Industry partnership - An upshot report

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***Abstract*—Engineering education is on the brink of a genesis into a new realm. This realm addresses the concerns and is aimed at facilitating the development of astute, dexterous professionals. Apart from transformations in the curriculum development and delivery and assessment methods, the new era encompasses collaborations with leading industries and premier institutions through the web or other wise to provide a wide exposure to development of technology and its applications. In this context, it is necessary to look at the tangible benefits, outcomes, concerns and futuristic trends of industry institute partnerships. This paper presents a conclusive evidence of benefits realized out of one such association, as well as a range of opportunities, challenges and breakthroughs that are possible.**

***Index Terms*— Industry-academic collaboration, engineering education, user survey and learning**

I. Introduction

Globalization in general has raised the bar for significant developments in various aspects that indeed contribute to the progress of nations. The economic growth of a nation such as India may be largely envisioned through its investment in human capital. This potential can be made available through a section of the strong population of 1.27 billion [1], by engaging, training and developing specialized human resource for the country's progress. The ministry of human resources and development, Govt. of India over the past several years has brought out several developmental schemes which are testimony to this fact. Engineering education being an important facet amongst the higher education sector, is going through a comprehensive quality enhancement endeavor by experts based on the country's National Knowledge Commission report [2].

The recommendations of the knowledge commission report addresses the major concern of un-employability of engineering graduates in the country. Though it lists several recommendations for reformation, curriculum reform is highlighted, that focuses on the teaching/learning process that integrates skills such as problem solving and logical reasoning, process orientation, learning ability, English communication and programming fundamentals. According to the report, industry participation to discuss real life case studies is to be encouraged. Laboratory courses need to be revamped to develop a healthy attitude towards experimental work. It also emphasizes on a congenial environment to be created to encourage students to participate in co-curricular activities.

Hitherto, engineering education was teacher centric and analogous to an open loop system where the only focus was on the quality of teaching. The teacher in turn was focused on generating valuable course contents for the class. With the evolution of digital technology and the available opportunities for teachers worldwide to upload their course material, the sources available for learning material are many. The shift in paradigm from teacher centric to student centric with an emphasis on the assessment of the learning imparted calls for a whole new paradigm to operate from. This paradigm shift also necessitates exploration into a plethora of ways in which learning can be successfully imparted and measured with the role of the teacher shifted to that of a facilitator.

The National Board of Accreditation, is the governing body to assess the quality of engineering education imparted and with India being a signatory to the Washington accord, the whole conceptual framework of curriculum is to be centered on three important aspects such as, knowledge, skills and attributes.

An industry-institute partnership is involvement between institutes and business-industry, unions, governments and community organizations. These partnerships are established by agreement between two or more parties to establish goals, and to construct a plan of action for achievement of those goals [4].This paper is an attempt to bring forth a sort of a panorama of learning experiences through collaborative activities with industries where the three aspects of knowledge skill and attribute are addressed. The paper addresses the experience gained by students through a collaborative multi-disciplinary project activity wherein an expert team from industry was closely involved with the students to design and develop smart chair for people with restricted mobility. The learnings obtained by the student team from the industry collaboration include, capture and analysis of end-user perspective, benefits of concept feasibility studies, technology alternatives tradeoff, performance and features Vs product cost, engineering simplicity, system integration and ease of use. An example is presented wherein the student team was exposed to the process of user-centric development and how it benefitted to capture the system requirements upfront. The students were also exposed to the techniques of user surveys that gave an insight

into the variety of graduate attributes that can be facilitated through such activities.

II. A PROFESSIONAL TWIST TO THE EVOLUTION ABOUT A MULTIDISCIPLINARY PROJECT

The metamorphosis of an engineering graduate into one with a high degree of employability entails the inclusive approach of imparting certain engineering skills. Apart from innovative practices such as problem/project based learning that the curriculum may provide, it is essential that there is sufficient exposure to approaches and practices adopted by the industry in providing an engineering solution. The evolution in the students' learning experience through an industry supported project work, "Design and development of a smart chair for people with restricted mobility", is discussed. We highlight, by providing the following joint activities as key learning steps for the student team, the benefits obtained from such an industry-academic collaboration exercise:

Critical evaluation of the objective and scope: It is very important to have a clear perspective upfront on the objective and scope of the project being undertaken. This perspective can be strengthened through the process of critical evaluation and questioning about the objectives put forth in the beginning. This aspect was emphasized and put into practice by organizing discussions among the student team members, the faculty involved and the industry experts. During such discussions, the industry also brought in their business development experts and trained the young students to look things from different perspectives so that a noble idea such as providing a smart wheel chair for people with restricted mobility can be realized not only satisfying the needy but also in a commercially viable way.

Customer segments identification: Next in the sequence of collaborative exercise was to understand, if such a smart chair is brought as a technology enabled product, the possible customer segments where it can be offered. During the various discussions within the teams and also with many end user representatives like hospitals and elderly homes, it was found that the smart chair as envisaged in the beginning will have only limited market and number of users (initially the target was only to address people with Paraplegic disability, i.e., being paralyzed from waist down) and hence the commercial viability was doubtful. Hence, the industry experts suggested to the students to fan out to various other potential target groups that could use the smart chair. It was a very timely intervention and exercise suggested by the industry – that a commercial product can be brought out profitably only if the product was affordable from the overall cost perspective and in order to make a realistic commercial offering, there was a need to expand the target user segments. Hence the student team received this challenge from the industry and enthusiastically approached various segments of society, i.e., hospitals, old age homes and in fact found that the smart chair can have broader usages than originally intended. The team, after meeting various customer segments, sat down to adapt their initial designs in such a way that different type of users can also use the smart chair. The feasibility of such a product was also assessed from the technical and commercial parameters.

Alternatives and tradeoff: Once the concept and high level feasibility assessment from technical and commercial parameters was accomplished, the challenging task assigned to the students was, instead of rushing in to start design of such a vehicle, but to take a deeper understanding and study of various alternatives that are possible in terms of technology and system elements. The industry experts joined the students' team and facilitated a high level exercise and to identify the CTQs (Critical to Quality) for the smart wheel chair. This exercise was very much appreciated by the team and the learnings were very vital at this step. At this stage, a high level tradeoff also was done for various elements, viz., the drive system, sensing system, perception and obstacle avoidance approaches, the interfaces for the user like audio / visual cues, etc., so that different type of users can use the chair with ease.

Usability survey and capture of key expectations: The industry had certain expertise and people with skills that are essential to understand customer requirements and usability studies. The students' team was taught the fundamentals of such a user study and made to understand that if a product has to be produced and successful in market, it must satisfy the end users expectations and usage patterns or scenarios. A training was organized to the students on questionnaire based user survey and interviewing techniques. This training was very useful and the students felt at ease to meet various user groups and individuals across various target customer segments and capture their must-have and nice-to-have features for a smart wheel chair. It also helped the students to bring out various not-so-well-stated (implicit) usage scenarios and corresponding expectations on the smart chair. The details of such an exercise are worth presenting, and hence in the next chapter they are explained.

System requirements generation and analysis: Having accomplished the above mentioned systematic tasks and getting the outcomes of those tasks, the students were asked to spend a considerable amount of time and efforts to bring out a system requirements document. The various principles to be followed and the expected outcome of this step were taught to the students and were guided through the exercise. It was also emphasized to the students that, in addition to functional requirements, there could be many non-functional requirements like modularity, safety, reliability and performance that the product must aim so that the user needs are addressed well.

III. THE OUTCOME OF THE USABILITY SURVEY

The product was to be designed and developed for use by people who could be paraplegics, quadriplegics or anyone who has restricted capability for moving around. A survey was conducted by getting associated with various NGOs and interacting with the differently abled. A one on one interaction gave an insight into the technological requirements be it

conventional or non-conventional. It gave an insight into the, different modules sought to be installed in the smart chair to ease out day to day activities of different categories of users of the chair.

The students created a questionnaire the answers to which helped them to arrive at tangible conclusions on the popularity of various technical features that could be incorporated as shown in Fig.1.

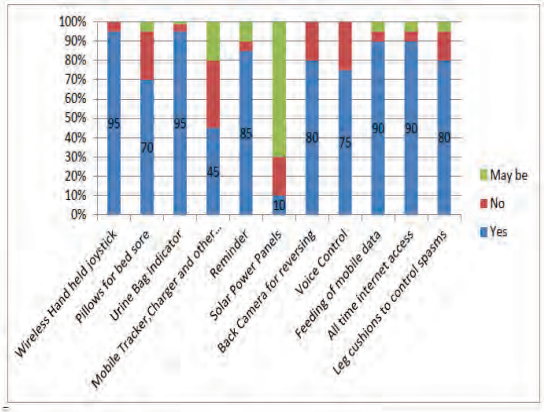

Fig.1. Analysis on the popularity of the technical requirements of paraplegics

The following conclusions were made: As seen from the analysis 95% of the differently abled demand a wireless hand held joystick so as to control the movement of the smart chair from any place provided it is in proximity. About 70% of the people demanded for a pressure controlling bubbled pillow in the form of seating arrangement on the chair in order to reduce bed sores. A urine bag filling indicator has been demanded by almost 95% of the people. The paraplegics have no sensation below the waist and hence require an indicator to replace a filled urine bag with a new one. Mobile tracking facility is appreciated by hardly 45% so is a charger and other related accessories. A reminder for food, water, medicine intake and many others have been demanded by an overwhelming 85%.
Solar power panels render more dependency on the care taker and thus have been appreciated by hardly 10% of them. As the movement of the neck is restricted a back camera has been demanded by 80% of the paraplegics. Voice control facility was appreciated by 75% of them. This facility would ease out their day to day activity to a great extent. About 90% of them requested for a module to be incorporated into the smart chair which would carry all the data fed in the mobile phone. Tech savvy demanded for an all-time internet access. Paraplegics suffer from spasms and have no control over it. They demanded for a cushion to automatically move their leg in a stipulated amount of time. 80% gave a go ahead for the incorporation of this module.

The graph shown in Fig.2 indicates the analysis of the technical requirements of chair users with cerebral palsy.

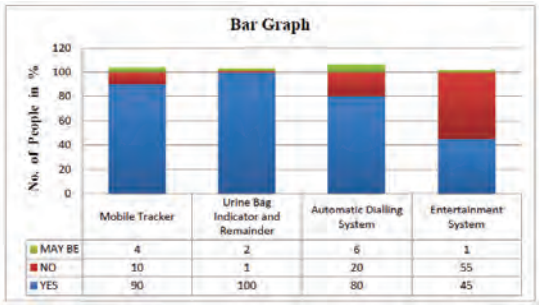

Fig.2. Analysis of requirements by people with cerebral palsy

At the end of survey of cerebral palsy the conclusions made were that all most all wheelchair users need urine bag indicator, that is 100% people found that it is most needed and basic necessity of their daily life. The urine bag attached on to the wheelchair should be more suitable for seating positions and it must fit well and should be comfortable with assorted sizes and styles and the inclusion of the reminder which buzzes up every time the bag is full thus making the need. The mobile tracker would be of much use for the different abled people especially for cerebral palsy who are very much dependent on the wheelchair where it helps them to locate a user number to get the location and signaling where it uses the GPS system to determine the handsets location. And 90% people find it is very useful because they need a constant support and assistance of their caretaker, so this would be helpful for the caretaker to track their differently abled people.

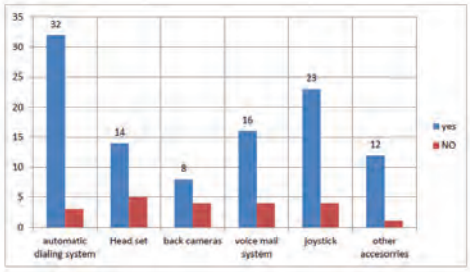

Fig.3. Analysis of requirements by people with amputations

At the end of the survey, about 100 % of the finding difficulties with the present wheelchairs and thus needs a replacement. Of those interviewed 100 % of the people add on of wireless joystick. About 80 % found the pillows of bedsore on the wheelchair as a great aid. Almost all insisted on the inclusion of the urine bag indicator. About 45 % of people wanted the mobile tracker feature to be added to the smart chair. About 80 % of the disabled found much use of the addition of the solar power panels. Most of the amputees almost up to 95 % said yes to the pillows of bedsore. Addition of the other accessories like mobile charger, internet access on to the wheelchair were accepted by the differently abled.
Fig.4.shows the summarized analysis of the requirement by people with physical disabilities.

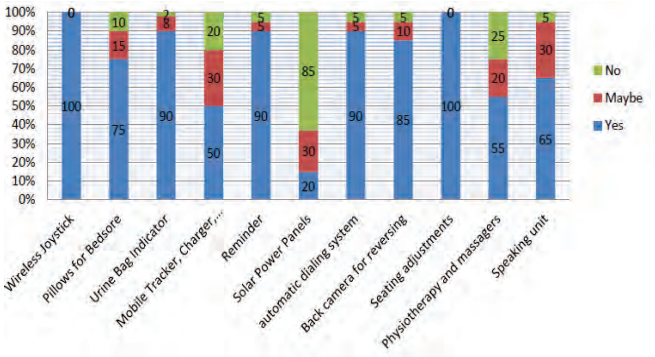

Fig.4. Summarized analysis of requirements by people who are differently abled

It can be seen that almost 100% of the physically disabled said wireless hand held joystick is must so that it can ease the motion of their chair. 75% of them demanded pillows for bed sore so that it can prevent them from getting bed sores. Almost 95% of them told urine bag indicator should be installed on the chair so that it can remind them about emptying out of the bag. 50% of the physically disabled people were comfortable on using internet and mobile trackers. The reminder was demanded by some 90% of the people to remind them of their medicines, food, etc. Only 20% of them were comfortable with the solar power panels. Automatic dialing system was almost demanded by 90% of them to limit their phone usage. Back cameras that would help in proper reversing was appreciated by 85% of them. Seating adjustment was a must for almost all and 100% of them demanded for a best seating adjustment on the chair. Physio-therapy and massagers was appreciated by 55% of them. And about 65% of them appreciated the speaking unit which could ease them.

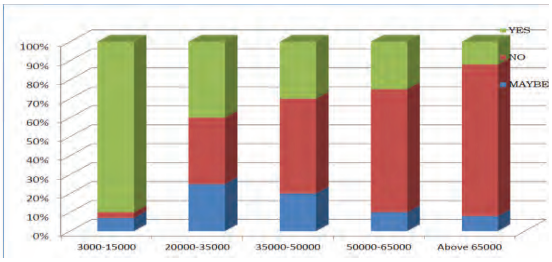

Fig.5. Analysis of requirements by people based on the cost

Fig.5 shows the results of the popularity analysis based on the cost of the price range of the chair. Around the range of Rs 3000-15000 about 90% of the differently abled were comfortable in buying the wheel chair. 40% of them were affordable for a wheel chair ranging between Rs 20000-35000. For a wheel chair ranging between Rs 35000-50000, 30% of them were affordable. 25% of the differently abled gave appreciation for the cost ranging between Rs 50000 -65000. About only 10% of them were affordable for a smart chair costing more than Rs 65000. And finally the conclusion from the cost graph was though many of the wheel chair users required a lot of technical requirements but the cost factor was the major issue for them. Many of them could not afford a costly wheel chair .To a certain extent they were comfortable in buying a smart chair in the range of Rs 20000-35000. It was the first opportunity for the team to explore the world of the differently abled. Reading the data collected from the internet gave the team a fair insight of the differently abled. However the most difficult part of such a survey was to sift the requisite data to put it in a cohesive manner. The plethora of information available in most of the articles is country specific or a group of sampling in a particular area. For example beggars and disability, education and disability, disease and disability, etc. Since the group had an aim for the project on wheel chair, the applicability of the disability to the use of the wheelchair was required to be established.

In summary, the skills developed by the students during this stage were the following:

- Exposure to the concept of user surveys
- Ability to create relevant questions of different categories of users
- Interviewing and compiling the information
- Analyze the responses
- Arrive at valid conclusions
- Translate them to product / system requirements

IV. Outcomes of the Project Work

The attributes gained as outcomes through the project work can be summarized as:

- Breakthrough in breaking barriers in communication amongst peers as well as with the outside world.
- Presentation skills to large/small audiences.
- Exposure to conducting literature survey
- Exposure to state of the art technology available.
- Ability to understand the available solutions in the market to the problem.
- Ability to design and test prototype models.
- Ability to bring forth engineering skills to culminate the design in real form going beyond the prototype stage.

V. Conclusions

A well-defined and focused approach was brought in through interactions among the students, faculty and the industry experts. The summary of learnings and benefits the students obtained through the industry collaboration are listed as follows:

- Market and customer survey – techniques and nuances
- Emphasis on a preliminary usability survey
- Deriving product and system requirements
- Carrying out alternatives and tradeoff studies
- A modular approach to the design based on the consumer's needs
- Involvement of multi-disciplines in the project at appropriate stages of the project
- Building and testing of the prototype features

- Implementation of the developed modules on an actual wheel chair
- Publication of the results

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