

# **Developing the Petroleum Institute in Abu Dhabi, United Arab Emirates: A Case Study of Cooperation Between Industry in the Middle East and a United States University**

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## **Summary**

At the request of the Abu Dhabi National Oil Company (ADNOC), the Colorado School of Mines has been retained to provide academic leadership required to design, start up, and operate the Petroleum Institute (PI), a world-class educational institution dedicated to educating engineers for the oil and gas industry. The PI will offer undergraduate and graduate degrees in five engineering programs related to ADNOC operations. A Foundation Program is also offered to help students make the transition from their high school preparation to the entry requirements for the baccalaureate curricula, especially in the area of English proficiency.

The Petroleum Institute is a unique enterprise that represents a collaboration between academia in the United States and the private sector in the Middle East. The academic programs at the Petroleum Institute involve intensive interaction with industry and four industrial partners (BP-Amoco, JODCO, Shell, and TotalFinalElf) who have teamed with ADNOC to provide advice to and support for the PI. In this presentation, we will discuss the process by which the PI was developed and the progress made to date in developing curricular programs and activities associated with imbedding outcomes assessment into the PI institutional culture. We will also discuss challenges associated with cultural differences and differences in learning style, and how these challenges are being addressed in the academic program at the PI.

## **Introduction**

The Colorado School of Mines has entered into a long-term contract to provide assistance and academic leadership to the Petroleum Institute in Abu Dhabi. The PI is a new private educational enterprise located in the United Arab Emirates and is funded by a consortium of oil companies including the Abu Dhabi National Oil Company (ADNOC), Shell, TotalFinaElf, JODCO, and BP-Amoco. The curriculum of the PI is sharply focused on the petroleum and energy industries, and includes the following undergraduate degree programs:

- chemical engineering
- mechanical engineering
- petroleum engineering
- petroleum geosciences engineering
- electrical engineering (power; instrumentation and controls)

The medium of instruction for all courses at the PI is English.

The Petroleum Institute opened in fall of 2001 with an initial intake of 140 students, gleaned from an applicant pool of over 800 students and representing male graduates of the Emirati secondary educational system. A second intake of 150 students was accomplished in August of 2002. At this writing, approximately 220 students are continuing to study at the PI in the Foundation and freshman years combined. The Foundation Program consists of a two-semester integrated program of study that features instruction in physical sciences, pre-calculus mathematics, computing skills, English as a second language (ESL), and English for special purposes (ESP). Exit criteria for the Foundation Program include a TOEFL score of 500 or greater, and a cumulative GPA of 2.00 or greater. Additional information on the programs and curriculum for the PI can be found at [www.pi.ac.ae](http://www.pi.ac.ae).

The long-term agenda for CSM in this project is to:

- 1) Lead efforts in curriculum, course, and facilities development that will establish the Petroleum Institute as a world-class educational institution in fields relevant to the oil and gas industries in the Arabian Gulf region;
- 2) Assist in the process of achieving international recognition and accreditation for the PI degree programs by a well-recognized accrediting agency (e.g. ABET);
- 3) Enrich the academic and intellectual environment at both CSM and the PI by virtue of educational ‘spin-offs’ and access to research opportunities within ADNOC and its industrial shareholders.

### **Inculcation of Program Assessment Across the Institute**

The establishment of a new university devoted to engineering and the sciences presents a unique opportunity to design educational programs and processes with concepts and procedures of program assessment, feedback, and continuous improvement embedded in the fabric of the Institute. This philosophy is being followed by CSM as the Institute progresses during these initial formative years.

As the Petroleum Institute evolves and grows over the next several years, its development will be guided by the vision embodied in three vital recitals:

- Institutional Mission Statement
- Profile of the PI Graduate
- Institutional Constituencies and Stakeholders

Not only will these documents provide the philosophical underpinnings for the Petroleum Institute, they will also become the cornerstone of the programmatic and institutional assessment plans that are required to ultimately achieve ABET accreditation for each of the five engineering degree programs. Each degree program at the Petroleum Institute will develop its own unique and independent assessment plan, but the procedures and methods that are developed at the

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program level will all begin with recitations of the Institutional Mission and the Institutional Constituencies and Stakeholders. A fundamental tenet of ABET<sup>1</sup> and EC2000<sup>2</sup> is that the goals and objectives for each program in the institution must reflect the institutional goals as embodied in these statements. Accordingly, setting statements of institutional mission and constituencies is the necessary first step in the road towards implementing across-the-board program assessment and achieving ABET accreditation for each engineering degree program.

### **Mission Statement and Graduate Profile**

As the Petroleum Institute takes its place in international academic and engineering circles, it is envisaged that it will become known in the following way:

**The Petroleum Institute** is committed to the education of students, and their development as a whole-person, in those fields of engineering and applied science that support and advance the petroleum industry in the United Arab Emirates and surrounding regions. Focal areas extend from on- and off-shore exploration and field development to oil, gas and petrochemical production and processing, and are coupled to appropriate health, safety and environmental management systems. Accordingly, the Institute offers specialized baccalaureate and graduate degrees of international repute, it is a venue for research to support curriculum replenishment, advanced study and industry benefit, and it hosts continuing education programs for practicing professionals. The Institute is organized and operated according to the highest expectations of a world-class university, and upholds the standards for academic quality, professional ethics, and an appreciation of the diverse cultures and free-market practices that are representative of the world's most advanced economies and societies.

To achieve this vision, the Petroleum Institute will:

- provide a customized Foundation Program that bridges between the academic preparation of prospective students and the entering academic requirements of its engineering curricula;
- provide programs of instruction leading to baccalaureate degrees in Chemical Engineering, Petroleum Engineering, Petroleum Geosciences Engineering, Mechanical Engineering, and Electrical Engineering;
- develop and evolve new degree programs in response to the needs of industry;
- manage the content, quality, design and continuous innovation of its programs in a manner that earns accreditation of an international stature;
- foster the creation of knowledge that is of benefit to the regional oil and gas industry, while continually enriching its academic programs;

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<sup>1</sup> Accreditation Board for Engineering and Technology: this is the organization that has been identified as the preferred accrediting agency for the Petroleum Institute ([www.abet.org](http://www.abet.org))

<sup>2</sup> Engineering Criteria 2000: the set of methods and guidelines that define ABET's outcomes-based accreditation policies and procedures

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- operate as an educational and research hub that interconnects with regional and international constituents in the oil, gas and petrochemical industries, and with international partners in education;
- evolve into a full-fledged educational and research institution, and accordingly provide programs leading to Master of Science and Doctor of Philosophy degrees;
- provide certificate programs that serve the on-going needs of practicing professionals for continuing education in the frontiers of oil, gas and petrochemical technology, and
- encourage its graduates and in particular qualified UAE nationals to pursue graduate engineering degrees at appropriate Universities with the goal of returning to the UAE as Petroleum Institute faculty members.

Recognizing that the most immediate and dominant product of the Petroleum Institute will be baccalaureate graduates, the institutional educational goals for baccalaureate degrees are captured in the following attributes that reflect “the whole-person development” of the graduating student:

- The graduating student will exhibit applied and theoretical competence in a field of technical specialization, and will be oriented in engineering practices germane to the oil, gas and petrochemical industries. The student will have the resourcefulness and capability to apply scientific and engineering principles for solving a wide variety of technical problems.
- The graduating student will appreciate the critical role played by verbal, written and graphical communications in engineering practice and project management, and will have the corresponding skills to communicate with a range of audiences, and the skills to employ information technologies where appropriate.
- The graduating student will acknowledge that technologies, economies and societies are in a continuous state of evolution, and should therefore have the flexibility to manage a career path that changes over time, and that is supported by life-long learning, critical thinking, teamwork, leadership and the ability to span several disciplines.
- The graduating student will understand the global nature of modern engineering and business, and in order to succeed in this international arena the student will have an awareness of customs and practices in different countries and the influence of diverse cultures and geopolitical factors.
- The graduating student will have the professional integrity and maturity to serve humanity and its highest values, and will have the educational background required to make ethical decisions as they relate to society, corporate operations, technology, and the environment.

## **Statement of Institutional Constituencies and Stakeholders**

The Petroleum Institute will serve the clientele that has the most immediate interest in the quality and characteristics of its dominant product, which is the graduating student. Therefore, in managing its programs and evolving their particular goals, the governing board, administration, faculty and staff of the Petroleum Institute will respect the views of:

- employers of entry-level professionals in the oil, gas and petrochemical industries;
- a representation of technical and business executives in the oil, gas and petrochemical industries;
- sponsors of the physical and human resources of the Petroleum Institute;
- educational partners in the academic development and operation of the Petroleum Institute;
- sponsors of research conducted at the Petroleum Institute;
- prospective, enrolled and alumni students of the Petroleum Institute; and
- sponsors and parents of students enrolled at the Petroleum Institute.

While regular interaction between the Petroleum Institute and these constituencies will be distributed among programs and at most levels of the Institute, it will also be coordinated and recorded in a way that stimulates effectiveness and on-going improvement in all facets of its operations.

## **Assessment of the Foundation Program**

Achieving accreditation of the five engineering programs at the PI is an overriding goal for the Institute and is a critical component of the partnership between the PI and CSM. The Accreditation Board for Engineering and Technology (ABET) from the USA has been chosen by PI management and sponsors as the preferred accrediting agency. In order to inculcate the culture of program assessment at the Petroleum Institute and to provide a framework for assessment of the freshman program, a Program Mission Statement, Program Educational Objectives, and an assessment mechanism including evaluation rubrics for the PI Foundation Program has been developed and is now in operation. Even though formal ABET accreditation will not be requested for the Foundation Program, it was felt that the program assessment culture at the PI needed to be established from day one and that implementing a viable program assessment system for the Foundation Program would facilitate later efforts at developing similar mechanisms for the five engineering degree programs.

Accordingly, the concept of outcomes-based assessment was introduced to the Foundation Program faculty at the first Faculty Development workshop held in Abu Dhabi during August 2001 (just prior to the opening of the first academic term). This workshop was organized and run by CSM and utilized the following facilitators:

- Dr. Ronald Miller, CSM
- Dr. Barbara Olds, CSM
- Dr. Karl Smith, University of Minnesota

**Foundation Program Educational Objectives.** As a part of the initial steps in developing a program assessment process, the Foundation Program faculty were required to develop a Mission Statement and a set of global programmatic Educational Objectives. The process for developing these statements was started during the faculty development workshop in August, 2001 and these statements were reviewed, refined, and adopted during an assessment workshop lead by Professor Miller at the Petroleum Institute in March of 2002. The final wording for the Foundation Program Mission and Educational Objectives is as follows:

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***Program Mission and Educational Objectives  
The Petroleum Institute, Foundation Year Program***

*The mission of the Foundation Year Program is to enable students to begin successfully their freshman-year studies at the Petroleum Institute.*

*To achieve this mission, the Foundation Year Program is designed to meet the following educational objectives:*

- 1. To prepare students academically to an acceptable level for entry to the freshman year in terms of the following disciplinary areas:*
  - a. English language*
  - b. Physical Sciences*
  - c. Mathematics*
  - d. Computing skills*
- 2. To assist student in developing the necessary integrity and personal and interpersonal skills to become successful students and engineers*
- 3. To assist students to develop as autonomous learners*
- 4. To give students a general understanding of the oil and gas industry*

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**Foundation Program Student Outcomes.** As prescribed by the ABET-mandated assessment process, a set of program Student Outcomes was next developed once the Program Objectives had been set. Since the Foundation Program at the PI consists of four separate curricula or sub-disciplines, Student Outcomes for each individual curriculum were promulgated. The Student Outcomes eventually adopted in each of the Foundation Program curricular areas are as follows:

*After completing each curriculum in the Foundation year program, students will be able to:*

**English curriculum**

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- *Demonstrate a sufficient level of general English proficiency in order enter to the freshman Year;*
- *Demonstrate a sufficient level of academic English skills in order to be able to study effectively all their freshman courses in English;*
- *Demonstrate a sufficient level of scientific English proficiency in order to be able to complete successfully the Foundation Natural Science curriculum;*
- *Demonstrate autonomous learning skills.*

#### Science curriculum

- *Demonstrate knowledge of basic concepts of Physics, Chemistry, and Geology in English;*
- *Make accurate scientific observations and make reasonable predictions of natural systems using basic scientific concepts and principles and record observations and results in English;*
- *Make accurate scientific observations and measurements in cooperative laboratory projects and record observations and results in English;*
- *Apply scientific concepts and principles to make predictions and solve simple problems concerning real-life physical, chemical, and geologic systems;*
- *Complete an independent investigation involving literature and web-based research, data acquisition, and interpretation*

#### Math curriculum

- *Compare and contrast solutions to both linear and non linear equations numerically, graphically and symbolically;*
- *Communicate mathematical ideas verbally, symbolically and graphically;*
- *Demonstrate autonomous learning skills.*

#### Computing curriculum

- *Define and communicate computing concepts and principles in English*
- *Control basic functions of a personal computer*
- *Acquire and evaluate data required to solve problems.*
- *With the support of a personal computer, analyze data, and present data and information required to solve problems.*
- *Demonstrate autonomous learning skills.*

**Development of Foundation Program Assessment Rubrics.** The next step in the process involved developing specific assessment rubrics in the form of program evaluation matrices that are used to measure Student Outcomes against Program Objectives in each of the four sub-disciplinary areas covered by the Foundation program. To carry out this step in the process the Foundation Program under the leadership of Foundation Program Director Tim Mizen, established an Assessment Committee which had one or two members from each of the four curricular areas covered by the Foundation Program. These individuals were given leadership responsibility for development and implementation of the assessment programs in their individual disciplinary areas, and collectively comprised the Foundation Program Assessment Committee.

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Preliminary work on development of program evaluation matrices and assessment rubrics began during the March, 2002 workshop, and continued in a follow-on workshop at CSM held in July, 2002. During this workshop, draft rubrics were presented for each of the sub-disciplines and shared with the members of the Foundation Program Assessment committee and program assessment experts from CSM. The draft rubrics were reviewed, discussed, refined, and finally adopted. Final rubrics in the form of Program Evaluation Matrices for each of the four Foundation Program sub-disciplines as adopted at the close of the August CSM workshop are available for inspection on the PI website ([www.pi.ac.ae](http://www.pi.ac.ae)).

The final step was to actually begin the program assessment process by assessing samples of student work. Accordingly, each sub-discipline was asked to bring samples of student work from the Foundation Program to CSM so that the rubrics could be tested for reliability and validated during the July workshop. This process led to further refinement of wording in areas where the rubrics were not sufficiently explicit to be useful. Analysis and refinement of these rubrics will continue under the guidance of the Foundation Program Director and the Foundation Program Assessment Committee.

During the coming year, the existing Foundation Program assessment scheme will be extended to include representatives from the freshman year faculty and samples of student work from the freshman year courses. Program Mission Statements, Educational Objectives, and assessment mechanisms will be developed for each degree-granting program in subsequent years.

### **Educational Challenges and Lessons Learned**

The idea of transplanting a western educational system, policies, and procedures to the Middle East is certainly not new nor unique; in fact this has been done several times elsewhere in the Arab world with mixed success. In order to avoid some of the pitfalls that have plagued similar enterprises, it is important to be aware of differences in culture and learning styles in our students and their Western counterparts, and to recognize the cultural impact on the traditions of teaching and learning that permeate primary and secondary schooling systems in the United Arab Emirates.

**Cultural Differences.** The United Arab Emirates as a society is in the midst of vast and rapid changes that are difficult for a Westerner to comprehend. In the span of little more than one generation, the society has evolved from tribal nomadic subsistence living to an ultra-modern, fast-paced, dynamic sociological organism that sustains one of the highest standards of living in the world. This rapid change has had an immense influence on the society as a whole, and on the expectations of the college-bound generation in the UAE.

Cultural differences that impact educational processes center on the importance of relationships. Societal interactions in the UAE have been based in tribal customs for many generations. Accordingly, the attributes that govern behavior and expectations for the young people of the UAE are often focused on the nature of these relationships, and not on rules. Of the many relationships, family relationships are paramount and often take precedence. The ‘majlis’ tradition in Emirati society dictates that nearly all decisions are reached democratically with all members of

the “family” as equal participants, are subject to negotiation, and the imposition of outside authority is not necessarily respected. Rather, authority must be earned and once earned is easily lost. Honor and ‘face’ are important interpersonal attributes that influence the daily interactions between students, faculty, and the staff and administration of the Petroleum Institute.

**Differences in Learning Styles and Traditions of Learning.** The history and tradition of learning in the Arab world in general and the UAE in particular is by the spoken word. The ability to memorize and recall large quantities of material is highly regarded. A specific example of this is found in the number of young men and women who memorize the Koran in its entirety and participate annually in competitions where they are required to recite sections of the Koran completely from memory. Winners of these competitions are richly rewarded and afforded enormous respect. Unfortunately, this oral tradition often times leads to a reliance on rhetoric rather than logic. Reading for pleasure or for personal development is a somewhat foreign concept to students exiting the secondary school system in the UAE. Great emphasis is based on rote learning in primary and secondary schooling, with a strong focus on cramming for the final exam. Many students are accustomed to hiring tutors to help them prepare for final exams, and will question any exercise, homework assignment, etc. that is not specifically focused on “what we need to know to pass the exam.” As a result, students entering the PI are weak readers, have never been encouraged to become autonomous learners, and possess poor critical reasoning skills.

Thus any educational process that does not take these student attributes into consideration is probably doomed from the outset. One of the most obvious accommodations is that students at the PI must be able to learn in English, and for many of our students this is a very challenging prospect. The Foundation Year program is designed to present little new technical material in math and science, but rather to give students the tools they need to learn in English through intensive instruction in English as a Second Language (ESL) and English for Special Purposes (ESP). The ESP component of the Foundation Program curriculum is sharply focused on the technical courses and is designed to give students the ability to deal with courses that are language intensive and vocabulary-rich.

At the PI we also use the Foundation Program to begin the transition from rote learning mentality to that of an autonomous learner. Our introductory science and mathematics courses emphasize the scientific method (observation/hypothesis/testing) in order to instill reliance on logic rather than rhetoric. In this regard, laboratory experimentation is critically important. Many of our students have never actually done an experiment in the laboratory. Labs in secondary schools in the UAE usually involve students watching the instructor demonstrate, but never asking the students to actually use their hands to perform an experiment. If asked to explain how one might prepare a 2M solution of sulfuric acid, our students understand the theory quite well, and can write down and solve the governing equations with great facility. However, if given a beaker of concentrated sulfuric acid and a beaker of de-ionized water and the associated requisite lab hardware required to actually make a 2M solution of  $H_2SO_4$ , they are generally unable to translate the theory into practice without a detailed recipe to follow. To address this deficiency, we have significantly increased the number of contact hours in labs during the Foundation and freshman years.

## **Status and Future Plans**

The PI is now operating with Foundation and freshman programs in full swing. Subsequent years will see the sophomore-, junior-, and senior-year programs roll out in sequence. Facilities development is taking place simultaneously, with a new grass-roots permanent campus due to break ground in mid 2003. While the Petroleum Institute is in only its second year of existence, a good deal of progress has already been made in setting up the procedures and policies that will be required to sit for a successful accreditation visit from ABET.