Development of Engineering Education in Saudi Arabia

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Abstract — *The development of any modern society, its environment and its technology depend to a large extent on its education process. Over the past half-century, education in Saudi Arabia has undergone through major developments and several reforms and receives the highest attention and support from the government. Starting from one government university in 1957 up to 24 government universities, 8 private universities and 20 private colleges in 2009 in almost every major city in the country. Similarly, engineering education in Saudi Arabia has been developed over the past fifty years. For example, College of Engineering at King Saud University was the first College of Engineering in Saudi Arabia and Arab Gulf States. It was established in 1962 with only 17 students. In 2009, the total number of engineering students is more than 18,000 students in about 18 engineering colleges distributed all over the country. Engineering education is considered to be pivotal in the development of modern societies. In this paper, the development of engineering education through the last fifty years in Saudi Arabia is presented. The paper also presents the details of the tremendous changes and improvements in the College of Engineering at King Saud University.*

Index Terms *— Accreditation, development, engineering education, King Saud University, Saudi Arabia.*

INTRODUCTION

Engineering profession is one of the oldest professions that have served humanity through improving the environment, developing means of production and working to provide the comforts for people such as homes, roads, communications and equipment in various fields. As evidence of this are the pyramids in Egypt, the Great Wall of China and various towers in Europe. The major role of engineers is to design and implement solutions that have not previously existed, and that directly or indirectly serve society. Engineering is distinguished from science by the process of creation. It was said by engineer Theodore Von Kármán that "scientists discover the world that exists, while engineers create the world that never was" [1]. An important aspect of engineering is the use of natural materials, applied science, and technology to create this "world that never was." [2]. Engineer is the person who is capable of creative application of basic science such as mathematics, physics and chemistry.

The general philosophy of engineering education is to produce graduates of high academic standard and of immediate value to the industry. Engineering Education is the process of training engineers for the purposes of initiating, facilitating and implementing the technological development in the society. The preparation of students who are deeply knowledgeable of the technical fundamentals as well as the professional skills of engineering is considered the main objective of engineering education.

There is no doubt that the development of engineering education is an ongoing process requiring assessment and curriculum development, evaluation and development of the performance of faculty members and updating laboratory equipment. Governments are interested in engineering education as it is one of most important means for the development of human resources for community and upgrading and facing the changes and challenges of the future. The preparation of engineers is the primary focus of engineering education providing them with the necessary engineering expertise to build and manage engineering projects. Since engineering education is provided by universities, it is appropriate to give a brief description about the education in Saudi Arabia first, then talk about the evolution of engineering education in the country.

EDUCATION IN SAUDI ARABIA

Education is considered one of the most important features of comprehensive development in Saudi Arabia. The roots of this new educational development go back to the time of the late King Abdulaziz who established the directory of education in 1923. At that time, the number of schools was 4 elementary schools. Establishing the Ministry of Education in 1953 is considered to be a major turning point in the history of the new educational development in the country as the Ministry continued the path of quantitative expansion in the different stages and types of education. The education in

Saudi Arabia was developed increasingly and rapidly during the period 1970-2009, which also included the years during which the five year development plans were executed starting with the first plan 1970- 1975 and ending with the eighth plan 2005-2010.This development involved an increase in the numbers of educational institutions, teaching organizations, enrolled students and graduates in all the different stages of education. Meanwhile, there was an increase in the educational budget [3]. The development was accompanied by an increase in investment to build and prepare facilities and infrastructure as well as necessary equipment for the educational process, in addition to continuous expenditures needed to run this process such as salaries, wages, and budget for educational services and the maintenance of its buildings and equipment. According to the World Bank database, public spending on education is 6.8 percent of GDP, and public spending on education as percentage of government expenditure is 27.6 percent in 2004 [4]. Education spending as a proportion of overall spending tripled from 1970 to 2000 and neither economic growth nor the price of oil had much impact on this trend in Saudi Arabia [5].

The most important feature of educational development in Saudi Arabia is represented in establishing the Ministry of Higher Education in 1975. The Ministry was given the responsibility to supervise universities and higher education institutions in addition to the Ministry of Education which was given the responsibility of supervising Public Education. The Ministry of Higher Education authorizes both the creation of a university and the programs offered. The Ministry's responsibilities are to raise the level of communication and coordination between institutions of higher learning, coordinate policy with government ministries and agencies based on the nation's needs, and assist in the country's continuing development. In 1993, Royal Decree formed a Supreme Council for Universities to act as a legislative coordinating body for all the universities. The Higher Education Council's responsibilities include supervising university education development, coordinating degrees and scientific departments among universities, encouraging research, and formulating rules and regulations. A university council is responsible for educational administrative and financial affairs, implementation of university policy, and preparing budget and future development plans. A scientific council at each university encourages scientific and research studies and publications [6].

Higher education witnessed rapid expansion in the last three decades of the twentieth century. The establishment of King Saud University in 1957 is a starting point of the modern higher education system in Saudi Arabia. The number of government universities increased to 7 in 1975, 8 in 1999, 11 in 2003, 18 in 2006 and 20 in 2007. During last year, four new universities and several colleges have been opened in different parts of the country, increasing the number of universities to 24 government universities, 8 private universities and 20 private colleges geographically distributed in the Kingdom regions as shown in Figure 1. All the universities are linked to the Ministry of Higher Education, but enjoy a high level of independency in both administrative and academic scopes.

FIGURE 1
DISTRIBUTION OF UNIVERSITIES IN SAUDI ARABIA

ENGINEERING EDUCATION IN SAUDI ARABIA

Engineering education in Saudi Arabia started in1962 when the first college of engineering was established within a collaborative project between the government of the Kingdom of Saudi Arabia represented by the Ministry of Education and the UNESCO Commission of the Organization of the United Nations. The college was under the auspices of UNESCO until 1969 when it became a college in King Saud University. Thereafter the establishment of colleges of engineering continued reaching 18 colleges in 2009 as shown in Table 1.

College	Year of establishment	University	City
College of Engineering	1962	King Saud University	Riyadh
College of Engineering Sciences	1965	King Fahd University of Petroleum and Minerals	Dhahran
College of Engineering	1975	King AbdulAziz University	Jeddah
College of Engineering and Islamic Architecture	1989	Umm Al-Qura University	Mecca
College of Engineering	2001	King Kalid University	Abha
College of Engineering	2004	Qassim University	Buraidah
College of Engineering	2005	Taibah University	Madinah
College of Engineering	2005	University of hail	Ha'il
College of Engineering	2005	Jazan University	Jazan
College of Engineering	2005	Al Jouf University	Turaif
College of Engineering	2005	Al Baha University	Al Baha
College of Engineering	2005	Najran University	Najran
College of Engineering	2006	Al Kharj University	Al Kharj
College of Engineering	2007	Northern Borders University	Arar
College of Engineering	2008	University of Tabuk	Tabuk
College of Engineering	2008	Al Majmaah University	Al Majmaah
College of Engineering	2008	King Faisal University	Al Hasa
College of Engineering	2009	University of Dammam	Dammam

TABLE 1
COLLEGES OF ENGINEERING IN SAUDI ARABIA

Each college within the university has its own council charged with the responsibility to implement and carry out university policy and regulations, submit budget requests, and propose policy changes. Each department within the college has an organization paralleling that of the college and university.

Engineering education in Saudi Arabia was expanded to include all the disciplines that provide the engineer with base to enable him to keep pace with scientific and technical development. The number of engineering students was seventeen students in 1962, studying at the College of Engineering at King Saud University, this number increased to about 18,000 students in 2008 studying in all colleges of engineering in Saudi Arabia. The graduates of the first batch of Saudi engineers from College of Engineering at King Saud University was sixteen engineers in 1966; the number of graduates from engineering colleges increased to about 1900 graduates in 2008.

Figure 2 shows the number of students and graduates in colleges of engineering in Saudi Arabia during the last thirty years. It can be seen from this figure that the number of students increased to about four times from 1980 to 2008. This is also true for the graduates. At present, Saudi engineering graduates meet only a fifth of the country's needs and 68% of science jobs are filled by graduates from abroad. Saudi Arabia has a workforce shortage in many areas of science and technology, such as health, agriculture, engineering, biotechnology, nanotechnology, and information technology

There are several engineering disciplines offered by the universities in Saudi Arabia as shown in Table 2 for government universities. There are sixteen engineering disciplines offered by eighty-five departments in eighteen universities in Saudi Arabia. Both King Abdulaziz University and King Fahd of Petroleum and Minerals offer nine engineering disciplines, whereas King Saud University offers seven engineering disciplines. It is clear from Table 2 that both civil engineering and electrical engineering disciplines are offered by all universities except the newly established university (University of Dammam). Mechanical engineering is offered by almost every university. King Abdulaziz University is the only university offering the disciplines of mining engineering, production engineering, nuclear engineering and thermal and desalination technology engineering. Medical engineering, the new engineering discipline, is only offered by University of Dammam. Furthermore, King Saud University is the only university offering surveying engineering.

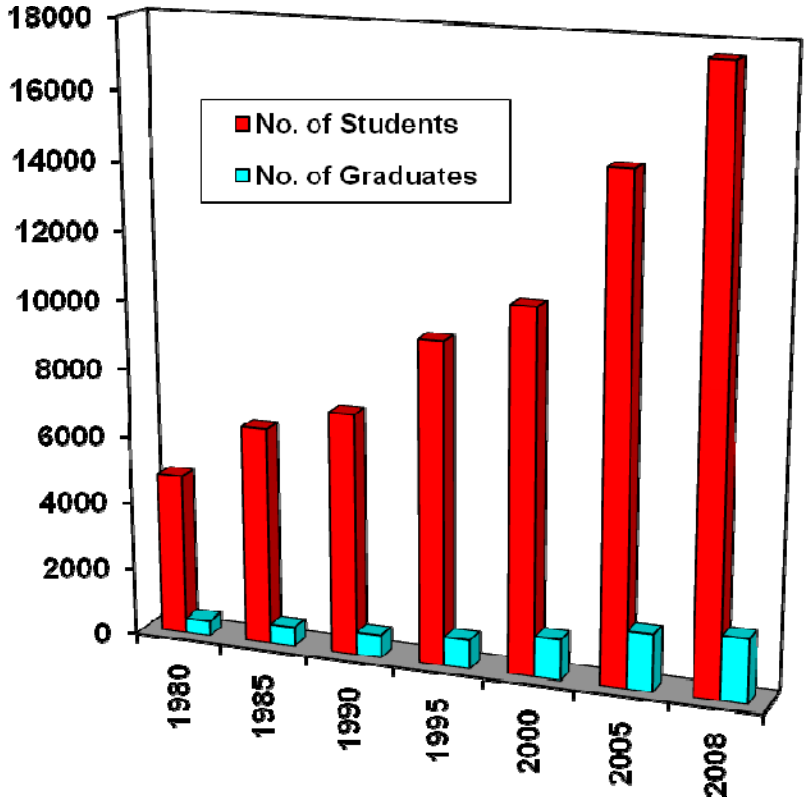

FIGURE 2
NUMBER OF STUDENTS AND GRADUATES FROM COLLEGES OF ENGINEERING

UNIVERSITY	Civil Engineering	Electrical Engineering	Mechanical Engineering	Chemical Engineering.	Industrial Engineering	Architecture Engineering	Computer Engineering	Aerospace Engineering	Construction Engineering	Petroleum Engineering	Production Engineering	Mining Engineering	Nuclear Engineering	Thermal Engineering	Surveying Engineering	Medical Engineering	Total
King Saud University	*	*	*	*	*					*					*		7
King AbdulAziz University	*	*		*	*			*			*	*	*	*			9
King Fahd University of Petroleum & Minerals	*	*	*	*		*	*	*	*	*							9
King Faisal University	*	*	*						*								4
Umm Al-Qura Univessity	*	*	*														3
King Kalid University	*	*	*	*	*												5
Qassim Univesity	*	*	*														3
Taibah University	*	*	*	*	*	*											6
University of Hail	*	*	*	*													4
Jazan University	*	*	*	*	*												5
Al Jouf University	*	*	*		*												4
Al Baha University	*	*	*			*	*										5
Najran University	*	*	*	*	*	*											6
Northern Borders University	*	*	*	*	*												5
Al Majmaah University	*	*	*				*										4
Al Kharj University	*	*	*														3
University of Tabuk	*	*															2
University of Dammam																*	1
Total	17	17	15	9	8	4	3	2	2	2	1	1	1	1	1	1	85

TABLE 2
ENGINEERING DISCIPLINES OFFERED BY COLLEGES OF ENGINEERING IN SAUDI ARABIA

COLLEGE OF ENGINEERING AT KING SAUD UNIVERSITY

The College of Engineering at King Saudi University was established as a joint project between the Ministry of Education of the Kingdom of Saudi Arabia and UNESCO in November 1962. This project lasted until 1969 when the College of Engineering became an official part of King Saud University. The college started with three departments which are: the department of civil engineering (CE), the department of electrical engineering (EE), and the department of mechanical engineering (ME). In the year 1968, the department of architecture was established which became a college in 1984 under the name of College of Architecture and Planning. In 1974, two departments were established. These are: the department of chemical engineering (CHE) and the department of petroleum engineering (PE). In 1988 surveying engineering (SE) was established as a program in the department of civil engineering. In 1982, industrial engineering program was established in the department of mechanical engineering. Later on the program became department of industrial engineering (IE) in 2002. Accordingly, there are currently six departments offering Bachelor of Science Degree in the following engineering fields: civil engineering, surveying engineering (offered by civil engineering department), electrical engineering, mechanical engineering, industrial engineering, chemical engineering and petroleum and natural gas engineering.

The college of engineering offers graduate programs in various fields in order to cope with scientific progress and to provide the Kingdom with highly skilled specialists needed for the ambitious development plans. King Saud University Council endorsed the initiation of graduate programs in all departments of the college since 1981. Currently, there are seven Master of Science programs in every department and four Ph. D. programs in civil, electrical, chemical, and industrial engineering departments.

The college defines its vision and sets up its mission and objectives. The same is done by every department which links their vision, mission and objectives to those of the college. The road map of the college is developed through its strategic plan which was built by identifying strengths and weaknesses, opportunities and challenges.

The college has a well-designed curriculum delivered by a quite competent and highly enthusiastic faculty. The College always kept a curriculum that is current, dynamic and designed with full consultation with the educational beneficiaries, namely the public and private employers. In the past twenty years there have been three revisions to the curricula. This curriculum is also supported by 44 teaching and research state of the art specialty laboratories. There are currently 220 faculty members serving the various departments in the college. Figure 3 shows a flowchart describing the entire organizational structure of college of engineering. There are four vice deans for administrative affairs, for academic (undergraduate), for graduate studies and research and for development and quality. Each vice dean supervises about five units [7].

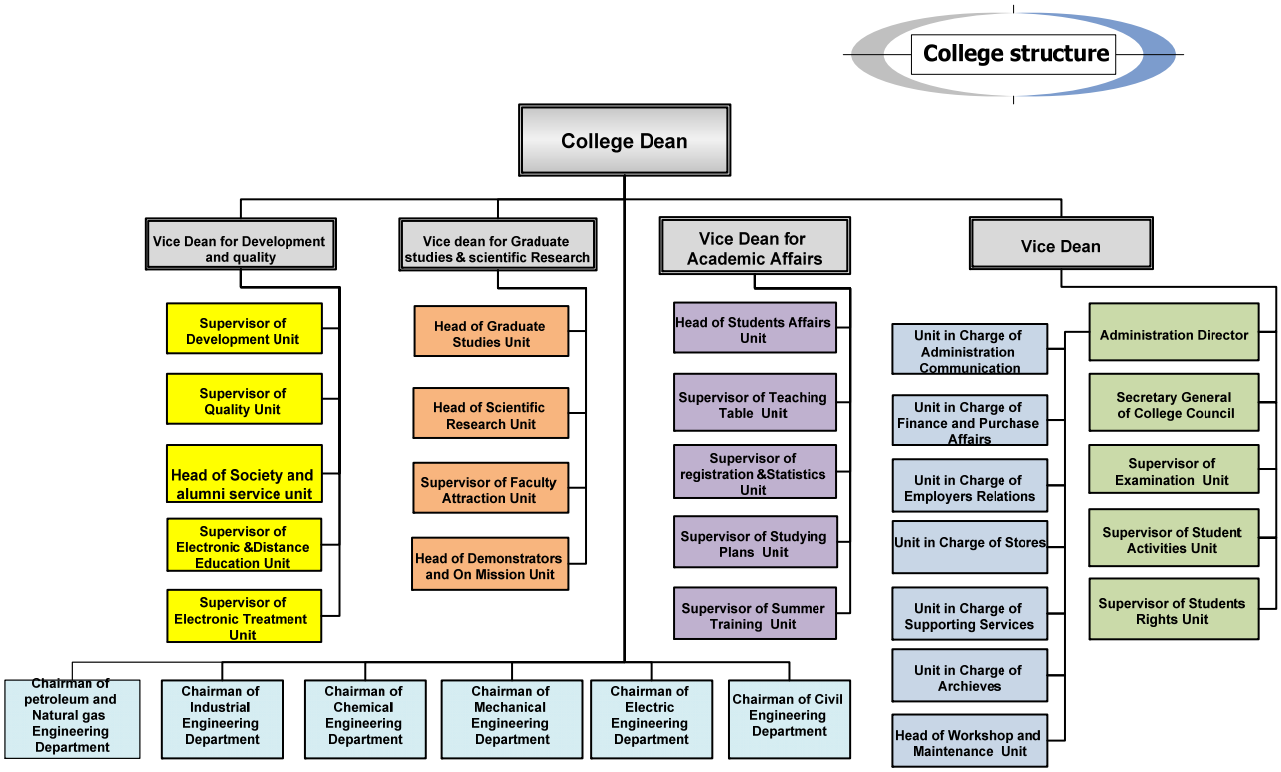

FIGURE 3
ORGANIZATIONAL STRUCTURE OF COLLEGE OF ENGINEERING

The number of students in the college has risen from 17 students in 1962 to about 4000 students in 2008. The faculty members have similarly grown in number from 4 to 210 during the same period. Figure 4 shows the yearly admitted undergraduate students since 1972. It can be seen from this figure that the average number of admitted student is about 400 students each year. **T**he accumulative number of graduates from the college since 1966 is shown in Figure 5. The graduates of the first batch of Saudi engineers from the college was sixteen engineers in 1966; the number of graduates from the college increased to 437 engineers in 2008. The total number of graduates from the college is about 8000 engineers.

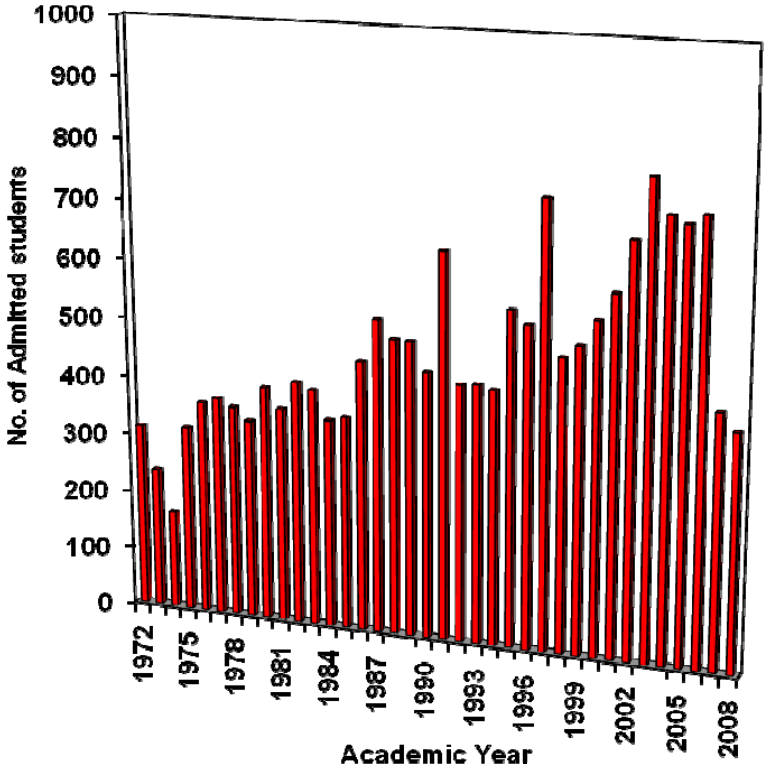

FIGURE 4
YEARLY ADMITTED UNDERGRADUATE STUDENTS IN COLLEGE OF ENGINEERING

The college strived to attract and maintain high caliber faculty members, students, and administrators. For this reason, the college made sure that many of its first and subsequent groups of outstanding graduates are recruited and sent abroad on scholarships to excellent universities, mostly to the USA and Great Britain, to pursue higher education and return back to serve on its faculty. As a testimony to the success of such a policy, over 50% of the current 220 members are Saudi nationals. The rest of the faculty members are selected from a variety of international origins with a wide range of academic backgrounds and experiences necessary to enrich the educational mission of the college. As it stands, the faculty members serving the college programs are all doctoral level persons. They are available to advise, evaluate and monitor students, and to determine success in meeting program objectives.

The college has secured twelve US and European patents in the recent past, the highest number among the Arab universities which shows the high level of achievement of its faculty. Furthermore, the college kept the tradition of only admitting good students who score relatively high in the secondary schools. These students are first admitted without departmental designation for a full year in the college. Upon successfully completing this first year these students are subjected to strict rules necessary to transfer them to the seven engineering programs.

The college kept, through a variety of activities, close relations with over 8000 alumni and their employers. It always kept good rapport with them and sought feedback regarding the quality of its programs and graduates with the intension of continuous enhancements of its activities. In addition, the college plays an important role in consultation and research activities as applied to local industries. In fact, the college considers industry as a major component of its external constituents. Saudi Arabia has many natural resources that include petroleum, natural gas, iron ore, gold and copper. It has major industries such as crude oil and natural gas production, petroleum refining, basic petrochemicals, cement, steel-rolling mills, construction, fertilizer, plastic, etc. The college's relationship with industry has developed over the years to full-fledged partnerships. Forms of cooperation include, but not limited to, active participation of

industrial constituent members; funding a number of research chairs and research centers in the forms of grants and contracts and sponsoring of college activities such as conferences and symposiums. It also included items relating to the students such as training and employment; providing scholarships for students and finally taking advantages of the facilities and laboratories of the college. These integrated relationships have culminated in the establishment of industrial advisory committees for the individual departments and the college at large. The well thought and strong outreach program of the college with government, industry and society has resulted in financial sponsoring various research activities in the college including four research centers and thirteen endowed research chairs.

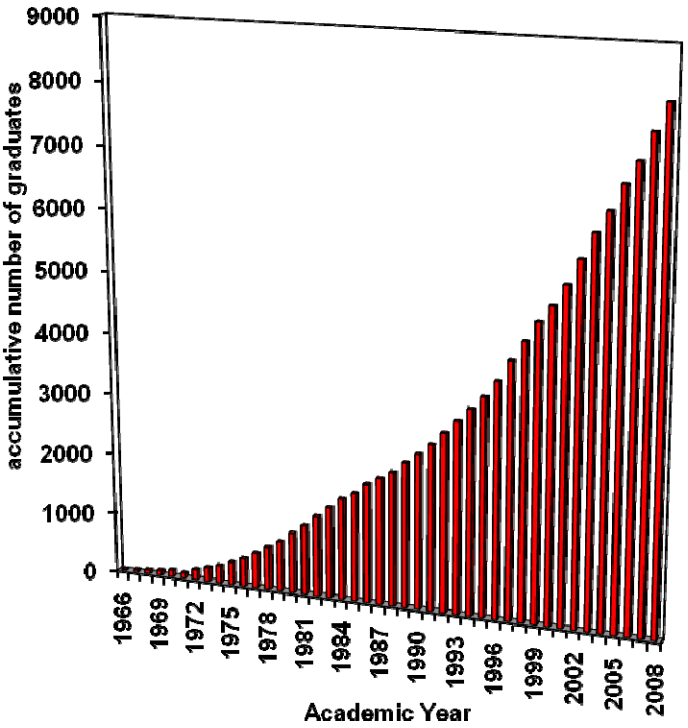

FIGURE 5
ACCUMULATIVE NUMBER OF GRADUATES FROM COLLEGE OF ENGINEERING

The college of engineering undergoes tremendous reforms towards international excellence and quality and works hard to satisfy quality requirement and international recognition. As a testimony to its desire to become a world class college, it was recently evaluated and obtained the ISO 9001:2008. In its effort to peruse regional and international recognitions, the college is seeking a ABET accreditation for its programs. The college was visited by ABET review team in October 2009 and hopefully will get the accreditation this summer for its six programs: civil, electrical, mechanical, chemical, industrial and petroleum and natural gas engineering. ABET criteria addresses the effectiveness of a program through an assessment and evaluation process that assures the achievement of the program objectives and outcomes. The faculty shared and compared their individual and collective knowledge and experience of the accreditation process. This was done through many private and public formal and informal seminars and discussions among the college faculty members and aided by a thorough review of the ABET criterion guidelines.

Both internal and external constituents are identified. Those internals include students, faculty, and administrators. Outsiders include student parents, alumni, and employers. The college then proceeded to form ABET preparation committees on the college and departmental levels. Weekly meetings have been conducted for these committees. The role of the college wide committee is to coordinate and standardize the efforts of the individual department efforts. The departmental committees were charged with preparing self-study reports including all the supporting documents required by ABET. Each department sets its main mission to provide broad background in both theory and practice of engineering to its graduates. Moreover, each department aims to build design skills, communication proficiency, and ethical/professional responsibilities in the engineering graduates. After deliberation between each department and its constituencies, the program educational objectives were set to fulfill the constituencies' needs and expectation. Each program outcomes were specified where the graduates would possess the characteristics required by ABET in addition to the specific characteristics of King Saud University. Each department proposed an assessment methodology and a set of indicators to assess the program outcomes and the level of achieving the program objectives. The indicators and the assessment methodology were applied and corrective actions and recommendation were proposed to improve the level of achieving the program outcomes and objectives.

SUMMARY AND CONCLUSIONS

In this paper, the development of engineering education through the last five decades in Saudi Arabia is presented. The first university in Saudi Arabia (King Saud University) was established in 1957. The number of government universities increased to 7 in 1975, 8 in 1999, 11 in 2003, 18 in 2006 and 20 in 2007. During last year, four new universities and several colleges have been opened in different parts of the country, increasing the number of universities to 24 government universities, 8 private universities and 20 private colleges geographically distributed in the Kingdom regions. Engineering education was also expanded to include all the disciplines to enable engineers to keep pace with scientific and technical development. The number of engineering students was seventeen students in 1962 and increased to about 18,000 students in 2008 studying in all colleges of engineering in Saudi Arabia. The graduates of the first batch of Saudi engineers was sixteen engineers in 1966; this number increased to about 1900 graduates in 2008.

The paper also presents the tremendous changes and improvements in the College of Engineering at King Saud University. The number of students in the college has risen from 17 students in 1962 to about 4000 students in 2008. The faculty members have similarly grown in number from 4 to 210 during the same period. The graduates of the first batch of Saudi engineers from the college was sixteen engineers in 1966 and increased to 437 engineers in 2008. The college of engineering undergoes tremendous reforms towards international excellence and quality and works hard to satisfy quality requirement and international recognition. The college was recently evaluated and obtained the ISO 9001:2008. In its effort to peruse regional and international recognitions, the college is seeking a ABET accreditation for its programs. The college was visited by ABET review team in October 2009 and hopefully will get the accreditation this summer.

REFERENCES

[1] Mackay, A. L.," Dictionary of Scientific Quotations", Hilger, London, 1994

[2] Crawley, E.F., Jianzhong, C., Malmqvist, J., Brodeur , D.R.," The Context of Engineering Education", *Proceedings of the 4th International CDIO Conference, Hogeschool Gent, Gent, Belgium, June 16-19, 2008.*

[3] http://www.moe.gov.sa/openshare/englishcon/

[4] *UNESCO IBE 2007.Saudi Arabia,"World Data on Education,6th Edition."*, 2005/2007

[5] "The World Bank 2008."The Road Not Travelled: Education Reform in the Middle East and North Africa." World Bank 2008 Education Flagship Report, p.105". 2008.

[6] http://www.mohe.gov.sa/EN/Pages/default.aspx

[7] College of Engineering, King Saud University , "Undergraduate Bulletin 2009".