ON ENGINEERING EDUCATION IN THE ARAB GULF STATES: CHALLENGES AND IMPERATIVES

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ABSTRACT. Engineering education in the Arab Gulf States, from author's perspective, faces many challenges today. A major concern is that the perpetuation of the old paradigm by engineering colleges of the Region will all but assure insignificant roles for engineers in the future, as well as difficulty in adapting to the exigencies of the fast-paced global marketplace. The transition from the present to the new paradigm, if and when it takes place, would not be easy since the decision to make the change rests mostly with those who oppose the change in the first place. The purpose of this paper is to provide some historical perspectives while renewing the call for the need to "rethink" engineering education and to undertake constructive steps towards reforming the current systems. The paper addresses *change* related to programs' development in particular, and argues for the need to institutionalize the concept of continuous improvement by seeding the process within the college, and devising revitalization programs that fit the context of the institution, its student body, its faculty, and its objectives. A conceptual framework for "retooling" and/or "revitalizing" the academic programs is outlined. What lies at the crux is: what engineering students need to learn and how they can best learn it, as well as what engineering institutions should teach and how can they best embark on it?

1. INTRODUCTION

This paper amplifies the views expressed by Akili in a prior publication [(1)], and is a follow up to previous papers [(2, 3, 4, 5)] on engineering education reform in the Arab Gulf Sates (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 in the Arab Gulf Region, commensurate with demands for more rounded engineering graduates with the ability to function in a modern business climate. Engineering graduates must have the abilities and the skills to cope with challenges brought about by a highly competitive and global marketplace; and also are able to develop the capacity to adapt to unforeseen changes that could take place in the future. Needless to say that we live in a complex age of rapid change where differing views and conflicting interests tend to blurry the vision and create uncertainties when important decisions have to be made.

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. Certainly, there are other views and conflicting interests. That is why 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 change!

Although the different states, within the Region, do have their own specifics when it comes to: visions, policies, experiences, etc. The fact remains however, that what these states have in common, and in the arena of higher education in particular, far exceeds differences amongst them. Therefore, and from author's perspective, the Arab Gulf States constitute a well-defined entity that can be focused at as a "distinguishable" region within the Arab World.

In this endeavor, the author draws on his own past experience as a faculty member in the Arab Gulf States (recently in Qatar and earlier in Saudi Arabia); in addition to views and suggestions of: colleagues, graduates, and business leaders. The author is strongly committed to the Region, and has been an advocate of reformation of its current education systems at all levels. It should be pointed out that the need for reformation is by no means author's views alone, but rather the consensus of Region's eng. graduates, arrived at through a properly conducted survey [6] in 2000.

2. SOME BENCHMARKS OF ENGINEERING EDUCATION IN THE GULF REGION

Engineering education in the Arab Middle East, by and large, 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 on the East Coast of the USA. Colleges in Egypt and Iraq were influenced, at the time of their establishment, by the British system of education.[2, 3, 4].

Today, we witness in all Arab countries increases in the numbers of: engineering colleges, engineering students, and engineering graduates. This trend has continued for decades and exceeded expectations. But, unfortunately, the education process in nearly all government-run colleges within these countries, continue to suffer from: antiquated programs, improper teaching methods, poor management, and lack of resources. On the other hand, engineering institutions in the Arab Gulf States (the Region) have been spared! These States have, from the start, "got on the right foot" and founded - what appeared to be at the time - modern engineering colleges, with a decisive advantage over most of the institutions of the broader Arab Middle East.

Engineering education in the Arab Gulf States (the Region) 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. [2, 3, 4] The

strong political and economic ties between the States of the Region and some 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 programs.

Table 1: The eight "Main" engineering colleges of the Arab Gulf Region

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

These eight "main" public colleges have, since their inception, been guided by advisory boards made up largely from 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 of the Region in making use of the EC2000 whenever possible. Indeed, the EC2000 [9] has generated a lot of interest and challenges in the Region. Whether or not the EC2000 – or a tailor-made version of it - would be properly implemented, depend on: institutional vision, available resources, students' preparedness, and prevailing traditions and norms. The organizational structure is nearly the same in all eight colleges. 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 had attended the "prep year," during which students embark primarily on improving their English skills.[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 components: (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, desire to learn, creative thinking, leadership skills and the importance of team work [3, 4]

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, also, be able to adapt to the ups and downs of business cycles. Views of the graduates have by and large been similar to those of the author and to the views of some faculty members in Region's colleges; and are consonant with developing a more "responsive" educational environment.

In retrospect, 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 are stagnant, lacking in: content, relevance, & coherence; and have become increasingly fragmented. While the challenge is clear, the solution, however, has not as yet loomed on the horizon.

3. RESPONSE TO THE CHALLENGE

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. 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. Perhaps, as important will be the voice of industry - a major "customer" of academia in the Region. Unless, and 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 in the Region 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, & select new components and characteristics of the programs in terms of: content, structure, prerequisites; in order to create and assert the new emphases; and
- outline strategies to implement well thought out and agreed upon changes, in steps.

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, the interrelationships and dynamics of social, political & economic systems of the region.

A. Desired Characteristic of Future Graduates: The characteristics which future graduates should possess to become leaders of their profession should, in broad terms, include:

- a strong foundation in mathematics, basic sciences and engineering fundamentals;
- a capacity to apply these fundamentals in 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 in English and Arabic;
- 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 thirty thousand engineers; some with reasonably good technical skills, but most of these graduates were not adequately prepared to assume leading roles and/or are 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, most do not desire to get their hands dirty, no experience working in teams, and do 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, ability to work as a member of a team, understanding of non-technical matters that affect eng. decisions, and lifelong learning.

B. 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, that provides the experiences identified with the above characteristics, would emerge.

More specifically, the salient features of the new paradigm, reflecting author's views[2,3,4,5] and consonant with views of other advocates[11, 12, 13, 14] of engineering reform, plus the "crux" of relevant reports on future of eng. education,[15, 16, 17, 18, 19] would entail many 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 to be used from the beginning, i.e., not 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 and 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;

- 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, also, 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 eng. faculty and their colleagues in other disciplines (science, mathematics, humanities, social sciences, etc.) in building teams to plan, revise, and teach topics with interwoven connections and engineering context, thus transcending cross-department /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 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.

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.

4. LOOKING FORWARD

The majority of Region's colleges have made some changes in their undergraduate programs; either 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 "main" 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. A thorough review of present programs at the eight government-run colleges, referred to earlier; 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 previously by the author. [3, 4]

Third, there appear to be less than desirable College of Engineering influence and/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 the present trend in North America, where comprehensive design exposure along with 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 revitalize engineering education programs in the Region, with the objective of phasing out traditional 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.

A. 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).

i. 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.

ii. 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, general meetings between academics and industry representatives should be arranged to enable both sides to express their views. Industries input to the programs, if and when implemented, may help reduce the burden of having to train future employees.

iii. 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 determine whether the *pilot program* meets desired objectives.

iv. 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. One

such diagrammed process is shown in Figure 1. It outlines the way data from various constituents flow through an academic institution and how changes and/or improvement decisions are arrived at based on the results of the feedback loops. 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. 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 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 abroad. There has been a great deal of information flowing from the west towards the Region. To the contrary, little, if any cross-linking, within Region's colleges have been established.

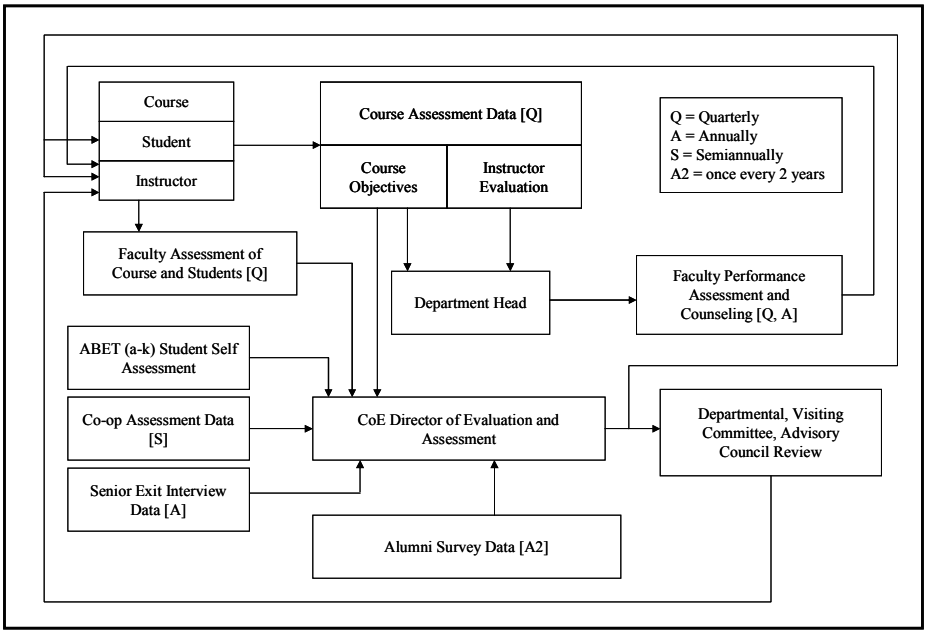

Figure 2: Example of a structured assessment and feedback program (modified after ref. 11).

B. Seeding the process: 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 evolve 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, assessment, etc.

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 and administrators can contribute to such an effort- each in their own way. Industrial leaders, professional societies, enlightened community members, and many others can also contribute as facilitators of the change. Finally, Region's engineering institutions have to live up to expectations, meet the challenge head–on, and charter "a path-forward" with achievable goals that would bring innovations & flexibility to undergraduate engineering education in the Region.

5. SUMMARY AND CONCLUDING REMARKS

The fast changing global marketplace has been pressuring engineering colleges in the Arab Gulf States to graduate more rounded engineering 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, calling for: increased emphasis on synthesis and design, maintenance of depth and breadth in technical subjects, broadening non-technical perspectives, etc. created a dilemma and exacerbated further against student time for independent thought, development of skills, and other personal traits. Attempts to meet all of the above-noted demands evolved an intense experience devoid of: depth and breadth in learning, opportunity for intellectual enjoyment, and appreciation for engineering as a profession. What is engineering education for? And what engineering students need to learn and how can they best learn it? Answers to these questions should be arrived at as a result of an internal debate where all stakeholders express their views and voice their concerns. The challenge is clear. Solutions, however, are not easily attainable!

The paper provides some historical perspectives while renewing the call for reform of engineering education in the Arab Gulf 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 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 program development in particular. After overcoming traditional barriers, an initial framework for "retooling" and/or "revitalizing" the academic programs should be outlined. The process, should broadly sketch out and identify the following sets of imperatives: i) the desired characteristics of future graduates; ii) the program emphases necessary to develop these characteristics; iii) assessing present program's effectiveness, or lack of it, in meeting desired goals and objectives; 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 and ready 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 widespread reform to ensure the vitality and currency of engineering education in the Region. Indeed, a significant and sustainable cultural change must take place in the education arena of the Region as a whole. 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.

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