DESIGN SKILLS WITH BUSINESS ATTITUDES

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ABSTRACT

Any design has no value unless it is related to a marketable product. Engineers have to play a major role in design. This paper describes the new dimensions needing careful considerations in Sri Lankan engineering education.

1. INTRODUCTION

In order to improve the living standards of our fellow citizens, one needs to create more job opportunities, improve infrastructure facilities like road, electricity supply, telecommunication etc. All these activities require a large amount of money; in the order of billions of Rupees. Our country is not blessed with vast deposits of natural resources like Gold, Silver, Oil, etc. to earn money. Countries like Japan created money and prospered by designing products, manufacturing them and selling these products in the global market. Through product design, one could convert raw material worth hundreds of Rupees, into value-added products worth several thousands of Rupees. As our population is highly literate, this is the only way our economy can be boosted within a reasonable time.

In such an approach, products with market values must be developed. Engineers have to play a vital role in designing and manufacturing. In the design stage, special attention must be paid to the manufacturing aspects. Therefore, the role of a mechanical engineer comes into the picture for all kinds of products. In the present context, the design experience obtained by the engineer has only an academic value. Lack of knowledge in product synthesis in association with the manufacturing process is a major draw back. Product synthesis is more complicated than solving equations as practiced in a conventional design assignment.

The paper describes the ways to develop design skills with business attitudes for development of entrepreneurship of students and to redefine the role of the university teachers for achieving this.

2. PRODUCT LIFE CYCLE AND PRODUCT DEVELOPMENT

Rapid development in science and technology during the last two Centuries has radically changed the types of products used by the contemporary society. The scientific and technological advances are occurring at an accelerating pace and new products are innovated everyday to replace the existing products. These tendencies have created rapid changes in need patterns, thus decreasing life-time of products. In general, four stages can be identified in the sales history of any product.

These four stages are known as phases of introduction, growth, maturity and decline. The product life cycle plays a very important role in product planning which deals with the development and renewal of the range of products manufactured and marketed by a company. As indicated above, the product does not have an eternal life. Therefore, new products must be introduced into the market at the correct time for continued survival of any manufacturing organization. In order to maintain a healthy competition, the product range of a company must be a mix of products dwelling in different stages of the product life cycle. The collection of various products in various stages of the product life cycle is referred to as the product-mix. The largest contribution for the profit of a company would be from the products in the maturity stage. Time to come, these products enter into their decline stage. Therefore, a balanced product-mix must consist of products in the growth stage and introduction stage along with those in the maturity stage.

In the product innovation process, at least ten different distinct stages can be identified as indicated bellow:

1. Policy Formulation
2. Preliminary Research
3. Feasibility Study
4. Design Development
5. Prototype Development
6. Trading Study
7. Production Development
8. Production and Marketing Planning
9. Tooling and Market Preparation
10. Production and Sales

A team consisting of policy makers, technical experts, marketing and sales experts collaborate to achieve a common goal*: Development of the new product that can be manufactured cost effectively.* A multidisciplinary team of technical experts come from relevant disciplines such as electronic engineering, mechanical engineering, materials engineering, marketing, etc. with an in-depth knowledge of their discipline and a sound understanding of other disciplines as well.

The feasible products identified at the feasibility stage, after successful completion of the preliminary research and policy formulation stages, are described by their functional nature. The technical team creates the new design from its functional description by iterating several cycles of the basic design cycle. The basic design cycle consists of four stages: Analysis stage, Synthesis stage, Simulation stage and Evaluation stage. Based on the functional description, design specifications are created in the analysis stage. Provisional designs are then created in the synthesis stage. The performance of these designs is then obtained during the simulation stage. The performance of the designs is then evaluated against the design specifications to select the best designs and to improve them further.

Actual designs are created in the synthesis stage by combining together of ideas, separate items, etc. It is very important to follow divergent and convergent activities, as there is never just one solution to a design problem as a whole, for the components, for the material, for the principles and concepts. Hence the human creativity plays a major role in this process. In order to combine different ideas, items, etc. one needs a good feeling of them and a team effort.

Furthermore, for successful product development, one has to make a distinction between the technology incorporated into the product and the process technology used to manufacture them. Therefore, the innovation of new products is associated with two innovation stages known as product innovation stage and process innovation stage. The product innovation creates new ways to produce better products while alternative methods for manufacturing is created in process innovation.

The role of mechanical engineer plays a vital part in product development. The product needs components and a process to manufacture them. The components must be designed to meet required mechanical properties. The manufacturing process needs machines. These machines may need jigs, moulds, tools, etc. These are few activities where the design capability of the mechanical engineer is required for product development.

3. NEW DIMENSIONS REQUIRED

With reference to the activities in the product development process, the design experience gained by engineers using the present education system has mainly an academic value only. Many university colleagues may disagree with this statement. However, it is the true situation. We have come to this conclusion with a research experience of more than 15 years of product development and with our study of Sri Lankan Industry. Further, some of our industrialists would also disagree with us. Due to some reason or other, very few industries are actually carrying out product development. Most of the time, they may be manufacturing the same item without any improvements, or manufacturing only a part of a product for their foreign supplier, specially in BOI industries. Whatever the reason, university academics have to play a major role in collaboration with industrialist to improve the economy of this country.

In order to create an economic development by designing products, manufacturing them and selling these products in the global market, one has to design products meeting following requirements:

a) the product must have a market value
b) the product must be competitive
c) the product must be of high quality
d) the design must be ready in time

In order to meet above requirements, design skills must be developed together with several other attitudes. As these attitudes lead to design

skills for marketable products, the combination of these attitudes is identified as business attitudes.

3.1 Creativity

Human creativity plays a major role in product development, as there is never just one solution to a design problem as a whole, for the components, for the material, for the principles and concepts. The issue of creativity is not well addressed in engineering education in Sri Lanka. Following techniques have been used in industry to improve creativity.

1. Brainstorming Technique
2. Brain-writing Pool Technique
3. Individual Association Technique
4. Forced Relationship Technique
5. Synetics Technique
6. Morphological Technique
7. Interconnected Decision Area Technique
8. Work Simplification Technique
9. Suggestion Technique
10. Creativity Tests
11. Climate Measurements

Design assignments given to undergraduate students must be carefully selected such that the student's creativity is enhanced by providing hands on experience on the above techniques.

3.2 Multidisciplinary Aspects

Today, not a single product can be manufactured competitively without the assistance of several engineering disciplines. For example, electronics are increasingly applied in control functions of machines. Computer hardware and software are used in many engineering applications. Alternative materials such as plastics, ceramics are used in place of metals. Chemicals are used to improve the properties of metals. Therefore, the designers must have good interdisciplinary knowledge in the related fields.

In the current context, design assignments carried out at our universities tend to work in isolated areas. The students do not see a marketable product through their designs and this has made design assignments routine and boring.

Design assignments given to undergraduate students must be carefully selected such that the students get hands on experience in multidisciplinary aspects of engineering.

3.3 Process Innovation

Technological innovations are concerned with creation of new technologies. A technological innovation can be a *product innovation* or a *process innovation*. In product innovation, new products are created. In process innovation, alternative methods for manufacturing, and assembly

of components of a product are developed. A process innovation would enable an existing product to improve its quality, reliability or to reduce its production cost. On the other hand, new products emerging from product innovations would be benefited with process innovations as the products must be manufactured competitively.

Design assignments given to undergraduate students must be carefully selected such that the students get hands on experience in process innovation. The student must address the process innovation aspects during designing.

3.4 Simultaneous Engineering

In the past, product design and manufacturing had been divided into separate departments with very little communication between them. However, the walls between design and manufacturing are now crumbling in a new culture known as *concurrent development* or *simultaneous engineering* that has emerged primarily due to heavy competition. In this new culture, the product development process is carried out concurrently within the organization to reduce the product development time and to minimize the product development cost. In the previous section, ten different activities that are carried out from the policy formulation to the production and sales were presented. In order to visualize the concurrent nature of the product development process, these activities are assigned to a phase model as depicted in Figure 1 [1]. Each block in the diagram identifies a unique phase in the product development process while the numbers inside them indicate the activities.

Policy formulation activity (1) is carried out in the product-policy phase. After the product policy formulation, the first stage of the preliminary research activity (2) is commenced to define the product goals. Once the product goals are defined, the second stage of the preliminary research activity is commenced within the design-specification phase and marketing-plan phase concurrently. The selection of inventions, discoveries, scientific principles, product ideas and relevant technological bases are the activities related to the design-specification phase. The identification of the needs, market openings and consumer appetites for the new product are the activities related to the marketing-plan phase.

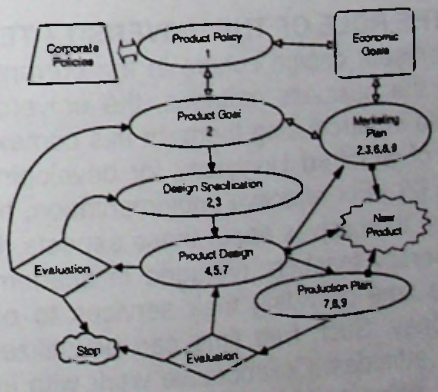

Figure 1: Simultaneous Engineering Process

The next activity, *feasibility study* activity (3) is also carried out concurrently within the *design-specification* phase and *marketing-plan* phase. The *design development* activity (4) and *prototype development* activity (5) are assigned to the *product-design* phase. The *trading study* activity (6) is assigned to the *marketing-plan* phase. Whenever a few prototypes are created, concurrency of these three activities could be maintained for different prototypes, i.e., the first prototype construction is commenced before the *design development* for other prototypes are ready. Similarly, the *trading study* is commenced after the first prototype is ready without waiting for other prototypes. Once a suitable design is decided, the *production development* activity (7) is carried out concurrently within the *product-design* phase and *production-plan* phase. During this process, the design is fine-tuned to the production requirements. The *production and marketing planing* activities (8) are carried out within the *production-plan* phase and *marketing-plan* phase concurrently. Similarly, the *tooling and market preparation* activities (9) are carried out within the *production-plan* phase and *marketing-plan* phase concurrently. Finally, the *production and sales* are carried out.

The above description clearly identifies the involvement of various departments of the organization and coordination between them to achieve a common goal, i.e. to develop competitive products cost effectively within the shortest possible time.

Design assignments given to undergraduate students must be carefully selected such that the students get hands on experience on simultaneous engineering.

3.5 Team work

The detailed description of various activities in simultaneous engineering clearly shows that people with different expertise are required for product development. In such an environment, teamwork is an essential factor for success.

Design assignments given to undergraduate students must be carefully selected such that the students get hands on experience on teamwork.

4. THE ROLE OF THE UNIVERSITY TEACHERS

As the present design culture in the current education system does not address the business attitudes, the university teachers have to play a major role in introducing them. In this context, the role played by of Prof. Terman of Stanford University for developing Silicon Valley is a classic example [2]. For effective implementation, first of all, University teachers must train themselves about these aspects. In Sri Lanka, it is common to find university teachers engaged in academic teaching activities during their free time providing their services to outside organizations to earn extra money. Such free time can be utilized to train themselves about business attitudes. Collaborative work with industry during their free time definitely helps to develop those attitudes. The university teacher must

establish effective and trustworthy links with the industrial organizations such that he can develop his business attitudes without endangering the economic goals, corporate policies, product policies, etc. of the industrial organization. For establishing effective and trust worthy links with industrial organizations, he must help the industrial organizations to grow. The business attitudes acquired by this process must be then disseminated to students during their design assignments.

5. CONCLUSIONS

Based on our personal research experience in product development during last 15 years, five important issues were discussed. They are:

a) *Creativity in design*
b) *Multidisciplinary nature in design*
c) *Process innovation aspects in design*
d) *Simultaneous engineering in design*
e) *Teamwork in design*

As these attitudes lead to design skills for marketable products, the combination of these attitudes is identified as business attitudes. Developing design skills of engineering students with business attitudes is essential in current context. The design assignments given to undergraduate students must be carefully selected such that the above attitudes are developed among students.

For effective implementation, first of all, University teachers must train themselves about these aspects. Collaborative work with industry during their free time definitely helps to develop these skills. For establishing effective and trust worthy links with industrial organizations, university academics must assist the industrial organizations to grow. The business attitudes acquired by this process must be then disseminated to students during their design assignments.

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