A CURRICULUM REVISION PLAN UTILIZING AN ADAPTIVE CONTROL MODEL

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Abstract —. Innovative approaches in engineering system design have led to well established methods to deal with many unpredictable situations. As a result, one often hears terms such as adaptive optics, adaptive control, smart materials, intelligent sensors, or actuators. Furthermore there has been a constant drive toward the development of computers that can predict and adapt. Although the adaptive approach has been a major success in engineering design, the engineering programs in many institutions have remained rigid and, in some situations, have failed to adapt engineering education to the continuous technological expansion. This has resulted in an engineering curriculum that may not address the current job market and industrial demands. An adaptive mechanism for selection and modification of courses and curriculum is needed to deal with the dynamics of technological growth and industrial expansion. A self-correcting system is proposed that allows continuous changes in courses and curricula to match the technological advancement and subsequently, increases the employment opportunities in expanding industries. In this approach, rigid curricula structures are replaced by concentrations of courses whose content and frequency of offering follow established and well known adaptive approaches in engineering. The major adaptive approaches that are considered include Gain-scheduling, Self-tuning, and Model Referencing. All these methods have been applied successfully to numerous engineering applications. A proposed adaptive model for curriculum development is presented. This model provides a mechanism that continuously samples the outcome, measures the educational demands, and produces corrections in course and curriculum. Such an approach allows the introduction of new information into the curriculum, while maintaining content directed toward the major objective of engineering program.

INTRODUCTION

In the sciences it is common that the validity of an approach is discussed within a scientific frame and the availability of an established theory that allows or prevents such approaches to be successful. Scientific theories are proved or disproved by experiments and those theories that are proven will finally result in discoveries and applications. Unfortunately, in field of education or social studies there are a very few well established educational theories and experimental methods in education that result in a definite outcome are not possible. As a result, teaching and learning, most probably, has not changed very much all throughout history. What is the best teaching, the best learning, or the best educational methods is only a matter of individual opinion with no universal support or approval.

One of the earlier studies in the U.S regarding changes reported what is known as the Hawthorne effect. This is named for a series of studies conducted from the late 1920s through the 1930s[1]. In its simplest form, the Hawthome effect suggests that any workplace change makes people feel important and thereby improves their performance. This has been translated in the educational system to mean that changes in teaching approaches result in an excitement that promotes better learning. This simplistic view is not always accepted and it is difficult to believe that all these so-called new approaches in education are just for excitement. However, during the past few decades we have encountered a new approach to engineering education almost every year. These approaches have been simple, long term, expensive, inexpensive, direct, indirect, or just different. The results of these approaches have been published, buried, forgotten, and then rediscovered, or are still collecting dust in some engineering department storage room. The question still remains, is there any method of learning or teaching in engineering which is more effective than others or do we need to search for a new one? Meanwhile, the demands of technological advancement for new knowledge have prompted the addition of new courses and programs. This new stream of topics in the engineering curriculum calls for new approaches in teaching, learning, laboratories, and requirements.

Generally, the new educational approaches have had two major objectives, which are, a.) Promoting the new techniques for learning enhancement and b.) Sugarcoating the traditional topics to increase student retention. There is no study available that shows any of these objectives have been meet or that the effort has caused any significant changes in undergraduate engineering education. Still, most of the courses are being taught in the traditional way and sugar coating has resulted in watering down rigorous topics.

The methods of learning and transferring information among people have developed over many thousands of years and have very little room for expansion. The procedure has been optimized over the centuries. The requirements for the best learning are well understood to be

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desire to teach or learn. . This is probably the best we can ever do for our educational system. Beside, individual learning is a process internal to an individual and is inaccessible to teachers or anyone else. The only scientific study that indicates one's learning can be enhanced is known as "reinforcing the consequence [2]" which is a process beyond the function of engineering departments.

The workers in educational field and social sciences have not provided us with an obvious, practical educational theory or well established methodology that fits our current situation of engineering education. On the other hand, the engineering faculty, whenever they want to improve their educational needs have looked outside the engineering field for an answer. This is ironic when the educational theories are vague or unproven while engineering methods are well established and are successfully applied.

Except in some special cases, the available learning or teaching methodology has not significantly changed over the course of the history and most probably will not change in the near future. What is changed, dramatically, and will continue to change at an explosive rate is the curriculum. Specially, engineering courses and curriculum that must constantly change and be refurbished with new ideas to keep up with changes in technologies and industrial demands. Since curriculum in engineering is entirely related to engineering activity, it is not necessary to utilized educational models or methodology. Instead, the well-established engineering approaches can easily be utilized in development of courses and curriculum that can deal with industrial demands and a changing job market.

From an engineering point of view, an engineering college can be thought of as a system dealing with unpredictable industrial and economical changes [3]. The courses and curriculum in engineering colleges are the powering mechanism for the system that needs to be controlled to deal with such a changes. The objective is developing a self-correcting system that senses what lays ahead and continuously changes course to minimize the deviation from the main goal and adapts to new changes. Such systems are commonly designed in engineering and engineers are most familiar with adaptive control. Such adaptive mechanisms are used in communication electronics, control, optical engineering, and many varieties of signal processing. The major task is to identify the key parameters and defined their functionality in an educational closed loop system.

PROCEDURE

A major component of the engineering educational system is curriculum. The function of the curriculum is to produce Students with degrees who are well Qualified with Specialties that are in Demand, (SQED). Such a curriculum must be flexible and always ready to change. A dynamic curriculum has an input, which includes new ideas that enter into the curriculum to keep the subject matter up to date and relevant to student needs. Also a curriculum has an out, which removes the old or not-of-current-interest ideas out of the curriculum. A possible curriculum is shown in Fig (1).

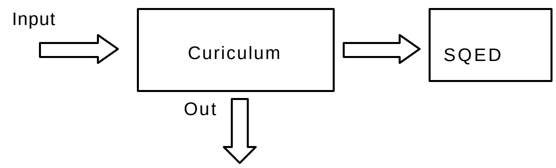

Figure 1 A simple model for curriculum

Also, the curriculum's "out" prevents the curriculum, which determines the requirements for a degree, from expanding beyond a reasonable limit. Therefore, the out is a mechanism that removes the unwanted materials from the curriculum while maintaining a level covers the requirements for a degree. Since most colleges are limited to a number of required credit hours for a degree, the out is a self-regulated mechanism in the curriculum.

This simple model of curriculum in engineering, shown in Fig (1), is unstable. That is, there is no mechanism that determines what are the limitations or desired parameters that determine the input, out, or the optimum size for curriculum. Obviously, such definition must come directly from industries that are expanding and are major employers of engineers. Since industries are rarely involved in course and curriculum development in engineering colleges there must be a university liaison to industries that we can refer to as Parameter Estimator (PE). These people, who may be university professors, provide the feedback to Curriculum Adjusters (CA) to establish a closed loop operation. As part of their work, the PEs attend to the needs or directions of industrial expansion by actually sitting in their board meeting and keeping completely aware of areas of expertise that are needed for the next generation technological advancement. Without PEs, the content of the curriculum cannot adjust fast enough to the pace of industrial expansion and it could be completely out of phase with new changes.

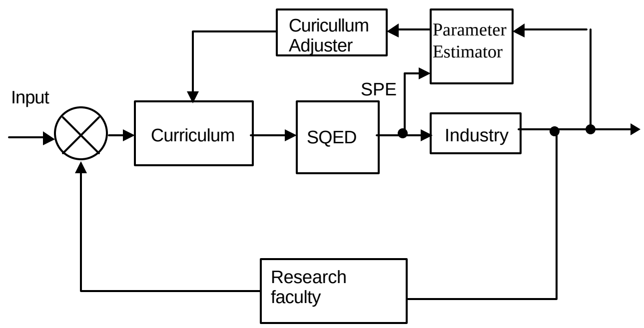

Figure 2 Self-tuning schematic for curriculum adjustment

Another important job of the PEs is monitoring the curriculum product, that is, SQEDs and making sure their quality is equal to what is expected. To accomplish this goal, the PEs must be completely aware of the outcome of the curriculum by continuous comparison level of the SQED with industrial demand. This loop assures that the CAs has executed the instruction from the PEs and implementation has produced desirable results. This adjustment is provided by SPE path that could be information that comes from student projects, final exams, or other reports regarding student performance.

Obviously the introduction of new courses or new topics in a course within the curriculum must be as a result of what faculty members believe to be most needed or relevant. This is a measurement process that can be accomplished by research faculty members who are exploring the frontiers of science and technology in their research activities. The faculty members who are involved with research can easily predict what is current and what is required knowledge for the next generation of industrial expansion. This group of faculty, while participating in development, can anticipate trends by sensing what are ahead and producing changes in curriculum.

Conclusion

The model that is presented here for course and curriculum development in engineering is derived from a very well known field of electronic machine control. It is commonly referred to as self-tuning closed-loop adaptive control system. It is an engineering approach to deal with a system of unpredictable load conditions. Such a method is commonly used in many complex engineering educational methods deal with people and cannot be compared with a machine, the concept presented here can be a good working model for adaptive educational system. Knowing the fact that training in engineering is intended to support the work force and aimed at industrial participation, an adaptive feedback control method between university and industry is inevitable. The results show that an agile curriculum that addresses the needs of students as well as industrial expansion requires an orchestrated effort by teaching faculty, research faculty, a university's engineering administration, and industry participation.

References

[1] The Encyclopedia of Sociology, NY: Macmillan, 1992, pp. 793-794

[2] B. F Skinner, The Gale Encyclopedia of Psychology, Detroit, MI: Gale, 1996 pp.334-335

[3] K. Daneshvar and W. Coleman, Free Market Approaches in Engineering Course and Curriculum, submitted for publication