve specific problems but rather be involved in solving a real life problem with extensive scope and with industry relevance. Postgraduate students should be widely exposed to oil and gas software and at this level critical thinking and problem solving skills will be impacted to the student while improving their proficiency on this software. Also, the students will be exposed to field problems such as field development project and their ability to use some of the software will be applied to implement the project.

This paper present a developed sample canned programs for various petroleum engineering courses for both undergraduate and postgraduate level as shown in figures 3 - 8.

D. Approach 2

This approach involves the use of industry software as a resource tool for training petroleum engineering students. This software will be designed according to student academic coursework. The advantage is that student will be able to use the application to solve class problem and also use the application to solve field problems. This software is company's property and its accessibility is difficult unless there is a university-industry agreement whereby company can license their software application for use by the university.

Assuming the area of operation of the company can be reservoir simulation, well test analysis, well logging etc the application software from the company in these areas should be integrated with academic coursework of the same area. This method is recommending that company software application should be used for training the student and simultaneously covering the theoretical section of the course. Let assume the company software application is based on well testing, well testing will be covered theoretically and using software application. To achieve this, the course content on well testing should be divided in sections and each section is explained and practiced with the software application.

Below is a course content for university X, department of petroleum engineering for well testing. See appendix

Group assignment

Given a specific well test data, using software application determine well and reservoir parameters, produce plots. Make a report from well test analysis using soft. Prepare a 10-minute presentation of your report.

VI. SURVEY

A survey was conducted to ascertain which area(s) of petroleum engineering will the student want oil and gas softwares to be made available by the university/faculty. The target respondents were undergraduate and postgraduate students of the faculty of petroleum and renewable energy, Universiti Teknologi Malaysia. The questionnaire was designed in such a way that the responded has to give reasons for his or her choice.

Which area(s) should oil and gas software be made available for FPREE:

Undergraduate student:

Table 1: UTM Undergraduate student choice areas where oil and gas software be made available

Petroleum Engineering Areas	Percentage
Reservoir Engineering	80%
Production Engineering	65%
Formation Evaluation	70%
Drilling Engineering	80%
Petroleum Economics and Management	40%

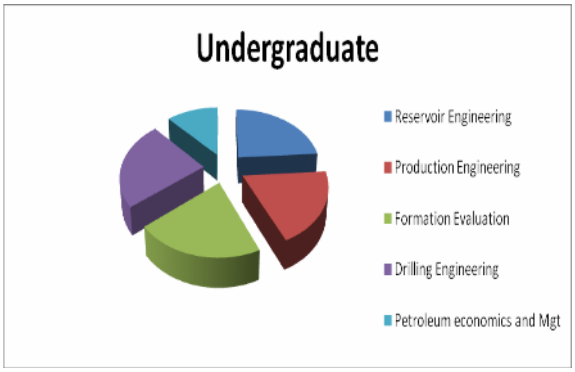

Figure 1: UTM Undergraduate pie chart distribution for areas
oil and gas softwares be made available.

Postgraduate students:

Table 2: UTM Postgraduate student choice areas where oil and gas software be made available

Petroleum Engineering Areas	**Percentage**
Reservoir Engineering	96%
Production Engineering	80%
Formation Evaluation	80%
Drilling Engineering	70%
Petroleum Economics and Management	60%

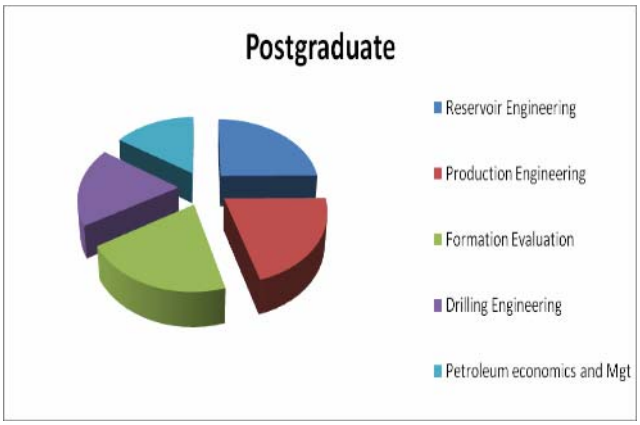

Figure 2: UTM Postgraduate pie chart distribution for areas oil and gas
softwares be made available.

VII OBSERVATION AND RECOMMENDATION

From the result of the survey, it is observed that reservoir engineering, production engineering, formation evaluation and drilling engineering are the areas students' wants software to be made available. Sequel to this, the author recommends that FPREE should make available softwares in these areas. The author also believes that the availability of these softwares in the aforementioned areas of petroleum engineering will tremendously increase students learning and better prepare them for the challenges ahead.

A. Factors affecting the use of software in universities

1. The major problem is interest both on the path of lecturers and students. Some lecturers does not see the benefits, while some believe that it will put more intense work on the students whose academic curriculum is already overloaded. On the path of students who believe that being proficient in word processing application is sufficient.
2. Again getting these oil and gas software application available needs the support of faculty. Due to budgetary constraints to make license for the software available.
3. Poor university-industry relationship.
4. Inadequate technical personnel or instructor to teach or training the students on how to use the software.
5. Inequipped computer laboratory. By a rule of thumb a computer laboratory personal computer to person ratio of 1 to 2 is in equipped.

6. Non-availability of professionally designed canned software to meet up with the academic curriculum of petroleum engineering.

B. Overcoming these factors

1. Firstly, the interest of both students and lecturer is very important. The responsibility falls on the shoulders of the lecturers to build interest into the student. This can be achieved by making programming a compulsory course to be undertaken by students and students are to learn how to write simple engineering programs.
2. During the pre-session plan by faculty members, the acquisition of these softwares should be part of the discussion and all necessary budget or funds should be allocated and set aside.
3. Another way of making oil and gas software available is by strengthening university-industry relationship. To have professionally designed software available in the faculty, the faculty should have a special kind of agreement with its donor company. This special kind of agreement was reached between a university and company where the company donated the resources for training of undergraduate and postgraduate students and on graduating they work for the company. These close relationship with the company not only provided the students with the training but also a ready employment after graduation.
4. Availability of standard computer laboratory. The student need a place for practice, the computer laboratory should be furnished with the necessary equipment to enable the student practice, carry out their individual and group assignment.

C. Benefits of integrating oil and gas software in petroleum engineering education

1. The use of oil and gas software to train petroleum engineering students will help build a proficient and competent digital petroleum engineer for the future.
2. It will help to improve the thinking and judgment of petroleum engineering students.
3. It provides alternative way for petroleum engineering students to analyze and interpret result.
4. With the increase in proficiency, petroleum engineering students will become competent and upon graduation possess skills employers of labour sought after.
5. Graduates of petroleum engineering adequately trained using oil and software can set up consultancy firms, where they can use the skills acquired to solve field problems.
6. Faculties that are known to offer exclusive trainings with oil and gas software alongside academic coursework are always renowned and highly recommended worldwide.

VII. RECOMMENDATION

To effectively integrate the use of oil and gas software in petroleum engineering education, we recommend the following:

1. Oil and gas software should be made available and the use of this software should be divided into sections and used for training the student alongside academic coursework.
2. Standard computer laboratory with all necessary equipment should be available. The computer laboratory is where students can come and practice. Students must be encouraged to develop their own canned program to solve specific problems in their coursework. The essence is to expose them on how this software work and when they start using oil and gas software their sense of judgment and appreciation would have improved.
3. The competency of the software instructor is very important. Software instructor that will assist in the training program must be adequately and efficiently trained on the software itself.
4. Apart from the time allocated to the coursework, a compulsory 2-hour must be allocated for student to practice. This time will be utilized by the student to solve problem and report back to the course lecturer.
5. In the absence of standard oil and gas software, petroleum engineering department or faculty can acquire standard petroleum engineering canned programs developed by experts in the field of petroleum engineering.
6. Maintaining a healthy university-industry relationship, if this union can blossom, its benefits to the university or faculty is enormous.
7. Petroleum engineering department can enter into an agreement with external professional experts to provide the training for the students.
8. Professional bodies like the society of petroleum engineers (SPE) should be able to: set up standard for training petroleum engineers and negotiate with oil and gas companies, other petroleum professional affiliation to assist universities to improve the teaching of petroleum engineering.

VI. CONCLUSION

To effectively integrate the use of oil and gas software in petroleum engineering education, students and lecturers has to build interest and appreciate computer programming which will be used to develop engineering programs to solve problems. These programs will be

developed to solve specific problems related to academic coursework. Again, industry based software can be introduced into academic coursework, taught alongside with the course syllabus for both undergraduate and postgraduate students.

APPENDIX

Select the bit which gives the lowest drilling cost based on the following information:

	Bit A	Bit B
Bit cost ($)	700	4000
Bit rotating time (hr)	8	61
Bit non-rotating time (hr)	1	1
Drilled depth (ft)	106	415

If the operating cost for the rig is $1,000/hr and trip time of 10 hours.

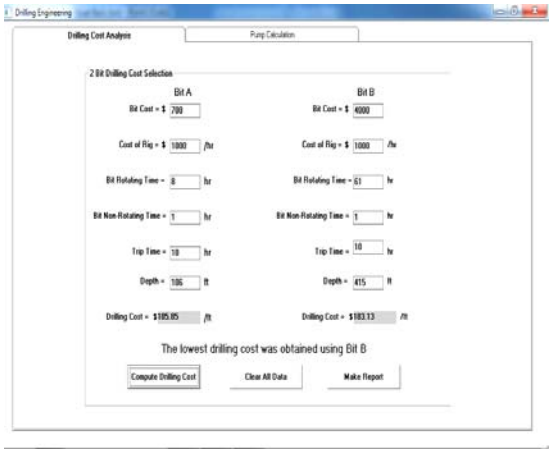

Figure 3: Canned program developed to calculate drilling cost and selection design

A triplex pump having 6-in and 11-in. strokes operating at 120 cycles/min and a discharge of
3000 psig. Compute the following:

(a) Pump factor at volumetric efficiency of 100%
(b) Flow rate
(c) Pump power

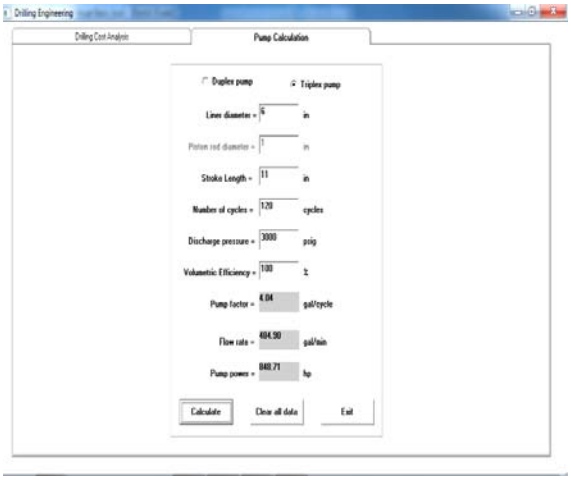

Figure 4: Canned program developed to calculate pump power and efficiency of pump

From information obtained from Log, determine water saturation and STOIIP. Other available information:
Area extent = 150 acres
Oil FVF =1.2 res bbl/STB

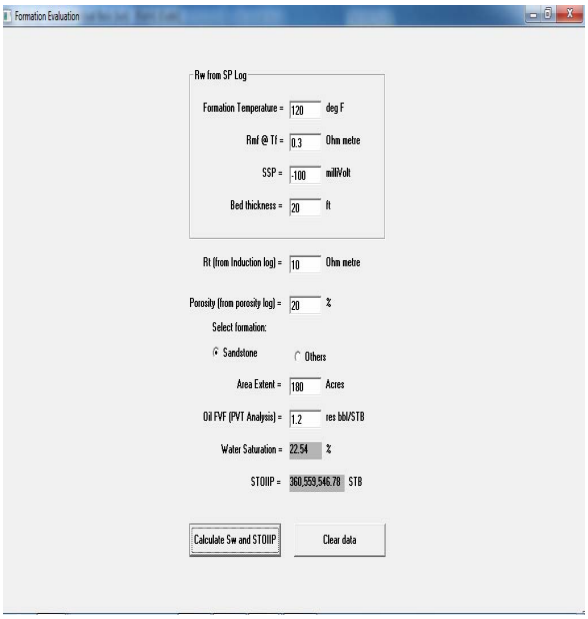

Figure 5: canned program developed to calculate STOIP from Log information.

Calculate the pseudo critical temperature and pressure for the components. Using: critical properties of components and Brown et al correlation.

Components	mol fraction
C1	0.7
C2	0.2
C3	0.1

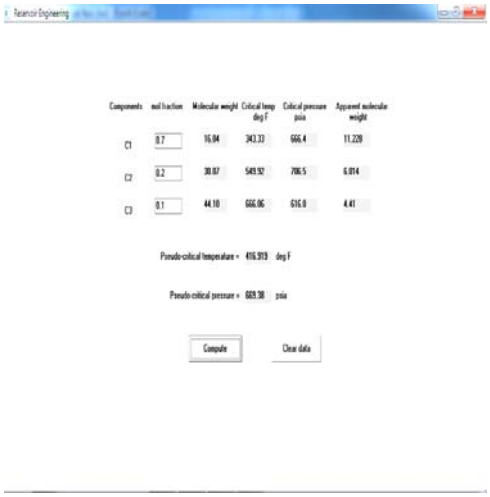

Figure 6: Canned program developed to calculate pseudo critical properties of gas

What is the future worth of an investment of $5,000 at 8% interest for 5 years?

Compute the net accrued payment of a series of regularly payment of $800 at 6% for 10 years.

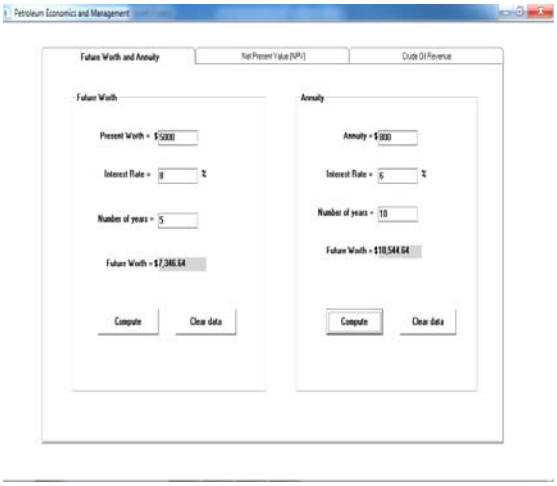

Figure 7: Canned program developed to compute future value and annuity.

Compute net present value for an investment of $75,000. Cash flow for 5 years at interest rate of 10%.

Years	Cash flow ($)
1	20,000
2	25,000
3	30,000
4	35,000
5	40,000

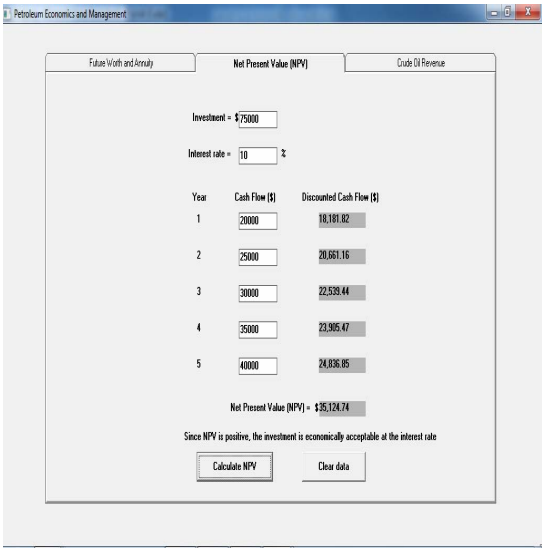

Figure 8: Canned program to developed to calculate Net present Value of a project.

Topic	**Topic outcome**	**Software application outcome**
Introduction to well testing -What is well testing? -Objectives of well testing	Student should be able to: -Define well testing -State the objectives of welltesting Well testing operation	
Types of well testing	Know types of well test Potential test, GOR test, -Characteristics of each test type	
Bottom Hole Pressure Test	-Types of BHP test: Draw down test, Build up test, injection test,	
Objectives of BHP Test	-Determine well parameters	With the use of software application to determine -Skin -Wellbore storage -Productivity test -Flowing pressure in wellbore -Static gradients -Fluid distribution in wellbore.
	-Determine reservoir parameter	with the use of software application to determine -Average pressure in the drainage area. -Permeability -Distance to boundaries -Gas/oil contact
Uses of BHP Test	-Result obtained from BHP test	with the use of software application and result from BHP Test -Select candidate for stimulation -Carryout reservoir simulation
Analyzing Test	-Calculate and plot build up test	with the use of software application generate -MDH plot -Horner's plot -Type curve overlay -Determine well parameters from plot.

ACKNOWLEDGEMENTS

My sincere gratitude goes to almighty God for the completion of this work. A big thank you to Dr Steven Eluwa for painstakingly proof reading this work.

REFERENCE

[1] Ershaghi, I., P. Donald, and M. Mehrzad. 2009. Strategies for training digital petroleum engineer. Houston, Texas. Paper SPE 123896 *SPE Digital Energy conference and exhibition*.

[2] Koederitz, W.L., B. Macon, and W.R.Whitehead. 1991. The use of computers in undergraduate petroleum engineering curricula. *Journal of Petroleum Technology*.187-196.

[3] Dougherty, E.L, and I. Ershaghi. 1986. What is the current role of computers in petroleum engineering education, and what should it be? *Journal of Petroleum Technology*. 197-207.

[4] Mian, M.A, *Handbook for the practicing engineer*, *volume 2*, 1992, Tulsa, Oklahoma,
Penn Well books, 286.

AUTHORS PROFILE

Okafor Henry Elochukwu, holds a bachelor degree and master degree in petroleum engineering from the University of Port Harcourt and Universiti Teknologi Malaysia respectively. Author of yet to be published technical paper: “Prevention first: Asphaltene induced formation damage mitigation”.

Mohammad Joukarborazjany, holds a bachelor in applied chemistry from the Islamic Azad University, Firozabad, master degree in Petroleum Engineering from Universiti Teknologi Malaysia. This author specializes in drilling and production petroleum engineering.

Farshid Attarhamed, holds a bachelor degree in solid mechanical engineering from the Islamic Azad University, Tehran south, master degree in petroleum engineering from University Teknologi Malaysia. This author specializes in drilling engineering and well completion.