REENGINEERING THE ENGINEERING SCHOOLS

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ABSTRACT. Many of the organizational structures of engineering schools have evolved over the years to accommodate specific needs of an era. In this age of rapidly changing technologies and tough competition in global markets, many companies are reengineering their businesses to keep pace with the change. This paper proposes that there is a real need for reengineering the organizational and departmental structures of engineering schools in the light of changes in demand for different types of engineer, vast changes in information technology and changes in conceptions of the ways to educate and train engineers to make them more responsive to the needs of industry.

1. INTRODUCTION

In a time of rapidly changing technologies, stiffer international competition, ever shorter product development and life cycles, many companies are finding that they are lagging behind in terms of quality, customer satisfaction and asset utilization. Using process rationalization and automation haven't yielded the dramatic improvements they needed, because companies used the new technology to mechanize old ways of doing business. They used the computers to speed up the existing processes. However, the existing processes, organizational structures, control mechanisms, work flows, etc. were designed before the advent of the computer and based on reducing cost and increasing the growth and control in the organization. Now the structure of the organization must be geared toward innovation and speed, customer service and quality to stay alive and win the stiff competition. Many companies in the developing world are reengineering their businesses to use the power of modern information technology to radically redesign their business processes and make sure that the work structures and processes keep pace with the change in information technology, demographics, business competition, and customer demands [1,2].

While all these things are happening in the business world, business are as usual in the academic institutions. Although the use of computers have been increasing, no appreciable change is taking place in the organizational structure of engineering schools to keep in pace with the changes in the industrial sector. Engineering schools are years behind the industry in terms of the level of technology taught and the level of applied research. This is true in the developing countries as well as in the developed world. It is still the academicians that decide what a student ought to know, how he should be taught it, and who can teach it to him.

In this paper, it is proposed to apply the reengineering principles to the organizational and departmental structures of engineering schools in the light of changes in demand for different types of engineer, changes in technology, changes in the amount of resources available and changing conceptions of the best way to teach engineering to make engineering schools more

responsive to the needs of industry. It requires a complete overhaul of departmental structures, creation of new departments, new ways of teaching and, the most important of all, a continuous evaluation of market needs and continuous change in the organization of engineering schools, course structures and contents.

2. REENGINEERING OF BUSINESS ESTABLISHMENTS

Reengineering is the name for the process innovation and core process redesign given by M. Hammer, a former professor at MIT, in his best seller book [2]. It is a search for and implementation of radical changes in business processes to achieve breakthrough results. Reengineering is the redesign of processes by the use of information technology to improve innovation and speed, customer service and quality. It is successfully implemented by automotive, insurance, communication and banking industry by braking down the existing departmental boundaries and redesigning processes with the results of better customer satisfaction, increased quality, and cost reduction.

If examined carefully, many private as well as public establishments today will reveal that many tasks that their employees perform have nothing to do with meeting their customer needs - whoever their customers are. Instead of providing excellent service, creating products in high quality and supplying it at a fair price, employees perform many tasks simply to satisfy internal demands of their own organization. They should be asking themselves "Why do we do what we do at all?" and then cause a radical change in their environment to that effect.

Although most change efforts start with what exists and fix it up, reengineering is not fine tuning of old procedures and certainly not simplifying and downsizing. It is not a continuous improvement supposed to start from bottom-up. Its real implementation starts with a clean sheet of paper. It requires a new look from the future and work backward, as if unconstrained by existing methods, people and departmental divisions. In effect it asks, "If we were a new company, how would we run this place?" Then with an ax and hammer, they conform the company to their vision [1-5].

Reengineering requires rewriting new job descriptions for people, inventing new recognition and rewarding system, revamping the computer system, retraining over the board and making extensive changes in financial reporting, writing proposals and contracts, dealing with suppliers, manufacturing, shipping, installation and billing. What matters in reengineering is how we want to organize work today, given the demands of today's markets and the power of today's technologies. How people and companies did things yesterday doesn't matter to the business reengineer. However, reengineering is not a one-time change. A truly great company should never be satisfied with its current performance, but should be improving continuously.

3. ORGANIZATION OF ENGINEERING SCHOOLS

In this section we will critically examine engineering schools from the point of view of societal demands in today's world and the ways they are responding to these demands.

3.1 Historical Trends in the Organization of Engineering Schools

Historically universities have grown from relatively simple organizations (from single liberal arts or engineering colleges) to complex organizations [6]. As they have grown they have also diversified into several departments. Many of the organizational structures of universities have evolved over the years to accommodate the specific needs of an era. Often new departments and laboratories are added to the existing structure, rather than reorganizing the entire school

to meet the changing needs. Engineering schools started as civil and agricultural engineering colleges. Later mechanical, electrical, chemical, metallurgical, aeronautical, nuclear engineering departments were added as a need came up. However, some of these departments are product departments (aeronautical, civil, nuclear engineering), and the others are functional departments (like mechanical, electrical, chemical engineering departments) [7]. There are a lot of duplication of subjects taught in product departments, since they must also cover all functions of engineering. Furthermore, it has been observed that the student enrollment in the product departments fluctuate more severely than that of the functional departments, since students do not select these departments when the products covered by the respective departments do not enjoy good sales performance.

3.2 New Demands From Engineering Schools

Today the problems of real world often refuse to fit into departmental categories. Consequently, both governmental institutions and private companies tend to support interdisciplinary research. New journals are founded everyday to fill the interstices between disciplines and encourage cross-disciplinary contact and fertilization. But instructional programs remains less flexible. Faculty who wants to teach subjects outside their department's traditional boundaries often find this difficult, and students who want to pursue a pattern of studies that does not fall under conventional departmental definitions are likely to run into a wall. The issue here is not specialization versus generalization. The issue is whether one way of aggregating specialized skills is better than another.

The name of new revolution in industry is quality[8]. It may as well applied to the products of engineering schools. As in the industrial products; the following elements can be adopted to the products of engineering schools:

1. Quality of educated students is to be viewed from the point of view of its impact on the whole society, from the time students enter the school, graduate and go to work in industry. A better educated student (i.e., one with higher quality) is one which imparts smaller loss to society.

2. Continuous quality improvement and cost reduction are necessary in today's competitive environment; quality has no meaning without a price.

3. A continuous quality improvement program includes incessant reduction in the variation of students' performance characteristics about its target value. By performance characteristics we mean the final characteristics of a graduate that determine the graduating engineer's performance in satisfying industry's need. In order to determine the degree of satisfaction, the ideal state of the performance characteristic from the customer's point of view must be known; this ideal state is known as the target value.

4. Society's loss can be thought as proportional to the deviation of the performance characteristics from its target.

5. Final quality and cost are determined (to a large extend) by the design of the program, and curriculum and learning process students have undergone.

3.3 The Way Engineering Schools Responding New Demands

Some concerned authorities said that when students come out of the university to take up a profession, they should be fully equipped with the know-how required [9]. Along these lines, we find that some universities are already subdividing their science and engineering departments to facilitate proper studies in each of them. MIT Department of Electrical and Computer Engineering has already created a five-year combined BS plus MSc degree to make sure that graduates are equipped with the required know-how when they enter into the profession [6]. Some universities in the USA allow graduate students to register into any engineering department and pursue an interdepartmental program. But these are exceptions, not common examples.

The response of engineering schools to the market pressure has been to increase social and engineering electives to provide students with more choice; to set-up optional paths within departments to give students a more organized path of courses while satisfying market needs. Still this did not give enough freedom to the students to tailor a program by cross-listing many courses from many department with the help of a faculty advisor. In some schools this is allowed in graduate schools, but graduates face an uncertain career path because of the departmental structures in the universities and job definitions in industry. Facing the challenge of the market competition will force many companies to have a new look at the business processes , and as a customer they will force the engineering schools to the same.

4. REENGINEERING OF ENGINEERING SCHOOLS

Based on the experience gained from business reengineering efforts, historical data on the organizational structure of engineering schools and new challenges facing new engineers, engineering schools should be reorganized to satisfy these demands.

4.1 Problems Encountered in Reorganization of Engineering Schools

It is much difficult to reorganize universities and colleges than any other organization [6]. The sense of royalty and affiliation to a particular department on the part of the faculty, students and alumni is very strong, and the external professional organizations are also structured along the traditional departmental lines, making a unilateral deviation of one school from the traditional structure difficult. Industrialists complain about the graduates, but they always hire graduates along the traditional lines. The academic profession increasingly determines the character of undergraduate education in the developed and developing countries. Academicians today decide what a student ought to know, how he should be taught it, and who can teach it to him.

Heavy investments in information technology and computerization have not delivered the expected results- largely because teaching institutions tend to use computers to improve their teaching methods, instead of redesigning teaching methods with computer use. Computer Aided Learning (CAL) did not go beyond the fixed questions and multiple answers stage. Some new textbooks provide a computer program to do some of the exercises in computer as an add-on. Many of our courses, textbooks came of age in a different environment of pencil and paper and before the advent of the computer. they are geared toward efficiency in terms of high student/faculty ratio and controlling the student progress with the chapters covered from a textbook, and evaluation their learning performance with tests that can be done by pencil and paper.

The conditions are similar to those many industrial companies are in. Some companies noticed that time has come for innovation, speed, better customer service and quality, and used the new information technology to computerize their work flows and control mechanisms. However their old job designs, work flows, control mechanisms and organizational structures were developed under different competitive environment and before the computer age. Therefore they did not achieve dramatic improvements in their performance. The problem was that it was a new ball, a new game, a new batch of spectators , had new playing rules and required tough, up-to-date players. Some learned it in the hard way that they should have reengineered their businesses by using the power of modern information technology to completely redesign the business processes.

4.2 How Can Reengineering of Engineering Schools Proceed ?

Reengineering of the business processes and universities in general should go together. Reengineering of the engineering schools can only be done with the cooperation of their customers: the industrial establishments. They are the ones that will employ their graduates. On the other hand, industrial companies can not complete their reengineering processes without the involvement of the universities in general. Universities are the sources that will provide them with qualified manpower, and will retrain their employees before the reengineering of their business processes can be implemented.

4.3 Implementation

Reengineering of engineering schools requires first a careful evaluation of customer (industry) needs in terms of processes that demand for personnel with high technical qualifications. This requires real involvement of industry in the decision process of teaching in engineering schools. Industry will not only involve what should be taught in engineering schools but also how it should be taught. This is like a customer company getting involved in the affairs of the supplier so that it gets the required products at the required level of quality. Once the processes have been determined, then they must be grouped coherently in departments without overlap or with as little overlap as possible for a best design [7].

Even if the reengineering of the engineering school have started today, their graduates will take 5 to 10 years to join in the reengineered structure of the businesses. In academic environments of universities, modifications in the existing structure, let alone a complete overhaul, take a long time, usually longer than it would take in business establishments. In the meantime, the engineering schools should develop flexible interdepartmental mechanisms to prepare graduates for the new job requirements of the reengineered industry, even the students in the existing programs should be given opportunity to reorient themselves to the new job opportunities.

Along the lines of the increasing power of the modern information technology, vastly different forms of education to the present systems should also be investigated. As an example, today it is not difficult to setup a lecture room in a company with a TV screen and two way communication where the working professionals can follow a lecture given in a university far away. They can listen lectures and have two way communication with the lecturer.

Today continuing education programs are becoming vastly popular with working engineers who feel that their knowledge need to be updated. These programs should be strengthen by universities to make them more up-to-date and more responsive to the needs of the industry.

5. CONCLUSIONS

Reengineering of the engineering schools is an up-to-date restructuring of engineering schools to make sure that they can face up to the demands of the business establishments from their products (students). Reengineering will provide the schools with new structures to respond industrial needs fast, to provide an education more in-line with industrial needs and global market demands. Their products (students) will have better ability to exploit emerging markets, enter new businesses, or generate new ideas and incorporate them in innovations. However, the schools can not succeed in this endeavor by themselves. They have to proceed along with the reengineering efforts of business establishments. Success of the reengineering depends on the cooperation of business establishments and the engineering schools. Otherwise, initial disruption may be too much and newly graduated engineers may not be accepted into the classical jobs of industry, and this surely may cause the reengineering efforts to fail, as it did in many industrial establishments. Those schools embarking on the reengineering process should learn from industrial successes as well as failures. We believe that many successful efforts in industry will provide excellent examples for engineering schools.

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REFERENCES

[1] Hammer, M., "Reeengineering work: Don't automate, obliterate", Harvard Business Review, July-August 1990, p.104-112.

[2] Hammer, M. and Champy, J., *Reengineering the Corporation : A manifesto for Business Revolution*, Harper Business, New York, 1993.

[3] Stewart, T.A., "Reengineering - the hot new managing tool", Fortune, p.41, August 23,1993.

[4] Cypress, H.L., "Reengineering", OR/MS Today, February 1994, p. 18.

[5] Hall, G., J. Rosentall and J. Wade, " How to make reengineering really work", Harvard Business Review, November-December 1993, p. 119.

[6] Jencks, C. and Riesman, D., *The Academic Revolution*, The university of Chicago Press, USA, 1977.

[7] Suh, N.P., *Principles of Design*, Oxford University Press, UK, 1990.

[8] Phadke, M.S., *Quality Engineering Using Robust Design*, Prentice Hall, 1989.

[9] Ramkumar, K.S., "Naseef calls for practical engineering studies", Arab News, p.2, April 4, 1994.