AC 2010-306: ON ENGINEERING EDUCATION REFORM IN THE ARAB STATES: A PATH FORWARD

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On Engineering Education Reform in the Arab States: A Path Forward

Abstract: The paper addresses reform of engineering education in the Arab Region of the Persian Gulf (Saudi Arabia, Bahrain, Kuwait, United Arab Emirates, Qatar, and the Sultanate of Oman) focusing on issues that have either been neglected or have not been suffiently addressed. The author argues for the need to institutionalize the concept of continuous improvement by seeding the process within the college, in order to make it possible for Region's colleges to tap into their own resources and devise revitalization programs that fit the context of these institutions; each, in terms of: its student body, its faculty, and its objectives. Initially, efforts need to be devoted to capacity building aimed at fostering culture changes transcending the traditional norms vis-à-vis undergraduate education in general and programs' development in particular. The paper provides some historical perspectives and examines the effectiveness and implementation of revitalization programs that are believed to meet Regions objectives and aspirations. The paper sheds light on the nature of such programs and argues for the need to carry out proper studies coupled with field data, to help guide the process of shifting from the old to the new paradigm. The stakeholders should realize the shortcomings and discrepancies of the current systems, be stimulated to debate, and eventually should arrive at scenarios that can be implemented, to ensure the vitality and currency of engineering education in the Region.

Introduction

Achieving change via engineering education reform is a formidable challenge to any college of engineering, whether in North America or anywhere else in the world! This paper, is a follow up to prior papers [1-6] on engineering education reform in the Arab Region of the Persian Gulf (Saudi Arabia, Bahrain, Kuwait, United Arab Emirates, Qatar, and the Sultanate of Oman) focusing on vital issues that have been either neglected or have not been sufficiently addressed. The purpose here is to provide some perspectives, and at the same time, renew the call for a new and fresh outlook at engineering education for the Region, commensurate with demands for more rounded engineering graduates with the ability to function in a modern business climate.

There are concerns that continuation of the old paradigm by the engineering colleges of the Region will but assure minor roles for engineering graduates in the future. The fact that students compete to attend the Region's engineering institutions is not indicative of the shortcomings of these colleges. Entering students have adjusted and accepted prevailing conditions as "normal", and would not necessarily realize that they have possibly been shortchanged. The major underlying questions here include: What colleges need to teach and how best can they teach it? The "what" lies at the crux of the matter. What is taught at the undergraduate level, in most of the Region's colleges, must be reconsidered and should include more than the technically prescribed material by standing committees and/or visiting experts. All stakeholders need to come together to understand opposing interests and endeavor to evolve the best path forward. Unfortunately, any transition from the old to the new paradigm is likely to be quite difficult since the means to undertake the change rests mostly with those with entrenched interests who tend to

resist change in the first place. The resistance to change, coupled with the fact that there is no "one-size-fits –all" transition scenario, is the major challenge to the needed change.

In this endeavor, the author draws on his own experience as a faculty member in the Arab Gulf States - a few years ago in Qatar, and earlier in Saudi Arabia. The author is strongly committed to the Region, and has been an advocate of reformation of its current education systems at all levels. The need for reformation is by no means author's views alone, but rather the consensus of opinions of Region's engineering graduates, faculty members and some administrators. And, was arrived at through properly conducted surveys, [5, 6] back in 2000 and 2007.

An Overview of Engineering Education in the Arab States

Engineering education in the Arab Middle East is relatively new, as organized educational endeavors go. It had its early start shortly after World War I. Colleges of engineering (or schools of engineering as they were labeled) were founded then, in Cairo and Alexandria, Egypt, and also in Beirut, Lebanon. By the end of World War II, colleges of engineering sprung out in Iraq and Syria. And two decades later, Jordan had its first college of engineering in its capital, Amman. The colleges in Lebanon and Syria paralleled, by and large, the French schools of engineering; except for the American University of Beirut (AUB), typically a North American school, looked after by a consortium representing colleges in the USA. Colleges in Egypt & Iraq were influenced, at the time of their establishment, by the British system of education. [1, 2, 3, 4]

Engineering education in the following Arab States: *Saudi Arabia, Bahrain, Kuwait, United Arab Emirates, Qatar, and the Sultanate of Oman* - started, in earnest, during the early to mid sixties. Initially, colleges of engineering were founded in Riyadh, Jeddah, and later, in Dhahran, Saudi Arabia. In the other smaller states of the Region, engineering colleges were founded soon after these states have gained their independence [1, 2, 3, 4] .The strong political and economic ties between the States of the Region and western countries- the USA in particular - has helped enormously in setting up, manning, and providing needed guidance to these fledgling institutions during their early years. The dramatic increase in oil revenues during the 70s, and 80s, coupled with lack of skilled professionals in areas deemed necessary for growth and development of oil-related industries of the Region, has been pivotal in the start-up of higher education in general and engineering in particular. There are today **eight main** public colleges of engineering in the Region (Table 1) in addition to several, recently established, private and semi private colleges and/or universities that offer engineering degrees.

These eight public colleges (shown in Table 1), have since their inception, been guided by advisory committees made up largely from experienced faculty members and administrators drawn from US colleges. Previously, the Grinters Report [7] and the Goals Report [8] have been used to guide the educational process. Recently, ABET Engineering Criteria 2000[9] has been the subject of seminars and workshops, intended to shed light and assist engineering colleges in the Region in making use of the EC2000 whenever possible. Indeed, the EC2000 has generated a lot of interest and challenges in the Region. Whether or not it will be fully implemented, would depend on: institutional vision and commitment to reformation, available resources, students' preparedness, and prevailing traditions and norms.

Country	*College of Engineering*	*Year Established*
Saudi Arabia	King Saud University – Riyadh	Early sixties
Saudi Arabia	King Abdul-Aziz University - Jeddah	Early sixties
Saudi Arabia	King Fahd University of Petroleum and Minerals (KFUPM) – Dhahran	Late sixties
Bahrain	University of Bahrain – Manama	Mid seventies
Kuwait	College of Engineering and Petroleum at Kuwait University - Kuwait City	Mid seventies
Qatar	University of Qatar – Doha	Early eighties
United Arab Emirates	UAE University - Al-Ain	Early eighties
Oman	Sultan Qaboos University – Muscat	Mid eighties

Table 1. The Eight Main Engineering Colleges of the Arab Gulf Region

The public colleges of engineering – the **eight colleges** shown in Table 1 - are part of the public university systems of the Region, and thus are government-run, and almost totally government financed. The organizational structure is nearly the same in all. Students are mostly nationals of their respective countries and graduates of similar public education systems. Admission policies, for all eight colleges, are based on grades obtained in an official examination sanctioned by the Ministry of Education, upon completion of the 12th grade. Additionally, an entrance exam and evidence of proficiency in English, a requirement imposed by many of these colleges, may exempt the applicant from a pre-engineering "prep year" administered as a separate unit from the college. Statistics have shown that over 80% of first year engineering students do attend the "prep year," during which students embark primarily on improving their English skills [2, 3]. The author has proposed to reform the "prep year" by making it two years, and widening the scope of the subject matter to include (in addition to building up English language skills to a pre-set level), the following tasks:(i) math and science courses- in preparation for engineering "gateway" courses;(ii) a practical hands-on "pre-college" training period; and,(iii) fostering a "proper learning environment", to help students acquire desirable attributes such as: analytical skills, curiosity and desire to learn, creative thinking, and the importance of team work [2,3]

Thousands of native Arabs (citizens of the Arab Gulf States) have completed their engineering education at one of the **eight** public colleges (Table 1) of the Region, and have, since their graduation, occupied government positions or joined the private sector, side by side with expatriates. Some have established their own business, and many have moved up the ladder into responsible managerial positions. Many graduates, particularly those that have practiced engineering, do provide valuable insights relevant to today's deliberations on engineering education reform. Some feel the urge to express their views in the open, and many prefer to relate their concerns privately through formal channels. The views that have been expressed point towards the need to: restructure programs, revise current educational methods, provide for professional development of faculty and students, and to graduate "well-rounded" engineers who

could address variety of challenges represented by a highly competitive global market place, and be able to adapt to the ups and downs of business cycles. The views of the graduates have by and large been similar to those of the author and to views of some faculty members in Region's colleges; and are consonant with developing a more responsive educational environment.

It is interesting to note that the developmental process of engineering education in the Region has passed through three consecutive stages. **Stage one**: the stage of ***founding and establishment***, lasted nearly a decade, and characterized mainly by adopting and transferring a North American model of engineering education to the Region. Expats, at the time, were entrusted with the tasks of the transfer, and were guided primarily by agreed-upon guidelines. **Stage two**: is the ***search for an identity*** stage. This is the period when nationals, who finished their graduate work abroad and have returned to serve their home institutions as young faculty, began to assert their presence and assume their role as a new addition to the faculty. Cultural issues, and conflicting views on how to move forward without adversely affecting earlier gains, characterized stage two. **Stage three**: the stage of ***pondering and deliberations***, which appears to have lingered on for a long time, is characterized by calls from industries, engineering graduates, and invited experts, for more rounded engineers with the skills and abilities to function in a modern business climate. Unfortunately, the response to these calls has been minimal. The "piece meal" approach and/or periodic adjustments to an already over-burdened curriculum, in an attempt to meet a broad set of demands, have not been effective in meeting objectives, and have convinced many stakeholders that the time has come for a radical departure from the traditional layered and sequential structure that has prevailed for decades. In total, the educational systems in place today, whether content or delivery methods, are: stagnant, lacking in relevance and coherence, and have become increasingly fragmented into independent parts. At the outset the challenge may be clear, but proper solutions are far from evident.

The Search for Solutions

To address the challenge, stakeholders have to come to grip with the realities and examine the entire framework of the undergraduate engineering education in their respective state and in the Region in general. It is argued here that collaboration and exchange among the different colleges of the Region is healthy, helps in ironing out differing views, leads to general consensus, and reduces waste of time and resources. Also, just as important, is the voice of industry - a major "customer" of academia in the Region. Until the major industrial sectors make their views known, and be reluctant to hire new graduates unless they have had the proper exposure to new paradigm education- it is likely that Region's colleges will continue to pursue their present course. Hopefully, the barriers to real and attainable progress in the quest to achieve a new paradigm in engineering education would break down and "reform" aimed at fundamental change, would eventually permeate and become a reality.

To start, the traditional momentum for incremental adjustments ought to be stopped and replaced with a broader vision, i.e., to think in terms of a totally clean slate, that should begin by raising some philosophical questions and attempt to provide well 'thought-out" answers; and, to devise plans and/or strategies of reform. In broad terms, the major headings at this junction include:

- the need to identify the desired characteristics of future graduates in terms of: academic preparation, skills, attitudes, and abilities;

- to identify programs' emphases required to develop these characteristics;
- to evaluate current programs' effectiveness and/or lack of it, in meeting set goals, and in equipping new graduates with the desired characteristics;
- to search, identify, and select new components and characteristics of the programs in terms of: content, structure, prerequisites, and methods; in order to create and assert the new emphases;
- outline strategies to implement required changes while retaining the positive features of current programs;
- to establish an agenda for catalyzing change as well as assessing progress toward systematic and sustainable reform.

It is equally important that future programs will have the depth and breadth that keep students at the edge of technology, and be keyed to the fact that future demands will be for the solution of multiple problems involving human values and attitudes, future outlook, the environment, safety issues, as well as the interrelationships and dynamics of social, political and economic systems on a regional as well as global bases.

Desired Characteristic of Future Graduates: The characteristics which future graduates should possess to interact positively and become leaders of the profession should, in broad terms, include:

- a strong foundation in mathematics, basic sciences and engineering fundamentals;
- a capacity to apply these fundamentals in the analysis and solution of engineering problems;
- familiarity and experience with experimental methods, and ability to deal with: physical systems, engineering devices, and field-related set ups;
- knowledge and skills in the fundamentals of engineering practice;
- knowledge of selected professional-level skills commensurate with students' future field and/or area of specialization;
- a strong oral and written communication skills;
- a focus on design issues involving life–cycle economics, environmental impact, sustainable development maintainability, applicable standards and ad hoc concerns;
- an awareness of business practices in the Region and elsewhere;
- an understanding of nontechnical forces that affect engineering decision-making;
- a perception of social, ethical, and political responsibilities;
- an awareness of the evolution of human civilization in general, with an emphasis on technological developments in particular;
- a commitment to lifelong learning, a capacity for critical judgment, and a sense of interdisciplinary approach in tackling engineering problems.

Region's colleges have graduated, during the last three decades, over forty thousand engineers; some with reasonably good technical skills, but most have not been sufficiently prepared to assume leading roles and/or able to manage innovative technology. To the contrary, a relatively high percentage of these graduates have found themselves "ill-equipped" to carry on as engineers. Many were reduced to the role of a "technician", and some have abandoned engineering, all together, to pursue other careers. This is attributable, to some extent, to colleges'

failure in creating an educational experience conducive for the development of the characteristics mentioned above. The author[10]reported the outcome of a survey of engineering employers in the Region, that summarized frequently cited perceptions of the weaknesses of recent engineering graduates: *lack of design capability and creativity, deficiency in thinking critically and independently, narrow view of engineering and related disciplines, weak communication skills, lack of appreciation for variation, can't use time and resources properly, majority desire to be analysts, do not desire to get their hands dirty, no experience working in teams, and lack the knowledge and skills to do their own search and/or learn on their own*. Employers have increasingly emphasized that success as an engineer does not depend on technical skills alone but also on: skills in communication, an ability to work effectively as a member of a team, an understanding of the non-technical matters that do affect engineering decisions, and a commitment to lifelong learning.

Future Program Emphases and its Desirable Features: To move forward, Region's colleges, with guidance and support of stakeholders, need to develop new programs that meet outlined objectives, while retaining the strength of the old paradigm, and at the same time alleviating earlier weaknesses. The optimum blend of programs' emphases is to create a total educational experience conducive for the development of the desired characteristics of graduates. Ultimately, a structure, philosophy, and subject matter specificity, compatible with the new culture, and providing the experiences identified with the above characteristics, would emerge.

More specifically, the salient features of the new paradigm, reflecting author's views[1,2,3,4,5,6] and consonant with recent views of other advocates[11, 12, 13, 14] of engineering reform, plus the "crux" of relevant reports on future of engineering education,[15, 16, 17, 18, 19] would entail many or all of the following:

- Recruitment of qualified academics, with experience in developing education tools, curricula, and delivery systems. Their primary role is to provide guidance, help in seeding the new culture, and in developing emerging professionals;
- Initiation and maintenance of regular well-planned interaction with industry; and to seek industries' input, assistance, and feed back;
- An engineering "up-front" approach, where engineering is the intellectual centerpiece of the curriculum and to be used from the beginning, i.e., not simply be the traditional introductory and/or survey type course offered as an independent exercise during the first year;
- An integration of basic math and science onto themselves, but most importantly, intertwining the theory to serve engineering principles and engineering applications;
- Proper connectivity between pre-college math & science with their counterparts in first year engineering;
- A vertical integration of the curriculum so that multiple objectives within the same course and time period can be achieved, i.e., lower–division students no longer face a set of isolated individual courses but rather a vertically integrated package that would be team developed and team taught;
- Emphasis on inquiry-based learning and pedagogies of engagement with less dependence on traditional lectures;

- Increased emphasis on experiential learning through properly designed laboratory experiments to teach engineering principles and verify theoretical work raised in the classroom;
- Stress on: life-long learning, systems thinking, organizational management, teamwork and group problem–solving skills, and cultivation of leadership skills;
- Focus on design issues of relevance to the Region, involving life-cycle economics, environmental impact, utilization of locally available resources, maintainability, and conformity with standards (local and international);
- Start a joint initiative between engineering faculty and their colleagues in other disciplines(science, mathematics, humanities, social sciences, etc.) in building teams that would plan, revise, and teach topics with interwoven connections and engineering context, thus transcending cross-department and cross-college boundaries within the same institution;
- Re-examine the fragmented and inconsistent course offerings under the umbrella of humanities and social sciences, and arrive tentatively at an interwoven sets of topics that are coupled, synchronized, and complement one another;
- Raise the bar for required communication skills(speaking, reading and writing) in English and Arabic, and encourage and facilitate the use of both languages in technical and non-technical forums; and
- Help in seeding and developing a creative and intellectual environment, a capacity for critical judgment, and enthusiasm for learning.

The attributes listed above need to be properly planned, detailed, and translated into "workable" programs. Some of the listed attributes are bound to change with time. Nevertheless, programs that reflect all or some of these attributes will not only yield better equipped engineers, with the tools to face an unpredictable future with confidence in their abilities, but also would positively impact engineering practice in the area where future engineers will live and work.

A Path Forward

The majority of Region's colleges have made some changes in their undergraduate programs, on their own- or more often, with the assistance of advisory committees made up of academics drawn from the USA and other western countries. But unfortunately, much of this change has been too limited and often too late! These incremental changes, often in response to outside pressures, have addressed bits and pieces of the curriculum, but never the total picture. Engineering education programs today, in all **eight colleges** of the Region (Table 1), are somewhat similar in terms of: structure, content, execution, and assessment methods. All eight colleges appear to have adopted the typical model of sequential layered courses in mathematics and science followed by engineering science and in turn followed by professional-level, department defined upper division courses and a senior design component. Review of present programs at the eight government-run colleges, referred to in Table 1; supplemented with feed back from colleagues, and comments made by some recent graduates, have lead the author to arrive at the following apparent short comings and/or deficiencies in the present program(s). ***First***, the program as a whole has become increasingly fragmented into what appears to the student as almost independent parts. Most programs are comprised of isolated individual courses or group of courses. Students seem to be indifferent and probably satisfied, regardless of the

fragmentation, so long as they graduate. The traditional momentum for incremental adjustments, rather than an "overall reform" approach, has adversely affected continuity and intertwining of subject matter throughout the program.

Second, the failure in bridging the gap between pre-university education systems and stepping into the program as an entering freshman continues to adversely affect outcome. The inability to properly connect pre-university mathematics and science with gateway courses is a pressing issue that requires attention and remedial action. Ways and means of addressing this discrepancy have been outlined by the author. [2, 3]

Third, there appear to be less than desirable College of Engineering influence or participation at the lower division level. Students do not seem to get real exposure to engineering- save the general introductory course during the freshman year, until the second semester of the second year or even the third year. This runs opposite to present trend in North America, where comprehensive design exposure and foundation mathematics and science, in an engineering context, are brought into the freshman year.

Fourth, by and large, the integration and sequencing of the subject matter in most of the forty to fifty courses required for graduation, despite adherence to prerequisites, is either "hard to trace" or ill-defined. In particular, connections between core courses and upper division courses are insufficient and do not seem to be apparent to students even after passing the course.

Fifth, the whole arena of design and design–related topics (upper division courses, capstone design courses, and final design projects), is drawn primarily from textbooks authored in western countries, with very little input that reflects the practice in the Region. Unfortunately, connections with local practitioners, who would be willing and able to contribute to the process, have not been properly cultivated.

Sixth, programs do lack emphasis on the essence of engineering as a profession, in general, and the role of future engineers as emerging professionals in particular. Also, subject matter relevant to professional development issues; including the imperative for superior communication skills and life-long learning in professional practice, have been left out.

Ways need to be found to revive engineering education programs in the Region, with the objective of phasing out some of traditional, ill-conceived programs in favor of broader more inclusive systems, with a focus on: the development of human resources, the broader vision and experiences founded on a multidisciplinary integrated education, restructuring and bolstering pre-university systems, and eventually, changing the educational culture. To instigate the proposed "change" and embrace the "challenge", ideas, scenarios, and new strategies need to permeate traditional intra-institutional boundaries within the single institution first, where faculty are the major players.

Evolutionary Stages in Program Development: Prior to any program restructuring and curricula reform, a consensus must be arrived at, reflecting the views of the stakeholders. The process in arriving at a new program should go through specific steps and/or stages. These stages are: i) reaching a consensus within the college, ii) the input of the industrial sector, iii) arrival at an experimental curriculum (a pilot program), iv) outcome-based assessment of the pilot program, and finally, v) full-scale adoption of the new program(s).

The consensus stage: This stage would be devoted to capacity building aimed at educational cultural change and new program development. Faculty members from engineering, science and humanities would participate in seminars, workshops, open forums, etc., to exchange ideas,

express their views, discuss the pros and cons of the status quos, and why they think a "change" should take place! By the end of this stage, an initial draft of the proposed changes or a pilot program would be arrived at. The senior faculty should assume a leading role in providing guidance and insuring that all faculty members, wishing to contribute or be heard, have been given ample opportunity to air their views.

Industries' feedback: The preliminary views arrived at during the *consensus stage* need to be passed on to the industrial sector. Those industries that have an interest and have made their views known regarding educational programs in general and engineering in particular, should have priority. To proceed in this direction, general meetings between academics and industry representatives should be arranged to enable both sides to express their views and concerns. Industries input to the new programs, if and when implemented, may help reduce the burden of having to train future employees. Industries in the Region must spell out the requirements for the quality and education of the engineers they hire.

A pilot program: After streamlining and scrutinizing information (proposals, opinions, feedback, etc.) generated in open meetings, an initial experimental curriculum (program) should be arrived at having all or most of the agreed upon views and ideas, and at the same time, insuring that weaknesses and deficiencies in the current program have been avoided. In broad terms, the initial draft of the *pilot program* should, in the author's opinion, embody the following features:

- a shift in focus from course content to broader multidisciplinary integrated approach,
- vertical integration of the curriculum in an attempt to reach multiple objectives within the same course and/or course sequence,
- an increased emphasis on early involvement in engineering with math and science brought in within the context of engineering,
- an emphasis on the synergistic relationship between science and engineering, as well as, the synergies between humanities and engineering,
- intertwining of engineering fundamentals with department-specific courses,
- the assertion that the student, as an emerging professional, has an unparallel role to play in the development of the Region, in the decades ahead.

Later, the *pilot program* would be structured, formatted, detailed, and made ready for adoption on a trial basis. The arrival at a general understanding on how to implement the *pilot program* and proceed to assess outcome, is an internal matter that may vary from one institution to another. Who are the enrollees? How long should the trial period last? What are the parameters that need to be tracked? These are some of the questions that have to be answered in order to bring the process into fruition and eventually determine whether the *pilot program* meets desired objectives referred to earlier.

Assessment and feedback: Taking the process a step further by making use of outcome-based assessment methods, would assist in narrowing down variables and in arriving at appropriate recommendations. Tools and other aids to assist in identifying objectives, establishing outcomes, and developing survey instruments are available in most of the Region's colleges; but may not have been sufficiently embedded or diffused in the broader community, as yet, to reap all the benefits that could be generated from using such tools. Irrespective of the tools and methods used, the adoption of the *pilot program*, or a variation thereof, should be based on quantitative results that show measurable improvements in student learning outcome.

Program change need not be a one time event, nor be instigated by outside pressure; but should spring out from within, in response to real need. To seed the process of change within an institution, efforts should be devoted to capacity building aimed at both the desired educational cultural change and program development. Hypothesizing about the future is challenging yet risky. Having to deal with the challenge is becoming increasingly evident however. In the long range, changes in the educational environment for Region's colleges of engineering should take place in two domains. One is in the education of engineering students, and the other is in college's broader role within the university, and also within the engineering community at large. Educational programs in the years ahead will most likely see more global and cross-institutional linkages with colleges and entities in the Region and abroad. There has been a great deal of information and material flowing from the west towards the Region. To the contrary, little, if any cross-linking, within Region's colleges have been established, as yet.

Seeding the process of Change: The new paradigm for engineering education in the Gulf region is keyed to the fact that prevailing attitudes, behavior, and practices, known to influence and control the academic work and all its ramifications, should begin to change! To accomplish this goal, the administration, in partnership with the faculty, should institutionalize the concept of continuous improvement, making it part and parcel of the academic process. Essential to this goal is diffusion of new ideas and dissemination of relevant information through: seminars, conferences, and workshops. Also, the use of a Web site as a digital repository that puts across materials received from contributing faculty members or generated elsewhere, would lead to wider interaction, constructive dialogue, and help reach audience beyond those who are directly involved. It is equally important to get the feed back to "proposed" changes and improvements from the various stakeholders including government, local industry, and the community at large.

Looking within any or all of the **eight colleges** of the Region (Table 1), one notices that a relatively large percentage of the *expat faculty* are not sufficiently involved in academic issues including curricula development and related matters. The *expat faculty* population, which accounts for 25 to 50 percent of the total faculty, is under a prevailing notion and/or general understanding that they are temporary members, and would be eventually replaced with new incoming young citizen of the State. This "abnormality" needs to be rectified, and a more equitable and just method of treating *expat faculty* should be found to insure wider participation by the *expat faculty* in the affairs of the college. Once misunderstanding and injustice have been squared away, and *expat faculty* members become active participants, the sphere of innovation and development should extend beyond the issues of curricula and program development, to include: faculty professional development, outreach, instructional technologies and methodologies, assessment, linking and sharing with industries, and the K-12 arena as well.

Proven methodologies and knowledge generated elsewhere, if and when properly adapted, should make it possible for Region's institutions to devise revitalization programs that meet Region's needs, objectives, and aspirations. Who should be entrusted with the process of shifting from the old to the new paradigm? To start, "forward-looking" faculty members can contribute to such an effort- each in their own way. Industrial leaders, professional societies, community members, and others can also contribute as facilitators of the change. Other segments of the university may also contribute to this challenge. Region's engineering institutions have to meet

the challenge head–on, and charter **"a path-forward"** with achievable goals that would bring innovations and flexibility to undergraduate engineering education in the Region.

Although, there has been some progress over the last decade, resistance to change continues, notwithstanding increasing competition from alternate service providers as well as apparent "student-pipeline" and job security problems that have now been brought to local and regional attention. The time is right to initiate "the change" and take "bold" steps towards reformation as soon as possible. Engineering colleges advisory boards could serve as the initial "*Path finder"*; however, many existing boards will likely require a restructuring to accomplish the mission. Eventually, the extant barriers to real progress in the quest to achieve ubiquitous realization of the new paradigm in Region's engineering education will breakdown. Building on the wealth of knowledge and experience of others, change agents- who ever the may be- should continue working to catalyze reform aimed at fundamental change, i.e., systemic change that lies well beyond rhetoric and cosmetic experiments. At the start, engineering deans, department heads, professional societies, and faculty members can contribute as facilitators and agents of change. Also of interest would be the arrival at an agenda for catalyzing the change as well as assessing the progress in implementation of novel programs/ideas toward systematic and sustainable engineering education reform. Ways have to be found to make engineering education programs more flexible without loss of needed technical strength. Also, newly structured programs should provide the opportunity and encouragement for students to pursue other intellectually broadening combinations with such areas as business, economics, marketing, entrepreneurship, education, psychology, and other social sciences, as well as combinations with mathematics, and physical sciences. In total, the new educational systems that the Region should aspire for, will provide for a new renaissance engineer recognizing multiple career and personal intellectual interests.

Summary and Concluding Remarks

The engineering colleges in the Arab Region of the Persian Gulf (Saudi Arabia, Kuwait, Bahrain, Qatar, The United Arab Emirates, and Oman) are under pressure to graduate more rounded professionals with the ability to function in a socially interactive, communicative, and business climate of modern industry. Concurrent with establishing and maintaining these institutions over the last three decades, the engineering educational experience, in general, has become increasingly fragmented into what appear to students as independent parts. The continuous mounting pressures on already overburdened curricula created a dilemma and exacerbated further against student time for independent thought, development of skills, and personal traits.

The paper renews the call for reform of engineering education in the above noted Arab States. The paper addresses *change* related to *reform* in general and programs' development in particular. The author argues for the need to institutionalize the concept of improvement by seeding the process within the College. Initially, efforts need to be devoted to capacity building aimed at fostering culture changes transcending the traditional norms vis-à-vis undergraduate education in general and program development in particular. After overcoming traditional barriers, an initial framework for "retooling" and/or "revitalizing" the programs should be outlined. The process, should broadly identify the following sets of imperatives: i) the desired characteristics of future graduates; ii) the program emphases to develop these characteristics; iii) assessing present program's effectiveness, or lack of it, in meeting goals; and, iv) developing a

strategy to bring about the required changes through a multistage *evolutionary program development process* that starts with an experimental (*pilot*) program based on general consensus, followed by an assessment of the *pilot* program, and ending with a totally new program, or a revised version of an exiting one. In conclusion, the educational enterprise, and the faculty in particular, hopefully would be able to come to grip with the "ins and outs" of the dilemma in which they are immersed, be stimulated to debate, and motivated to act along workable paths to implement reform, to ensure the vitality and currency of engineering education in the Region. Ways need to be found to make engineering educational programs more flexible and responsive to the needs of emerging engineering professionals without loss of required technical strength. The challenge is clear. The solutions, however, are not easily attainable!

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