

AC 2007-3010: DEMAND FOR ENGINEERING PROFESSIONALS IN THE UAE: DEVELOPMENT OF AN ABET COMPLIANT PROGRAM OF ENGINEERING IN ABU DHABI

Reynold Macpherson, Abu Dhabi University

Keith Sylvester, Texas A&M University

Dr. Sylvester is an academic consultant to the Chancellor at Abu Dhabi University in the United Arab Emirate and teaches undergraduate courses within the Department of Construction Management at East Carolina University in North Carolina. His research has been funded by national, state and private agencies, leading to national and international recognition in the areas of photovoltaic analysis, energy simulation, and visualization. Most recently, he is developing a teaching model as a first step when simulating the built environment. This process teaches the fundamental physics and understanding for physical modeling in virtual environments. Specifically, his research represents an effort to develop, test, and validate the predictive nature of mathematical models when simulating the built environment. For the past fifteen years his research has focused on the integration of numerical and visual simulation of buildings systems and their construction. This integration has been directed 1) to enable computers to simulate the energy performance of buildings, 2) to check the predictive capability of activity-based events within construction, 3) to determine how other disciplines engage in building construction, and 4) to assist humans who are engaged in these tasks. Overall, his career in academia has been an effort to understand and further define the interrelationships between teaching, research, and service that foster a comprehensive learning environment, responsive to the real world.

Demand for Engineering Professionals in the UAE: Development of an ABET-Compliant Program of Engineering in Abu Dhabi

Abstract

New construction projects to be tendered in 2006 and 2007 are predicted to exceed Arab Emirates Dirham (AED) currency exchange of forty-seven (47) billion, including commercial and residential buildings, roads, airport infrastructure, industrial parks and government institutions. The construction sector of the Abu Dhabi economy is growing with significant expansion planned. As a result, the demand for professionals with degrees in construction related fields is escalating with a sustained growth expected throughout the United Arab Emirates (UAE).

Further growth in Emirate's construction industry is driven by government legislation and support intended to diversify the Abu Dhabi economy into industrial clusters and to engage international investment. This legislation has been made to address the rapid increase in population, shortages of commercial and residential space, and the impact of mega projects already underway.

Further acceleration of construction in Abu Dhabi is being enabled by a wider context of economic growth. The country's gross domestic product reached \$104.2 billion in 2004 after rising by more than seventeen percent (17%) over the 2003 GDP of \$88.5 billion. It is expected to record growth of twenty eight and one half percent (28.5 %) in 2005 to \$133.8 billion and to continue its expansion in 2006 to achieve \$150.9 billion. As a result, the current acceleration of construction in Abu Dhabi will require a long-term and steady expansion in the number of professionals with the ability to plan and deliver high quality and sustainable urban living and industrial environments.

This paper presents demand indicators demonstrating the need for engineering professionals in the UAE. The first is cultural and normative in nature, in that the title "Engineer" for graduates is accorded significant social and cultural status and gives the bearer residency privileges in the Emirates. The second set of demand indicators is from potential students; and the third set comes from potential employers. Thirty (30) construction companies and forty-five (45) consultancy companies in the Abu Dhabi Emirate were surveyed.

In addition, this paper presents a program in Engineering and Design to manage local pathways from secondary school to international professions in the construction industry, to sustain the supply of professional human capital for construction industries, and to provide a home for scholars of the built environment to engage the community of Abu Dhabi.

The Abu Dhabi Emirate

Like Bahrain and Qatar, the United Arab Emirate (UAE) became fully independent in 1971 as a result of a union between six Arabian Sheikdoms. A seventh joined a year later. As the capital of the UAE, Abu Dhabi, under the leadership of HH Sheikh Zayed bin Sultan Al Nahyan and now his eldest son, HH Sheikh Khalifa bin Zayed Al Nahyan, is the home of an estimated 4.3

million residents with an annual growth rate of 7% and a literacy rate of 80% for UAE citizens. UAE citizens, referred to as Nationals, make up 15% to 20% of the overall population. The remaining expatriates, defined as 'guest workers,' constitute the majority of a rapidly growing foreign workforce of 2.4 million people between the ages of 15 – 64 years of age. 8% of the current workforce is in agriculture, 32% in industry, and 60% in services. Recent UAE workforce projections by sector follow.¹

- The 520,000 workforce in the wholesale trade and repairing sector is expected to grow by 12% by 2010 and by 24% by 2015.
- The 400,000 workforce in construction is expected to grow by 61% by 2010 and by 210% by 2015.
- The 400,000 in the electricity, water and gas sector are expected to grow by 18% by 2010 and by 49% by 2015.
- The 400,000 in the oil and gas sector workforce is expected to grow by 13% by 2010 and 28% by 2015.
- The 300,000 public sector workforce is expected to grow by 28% by 2010 and by 76% by 2015, if the past approach continues, which is doubtful due to new privatization policies.
- The 220,000 domestic service workforce is expected to grow by 11% by 2010 and by 23% by 2015.
- The 140,000 workforce in the transport, storage and communications sector is not expected to grow at all by 2010 or by 2015.
- The 140,000 workforce in the social and personal services sector is not expected to grow at all by 2010 or by 2015.
- The 120,000 workforce in the agricultural sector is expected to grow from by 15% by 2010 and by 34% by 2015.
- The 82,000 workforce in real estate is expected to grow by 28% by 2010 and by 66% by 2015.
- The 34,000 manufacturing workforce is expected to grow by 27% by 2010 and by 68% by 2015.
- The 28,000 in the financial sector are expected to grow by 9% by 2010 and 18% by 2015.

Government policies are also likely to impact the current patterns of employment and therefore demand for education and training in construction engineering. The current UAE workforce is 85% male and 92% expatriate. 94% of income in the UAE is generated in Abu Dhabi, Dubai and Sharjah, with the highest average per capita income of USD 35,246 earned in Abu Dhabi compared to the national average of USD 23,770. Over 90% of the Nationals that have jobs work in Government departments. The Government has started to privatize public services while sustaining its commitment to the Emiratization policy. Since the unemployment rate of Nationals is reportedly about 16%, with about 10,000 Nationals currently unemployed, this situation might be expected to be translated into increasingly mandatory quotas for the employment of Nationals in the public-private partnerships that are central to the expansion of Abu Dhabi's construction industry.

Construction in Abu Dhabi

New construction projects to be tendered in 2006 and 2007 are predicted² to exceed Arab Emirates Dirham (AED) currency exchange of forty-seven (47) billion, including commercial and residential buildings, roads, airport infrastructure, industrial parks and government institutions. The construction sector of the Abu Dhabi economy is growing with significant expansion planned. As a result, the demand for professionals with degrees in construction-related fields is escalating with a sustained growth expected in the United Arab Emirates (UAE).

This additional surge in construction in Abu Dhabi is a result of recent changes to property law. In mid-December 2005, Sheikh Hamed bin Zayed Al Nahyan, Chairman of Abu Dhabi's Department of Planning and Economy, announced³ legislation that allows 100% private ownership in the Emirate's Higher Corporation for Specialized Economic Zones (HCSEZ) during the second phase of the Industrial City of Abu Dhabi (ICAD) initiative known as ICAD 2.

ICAD 2, as Sheikh Hamed explained,⁴ is intended to diversify the Abu Dhabi economy into "high value strategic and industrial clusters in sectors such as steel, aluminum, petrochemicals, automotive components, oil and gas services and pharmaceuticals." About a dozen industry-specific clusters are to be established in the HCSEZ. The driver is the fragmented industrial base of Abu Dhabi which creates opportunities for high value, industry clusters to transform the Emirate into an industrial, services and logistics hub.

Further accelerated growth in the construction industry in the Emirate is driven by the need to develop the property sector and international investment and engagement in the Abu Dhabi economy, actively encouraged by the Emirate's Government. Further acceleration of construction in Abu Dhabi is being enabled by a wider context of economic growth of the Gross Domestic Product (GDP).⁵

Consequently, the current acceleration of construction in Abu Dhabi will require a long-term and steady expansion in the number of professionals with the ability to plan and deliver high quality and sustainable urban living and industrial environments. This requirement is underlined by the world's largest environmental consultancy, Environmental Resources Management (ERM) who recently opened office in Abu Dhabi,⁶ and the need for energy efficient and environmentally-friendly technologies when building cities of the future.

Abu Dhabi requires a steady supply of high quality local graduates to meet this demand. The proposed civil engineering program will create professionals skilled using emergent construction technologies, in addition to energy conservation and environmental engineering strategies.

Table 1. Degree Programs Being Considered by Potential Students

<i>Degree being Considered</i>	<i>References</i>	<i>% References</i>
Business Administration / Management	382	31%
Engineering	345	28%
Computer Science/Information Technology	284	23%
Medicine	197	16%
Media, Mass Communications	148	12%
Arts (Fine Arts, Drama, Music, Design)	123	10%
Social Sciences (Political Science, Psychology)	86	7%
Architecture	74	6%
Teaching/Educational Skills	74	6%
Law	74	6%
Islamic Studies	62	5%
Natural Sciences (Physics, Chemistry)	37	3%
Other	12	1%

Note that many potential students were considering more than one degree and that the array of degrees nominated is limited. (n=1233).

Employment Opportunities in the Construction Industry

Market research has identified several demand indicators, each strongly positive in the local market. The first is cultural and normative in nature. Graduating as a Bachelor of Science in Civil Engineering will mean acquiring the formal title of 'Engineer' in the UAE. The title is accorded significant social and cultural status and gives the bearer residency privileges in the Emirates. This is a critical issue for expatriate, secondary school students, and their parents who, understandably, value opportunities to acquire the title. The second set of demand indicators are from potential students. Survey feedback was obtained from those who made enquiries at all exhibitions attended by ADU over the last year, along with all high schools. Respondents were asked which degrees they were considering. Their references to degrees and percentages of all references are summarized in Table 1.

The third set of data comes from potential employers. A survey was conducted of thirty (30) contractor and forty-five (45) consultancy companies in the construction industry in the Abu Dhabi Emirate. They were advised that the purpose of the survey was to enable the industry to advise Abu Dhabi University (ADU) concerning the development of a School of Engineering.

Many of those surveyed quickly indicated that they were facing major shortages but were too busy to respond. Useable replies were received from six (6) employers who together employ over 980 people. Table 2 clarifies the types and numbers of construction professionals that these companies currently employ, the numbers needed in future years, and current average salaries.

Table 2. Current Employment and Salaries of Construction Professionals

<i>Industry</i>	<i>Currently Employed</i>	<i>Future Years (% replacement)¹</i>	<i>Ave. Salary (AED)</i>
Civil Engineers	411	59 (14)	140 -180
Architects	60	35 (58)	190-200
Quantity Surveyors	18	11 (61)	80-240
Landscape Designers	13	13 (100)	250
Architectural Engineers	10	5 (50)	80
Urban Planners	8	7 (87)	240
Interior designers	5	2 (40)	260

Reported by contractors and consultants in Abu Dhabi (n=6)

¹ *Average additional numbers required per annum.*

Table 3. Civil Engineering Programs in the UAE

<i>Institution</i>	<i>Offering</i>
American University in Dubai, UAE	Bachelor of Science in Civil Engineering
University of Sharjah, Sharjah, UAE	Bachelor of Science in Civil Engineering Masters of Science in Civil Engineering
Higher Colleges of Technology	Higher Diploma in Civil Engineering Technology (Abu Dhabi Men's College, Dubai Men's College)

Due to competition over scarce expertise in the construction industry, the title of ‘Engineer’ – bestowed to graduating students, has a strong brand value in UAE society. Likewise, about one third of all inquiries at exhibitions were regarding a degree in engineering and about half of male students interested in careers in the construction industry prefer degrees in civil and architectural engineering. In review of regional institutions, one institution does exist within Abu Dhabi to offering a Higher Diploma in Civil Engineering, equivalent an associate degree offered within North American technical institutions.

Table 3 shows that there are no current competitors in Abu Dhabi for the proposed civil engineering program. The market gap defined earlier requires a substantial number of civil engineers who will be able to engineer state-of-the-art structural systems using emergent energy-efficient technologies. Abu Dhabi University would offer the only Bachelor of Science in Civil Engineering in the Abu Dhabi Emirate.

Market Survey of Potential Students

The principals of all 74 Government and 44 Non-government Schools in the emirate of Abu Dhabi were invited in January 2006 to collate their 12th Grade students’ preferences for degrees in UAE’s construction industries. A total of 17 (14%) principals responded; nine from government schools, eight from non-government schools. Their summaries of Grade 12 students’ responses have been summarized.

Table 4. Abu Dhabi Grade 12 Students’ Interest in Construction Industry Degrees

<i>Construction Industry Professionals</i>	<i>Males (% of all surveyed)</i>	<i>Females (% of all surveyed)</i>	Totals (%)
Architect	9 (2)	7 (3)	16 (2)
Architectural Engineer	18 (5)	2 (1)	20 (3)
Civil Engineer (Structural)	25 (7)	1 (-)	26 (4)
Interior Designers	5 (1)	23 (7)	28 (4)
Landscaping Designer		4 (1)	4 (-)
Urban Planner	1 (-)	3 (1)	4 (-)
Total	58 (15)	40 (13)	98 (14)
Total Surveyed	375 (100)	311 (100)	686 (100)

Numbers of Grade 12 students interested in a degree in this area.

These data suggest that about 14% of secondary school students are interested in a degree related to the construction industry. About half of the male students are interested in degrees in civil and architectural engineering, with about half the female students showing interest in interior design. This suggests that about 3.5% of female Grade 12 students may be interested in a degree in interior design. Comparative interest in careers in the construction industry is strong. All enquiries made at exhibitions and high schools visited by ADU over the last year were classified.

Abu Dhabi University

Abu Dhabi University is an institution of higher learning in the United Arab Emirate (UAE) that uses the American system of postsecondary education with English as its official language. Its

founders envision an institution of international excellence within the UAE, the Arabian Gulf region, and throughout the world. As a private, multi campus university it is dedicated to meeting the needs for educational opportunities in the United Arab Emirates and neighboring countries and is committed to developing and offering challenging educational programs. ADU participates in the process of growth, development and prosperity of our society by offering professional diploma, baccalaureate, postgraduate diploma and master's degree programs that are career-oriented; yet integrated with the liberal arts and sciences. The resulting Civil Engineering degree is being developed by engaging engineering professionals and academics around the world.

The Civil Engineering Program

The proposed Civil Engineering program would 1) manage local pathways from secondary school to international professions in the construction industry, 2) create opportunities for students to study a high quality, educational environment, 3) sustain the supply of professional human capital to construction enterprises, and 4) provide a home for a specialized community of scholars of the built environment to serve the community of Abu Dhabi.

Financially, the Civil Engineering program is a significant business opportunity in higher education that is derived from an analysis of demand and supply factors in the Abu Dhabi economy. The contractors and consultants surveyed have confirmed that growing human resource shortfalls are expected to worsen. Principals of schools surveyed have indicated strong interest by 12th graders in construction-related professional careers. Simultaneously, there is currently an absence of serious competition in the supply of construction-related degree programs in Abu Dhabi. The planned civil engineering program would graduate its first group of civil engineering professionals in 2010.

This Civil Engineering program is being developed in accordance to criteria set forth by ABET, Inc., an accrediting body for engineering programs in the United States and its territories. Accordingly, the program will demonstrate that graduates have: proficiency in mathematics through differential equations, probability and statistics, calculus-based physics, and general chemistry; proficiency in a minimum of four (4) recognized major civil engineering areas; the ability to conduct laboratory experiments and to critically analyze and interpret data in more than one of the recognized major civil engineering areas; the ability to perform civil engineering design by means of design experiences integrated throughout the professional component of the curriculum; and an understanding of professional practice issues such as: procurement of work, bidding versus quality-based selection processes, how the design professionals and the construction professions interact to construct a project, the importance of professional licensure and continuing education, and other professional practice issues. Likewise, the program must demonstrate that faculty teaching courses that are primarily design in content are qualified to teach the subject matter by virtue of professional licensure, or by education and design experience. The program must demonstrate that it is not critically dependent on one individual.

In accordance with these criteria, the educational mission of this Civil Engineering undergraduate program is to provide a structural engineering curriculum that is fundamental, yet broad and flexible. The program seeks to produce graduates who are well-grounded in mathematical, scientific, and technical knowledge; who have the ability to analyze, evaluate, and

design civil engineering systems; who have the ability to communicate effectively; who have had meaningful opportunities for undergraduate research; and who have acquired an understanding and appreciation for global and societal issues and are thus prepared for a career path toward leadership in industry, government, and academia. To accomplish this goal, a curriculum review of over fifty randomly selected civil engineering programs in the United States and its territories, along with other international programs of engineering, have been conducted. While ABET does not accredit programs outside of the United States, ABET approval for a substantial equivalent status will be sought.

Summary

In Abu Dhabi and the Gulf Region, both private companies and public agencies are seeking civil engineers to work as design engineers, field engineers and project managers. With its consistently increasing population and environmental challenges, government agencies are also seeking civil engineering graduates within transportation, water supply, environmental protection, and resource management areas. Abu Dhabi University anticipates that its graduates will also pursue MS and PhD degrees in allied fields, as well as business, management and law degrees.

Based on previous research data and the input of consultants, the curriculum is structured to provide a broad undergraduate education with students taking courses in each of the recognized areas of civil engineering. The first two years focus on mathematics and basic science courses to provide a solid foundation for the engineering science and design courses that will be taken in the junior and senior years. The program culminates in a two-semester capstone design course sequence in the senior year. The curriculum is computer intensive and includes a number of laboratory courses that reinforce concepts and principles taught in the classroom.

Several curricula design issues arise when considering a new program with no pre-existing support courses. First, the curriculum is designed to evolve in response to its faculty and their expertise, changing professional standards, and changing University policies. Secondly, the program must provide opportunities to develop new degrees within various areas of civil engineering and other closely related, such as construction management. Lastly, in the context of the Abu Dhabi University, as regulated by the Ministry of Higher Education and Scientific Research, the curricula contains a programmatic structure to remediate academic deficiencies for beginning students in the areas of science and mathematics.

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