Industrial Design Exposure To The Engineering Students In Indian Context

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***Abstract* – Engineering education should be able to train engineers in problem solving with innovative mind, to create innovations and design products that user can use. An engineering graduate with above attribute will be suitable for creating enterprise. In spite of Indian undergraduate engineering education being one of the best in the world, innovations created by engineering graduates of this education system is abysmally low. One aspect of this situation is very competitive entrance examination through which aspirant have to qualify and mars the joy of learning and creativity. Second aspect is the lack of creative inputs in the course curriculum. The third aspect is lack of exposure of industrial design to the engineering students. The students learn the theories and practices of their disciplines without considering the final aspects of creating products and services that can be productively used. This deprive them the pleasure of creation and turn the engineering into a dull profession. To overcome the above situation, it is imperative that students should be provided with exposure of industrial design to innovate marketable products and services. In absence of this in the curriculum, it is essential that an alternative process be worked out to generate awareness amongst the students and engineering educators to train engineers to be capable of context based product development. This has been achieved by providing short term summer training with hands on experience in a live project to selected students from various engineering institutions. The idea spread very fast within the student community. Results from this exercise have shown that many of the participating students after their graduation enjoyed their engineering profession and remained in their engineering oriented job. The outlook of these students changed and their overall performances became better and were absorbed by some of the best engineering companies in India. The success of this methodology is also evident with the ever increasing applicant for these summer training and workshops.**

Index Terms **– Hands on experience on live project, Industrial design, Innovations, Summer internship.**

INTRODUCTION

India is considered as a developing country even though its economy is one of the fastest growing in the world. 59 years has passed since India's independence. Its emphasis in Science and Technology made it self reliant in these areas. However, in absence of better products and services, benefits of science and technology have not been translated in terms of improved standards of life.

India has the distinction of having the largest technical and scientific manpower in the world. Indian engineering and technical education system is recognized globally as one of the best. India also has a well established engineering and consumer durable industry and industrial growth is commendable. Against this back ground, industrial growth and achievements failed to improve the living standards of people within the country. This can be related directly to India's effort for building its industrial infrastructure rapidly since its independence. Import of technical know how is imperative to catch up with the latest advancements in Science and Technology. The technological transfer to India from abroad has led to design transfer as well, resulting in low indigenous development in design abilities. India did not had a policy either for design education or design industry until recently and in its absence, this 'design dependency' has made Indian products less competitive in the world market and has adversely influenced the export performance. Due to its failure to develop indigenous design & development capabilities [1], Indian market continues to be flooded with foreign products that in many cases meet consumer aspirations but not their needs and self reliance.

To ensure industrial growth, along with improvement in the living standards of its citizens, it is important that the priorities are chosen properly. Industrial Design in particular can play a significant role in this growth and economic development [2], employment generation and exports in future [3]. Academic intervention and research in industrial design is taking a preferential shape.

Aim of engineering education in India should be to create engineers capable of designing products that user can use by solving existing problem faced by the users. This requires innovative mind to create innovations. If this can be achieved, a student with an engineering degree will make him suitable for creating enterprise rather than a job seeker, which is the present case. Indian undergraduate engineering education is considered to be one of the best in the world. However even after having the best education system, the number of innovations created by the students of this education system is abysmally low. One of the reasons for this situation can be attributed to very competitive entrance examination through which aspirant students have to qualify and second reason being the lack of creative inputs in the course curriculum. Very tough qualifying examinations make the aspirant students at the behest of their parents to be robotic in their endeavour. Thus the goal of obtaining a professional degree mars the joy of learning and creativity.

The current trend of engineering graduates aspiring for management studies as the preference for higher education to take up management positions that pays handsomely compared to practicing engineer has further reduced the possibility of attracting and retaining engineers in practice, so that they can innovate and contribute.

It is seen that when students were provided with creative process to problem solving, the end result is excellent. This is evident during technical festivals organized by engineering Institutions. Almost every premier engineering institutions in India organizes annual technical festival for to create competitive advantages for the students through application of their technical knowledge. These are also aimed to inspire the students. Although students compete and perform excellently in these events including playing games with self assembled robots, the activity remains academic in nature; these items remain semi-finished, without any form and aesthetics in absence of exposure to industrial design. Many functional products devised by the students as a part of their graduating projects remains in the lab and never see the prospect of actually getting manufactured and marketed.

The situation is not different when it comes to grass root innovators and observation in this case is also similar. National Innovation Foundation (NIF) and its affiliates Grass root Innovation Augmentation Network (GIAN) in India identifies grass root innovators and innovations and assist them to turn these innovations into marketable products and services through appropriate interventions. Although the innovations in many cases are excellent, these innovations require industrial design inputs to get into marketable products and services. However this is not readily available.

It is imperative that to overcome the above situation, engineering students need to be provided with due exposure to basics of industrial design, so that they can be aware of these aspects to innovate marketable products and services.

Compared to industrial development, formal industrial design education activity started quite late in India. It is only in early sixties that design education programme started with establishment of National Institute of Design (NID) in Ahmedabad and later in the same decade with the establishment of Industrial Design Centre (IDC) in Indian Institute of Technology Bombay (IITB) in Mumbai. NID initially offered diploma level programmes and then started offering post graduate programmes with specialization specific to various applications. IDC being part of an IIT system of technical education catered to the post graduate levels in industrial design and visual communication. Till 1994 India had only these two institutes offering design education. Situation has changed in the last decade with few other institutes offering design courses in master level stressing product design. In the nineties, Centre for Electronics Design and Technology (CEDT) in Indian Institute of Science, Bangalore (IISc) and Instrument Design and Development Centre (IDDC) in Indian Institute of Technology Delhi (IITD) as well as Indian Institute of Technology Kanpur (IITK) followed suit at different times.

In 1997, Department of Design (DoD) was established in Indian Institute of Technology Guwahati (IITG) to offer undergraduate level programme leading to B.Des in product design and communication design. This is the first bachelor degree offered in design discipline in India and is starting Master programme in July 2007 aiming to cultivate need specific specialization. Indian industry wants designer with strong engineering background. Thus a designer must be able to design as well as detail out the product completely to take it up for production. Gradually Indian design education is taking shape towards achieving this goal and many private institutions are also sharing this responsibility in building design reliance in India [4].

To derive the benefits of science and technology in terms of improved standards of life, through better products and services and also to meet the expectations of Indian industries, it is essential that, more and more undergraduate engineering students must be provided with exposure to industrial design. However contemporary undergraduate engineering education curriculum does not offer much exposure and scope to learn industrial design even as a secondary or elective subject. A few university and institution offer an elective course in Engineering Design, but this does not provide any exposure to various elements and factors associated with product design. Students from these institutions not only show keen interest in this area, but in a few cases have shown excellent results when they were provided with proper exposure.

In absence of this vital input in the academic curriculum of engineering education, it becomes essential that an alternative process is worked out to generate awareness amongst the students and engineering educators. Aim of this awareness being that, engineering education should create engineers capable of product development based on context.

To achieve the above goal, one way is to organize short term courses in educational institutions under Quality Improvement Programmes (QIP) that are attended by both the teachers and the students and also forms the part of continuing education. Department of Design in Indian Institute of Technology Guwahati has taken an active part in this direction by organizing several such courses including international conferences and workshops.

The second way to create awareness of industrial design amongst engineering students is by providing short term training with hands on experience in a live project to selected students from various engineering institutions. This can spread the idea very fast within the student community. The engineering education curriculum in India still incorporates summer training in industry or academic institution as mandatory aspect for completing their study and awarding degree to the students. This provision can be used for providing exposure to the students in the area of industrial design to complement their learning. Thus an attempt was made to provide exposure in industrial design to these students albeit in small numbers from the year 2003.

Third viable way is to conduct compact hands on workshop for students during the technical festivals of premier institutions. Since students from various engineering institutions participate in these workshops, the awareness created through this exposure is excellently received.

The last two processes are successfully practiced by the author to train engineering students in industrial design.

The methodology followed, results obtained and recommendations are covered in the following sections.

METHODOLOGY

I. Aim of the exposure programme

The basic aim of the exposure programme is to provide insight of industrial design to the engineering undergraduate students so that they can appreciate its various aspects through hands on projects. Once they are aware of these aspects, they will be able to solve a problem in their own area creatively and deliver a marketable product. These students may also opt for higher study in design area. The students after undergoing the exposure training programme should be able to differentiate between product design and engineering design. They should be able to comprehend morphology of design [5], various product conceptualisation process, data collection and analysis process, documentation of design processes at various stages, report writing etc.

II. Deliverables from the students

Students undergoing the exposure programme are expected to deliver either a developed concept of a product based on the design brief formulated, a functional prototype or a rolling prototype with all details ready for manufacturing. They are also expected to undertake trials and testing of these products. The actual work the students carry out also depends upon the stage of the live project at which they are inducted to the exposure programme. Irrespective of the stage and work done, each student is required to prepare a detailed report of work done by him as hard and a soft copy.

III. Selection of the students

First step involved in the methodology followed for the exposure programme formulated for providing exposure to undergraduate students of engineering institutions is selection of the candidates. For any programme to be successful requires involvement from the participants. In Indian engineering education, training through internship in educational and industry is a mandatory requirement. Therefore all students studying undergraduate courses undergo internship training. Many of these students desirous to gain exposure to industrial design request for summer and winter internships. These normally last 4-6 weeks in institutions offering design education, such as Indian Institute of Technology Guwahati. Department of Design in IIT Guwahati stipulates few requirements for students intending to undergo exposure training in industrial design as a part of their internship programme. These are that the student must be recommended by the training and placement office of their respective institution, should have completed 2 years/ 4 semesters of engineering education and should have completed basic engineering courses (also referred as core courses) prescribed for undergraduate engineering students. This is to ensure that working knowledge of materials and process, workshop practice, Basics of Mechanical Engineering, Engineering Mechanics, Strength of Materials, Basics of Electrical Science are readily available with the students. They also should have adequate knowledge of using at least one CAD software, minimum being AutoCAD in addition to their disciplinary courses. To the extent possible, the students are required to stay in residential accommodation within the campus. This is to impart flexibility to the training programme. Since the module is very short, students can work in the workshop or studio during the day time and they can study in the evening in the library as well as continue their documentation and report writing in the computer centre. They can also convert the concept sketches to digital data through CAD.

IV. Funding of the programmes

The second aspect is, to arrange funding for these programmes. Since there is no provision for running these programmes institutionally, students participating in these programmes are required to bear their own lodging and boarding charges. Institutional facilities are extended for the programmes otherwise. However in addition to the lodging, boarding, library, computer facilities, there are other aspects associated with these programmes. These are cost of materials for design execution starting from stationeries to input materials such as hardware and consumables for fabrication of prototypes. This is one of the major expenses to be incurred. To fund this aspect, Small and Medium Enterprises were roped in. Existing and interesting design problems relevant to them are identified and they were requested to fund the programmes requirement in terms of consumables and hardware. In return, they were charged a minimum amount as royalty for implementing these designs by them in the market. After initial reluctance, this was readily accepted as very positive part of their involvement and several products came into the market. Presently there is tremendous demand of this programme from the both the students and the SMEs.

V. Structure of the exposure programme

The exposure programme starts with an induction phase. This is to explain the students regarding various aspects of product design. During this stage itself, students are introduced to a live design problem. This problem is normally taken from ongoing projects available with the faculty member imparting this exposure programme. The induction phase is through lectures, interactions and study materials. This phase is normally planned for three days.

The second phase is to introduce the students to conceptualisation means and visualisation techniques. Since most of the students are without desired skills for preparing sketches and renderings, to suit their background, normal line sketch in scaled dimensions followed by physical wire model is encouraged.

Students are also simultaneously introduced to Human Factors / Ergonomics relevant to the project at hand.

Along with the physical modeling, for optimisation and to check fit and functions, virtual prototyping with CAD is initiated. This phase is completed at the end of 2nd week. However, this can be shortened based on the actual progress made by the students.

Physical prototyping in full scale to fabricate a functional prototype is started in the third phase. Along with this activity, report writing is also initiated. Once the physical prototype is ready, its trial and testing is started. Based on the feed back, any redesign is carried out.

ADVANTAGES OF THE APPROACH

The above methodology of providing design exposure and inputs to undergraduate engineering students were tried out for over a period of 5 years. This has various advantages to different stake holders.

For the students, they were able to get an exposure in the product design field to enhance their knowledge and capability through hands on programme.

For the faculty member offering this programme, he received enthusiastic young mind ready to experiment and work hard to learn and this actually accelerated the project undertaken by the faculty member and cost of these project could be reduced to affordable level by SMEs.

The specific advantages to the SMEs are that, they can obtain complete design inputs including prototypes at a substantially lower development cost by sponsoring these programmes compared to design inputs obtained by engaging consultants for these work. Normally, SMEs are reluctance to engage professional designer in the first place and working through this mechanism removed their inhibition. They felt that they are also member of the design development team and could participate in this process.

The technology transfer for the product developed was found to be much easier due to the involvement of the SMEs from the initial stage and also due to the fact that functional prototypes and jigs and fixtures were readily available in addition to detailed drawings of each and every part.

RESULTS AND RECOMMENDATIONS

The results of this exercise to provide 'Industrial Design Exposure to the Engineering Students in Indian Context' are multifaceted. These above exercise have shown that majority of the students who have undergone this programme improved tremendously in various aspects. The outlook of these students changed and their overall performance became better, whether it is in their academics, or in their personality. Several of them have won awards in national levels. The students themselves attribute this to their exposure through this programme. Many of these students were either qualified for higher studies or were absorbed by some of the best engineering companies in India with a higher pay packets compared to those who did not had this exposure. Most of the participants students after their graduation enjoyed their profession and remained in the profession compared to those colleagues who did not had this exposure. The success of this methodology is also evident with the ever increasing applicant for these summer training and workshops. The faculty member had been invited to conduct a national hand on workshop in automobile designing at one of the premier national institute of technology in India. Students from foreign universities have also undergone this exposure training.

As a tangible out put, a few Human Powered Vehicles were designed and prototype made through these programme and these were put to regular production with immense success due to their sound context specific design. In addition to the HPVs, a rural transportation vehicle, a solar powered electric trike, an aeroboat were designed and prototyped.

The worth of these outcome in Indian Rupees is more than Rs.10 million in quantified value for man days engaged.

This programme is running for last 5 years and from its success this process can be recommended for providing exposure of industrial design to undergraduate engineering students in India. This will be equally applicable for countries with similar socio-economic status to enrich engineering education.

Few snap shots of products developed under this programme is given in Figure 1-9

FIGURE 1
A TRIKE DESIGNED AND PROTOTYPED.

FIGURE 2
DIPBAHAN-A TRICYCLE RICKSHAW DESIGNED AND PROTOTYPED.

FIGURE 3
A DERIVATIVE OF TRICYCLE RICKSHAW DESIGNED AND PROTOTYPED.

FIGURE 4
A CLAY MODEL MADE DURING TRANSDESIGN WORKSHOP.

FIGURE 5
HUMAN FACTOR ASPECT IN RUBUS DESIGN PACKING

FIGURE 6
ENGINEERING ASPECT IN RUBUS DESIGN AND PROTOTYPING

FIGURE 7
PRODUCT DESIGN ENGINEERING ASPECT IN RUBUS DESIGN AND PROTOTYPING

FIGURE 8
DESIGN AND PROTOTYPING OF AEROBOAT

FIGURE 8
DESIGN AND PROTOTYPING OF AEROBOAT

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