INTEGRATION OF CDIO STANDARDS TO ENHANCE STUDENT'S ENTREPRENEURIAL SKILLS AND KNOWLEDGE

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ABSTRACT

Engineering education in recent years has shifted its original focus on technical knowledge and engineering skills to more on communication and entrepreneurial skills. The emphasis on entrepreneurship is especially relevant given many success stories on EE and IT start-ups ever since the late 1990s, which indicate that an engineer nowadays require a wide variety of skills and knowledge to survive the rapid and constant changes of technology to become successful. Harsh reality has shown that engineers, who fail to move up to management positions or to start their own business by the age of 35, will be easily replaced by younger generations of engineers. Successful entrepreneurship, however, requires many things besides a good opportunity, of which creativity, flexibility, and practicability are also essential and more importantly, they can be taught. This study based on observation and interviews, followed the path of actual work and incremental progress in a student's entrepreneurship project to determine important "ingredients" in the engineering education of successful entrepreneurs. The entrepreneurship project of our focus here is the Robohand project (by Duy Tan University staff and students), which strives to provide robotic hands to people who lost their arms and/or hands at birth or due to some peace-time or war-time accidents. The study found out that not only one or two or three, but a series of CDIO standards are simultaneously needed in a systematic and integrated curriculum so as to create well-rounded graduates with strong engineering and entrepreneurial skills. Those can be identified as CDIO Standards No. 1, 2,3, 5, 7 and 8, which respectively help students identify urgent socio-economic problems, integrate different skills and know-how for feasible solutions, select the optimal solution based on strong design and implementation knowledge, and continuously improve on the solution outcomes and designs by following certain technical, social and ethical requirements. Details of this paper, as a result, will be of benefit to universities and colleges, which are looking for ways to improve on their students' entrepreneurial skills and knowledge.

KEYWORDS

CDIO Standards No.1,2,3,5,7,8, creativity, engineering ethics, entrepreneurship, entrepreneurial skills, integrated learning, robotic hand.

1. INTRODUCTION

In Duy Tan University we often organize activities, which enable our students to get in touch with companies, to form associations right from the time they start taking their core courses. This encourages students to select and work in areas that closely match their areas of interest. As a result of these meeting, our students can determine the target area related to their study chosen by themselves to learn better. But the thing was just halted here until we acknowledged to more explore these meetings aiming the initiation entrepreneurship

from students. We realize that the project idea is the focal point of all inspiration and creativity, we therefore request that companies set fort not only simple presentation but also develop demand forecast for their products in their respective market areas. This is the most valuable source of information that will help the team to set up their rough draft of entrepreneurship plan.(Duong VU, Dong T L TRAN, Bao N LE-2017).

2. CDIO STANDARD NO. 2 & 3 REFOCUS FOR CONCEIVE AND DESIGN STAGES

Coming back to the CDIO Project, on stage **conceive**, all students freely discuss in teams preliminary idea of the theme they wish to follow. Initially these ideas may be unfeasible but if the proposal meets the basic guidelines and has practical applications, we encourage them follow. From the other aspect with the advanced CDIO Project, we require more personal skills, communication skills (especially oral and written English communication) and development ability, the guidance skill, systematic thinking, creative thinking, selective criticizing, problem resolving, team work (standard no. 2- CDIO Standards v 2.*0-2010*) that they have to gain conceive stage through activities:

- As a first step an instructor asks the students to provide the information that they obtained from meetings with the companies or links they formed and identified practical problems related to their subject matter mainly in the area of Mechatronics. Each student describes and outlines the outcome they envision (mind map)(Johnson, E.B.-2001) – Fig. 1. Pertaining to standard no. 2, this procedure facilitates learning outcomes, helps them to visualize what they have learnt through discussion with companies and associations.
- We encourage the students to be receptive to make changes in their initial plans based on the information they obtain in meetings with companies and associations. Having this opportunity, the students can fine tune, innovate and adjust their mind map themselves. This procedure helps students to improve their communication skills, promote creative thinking, become skilled at doing analysis and be open to critique theory in order to improve learning outcome and complete their mind map.
- We can apply this flexible model to catalyze discussions, reveal student's personal viewpoint on discerning information. Due to changing personal viewpoint, students can also reorganize their teams. We focus on problems which might be social in nature or demanded by the companies in the field of Mechatronics. The goals of the ensuing discussions may result in the requirement to deliver a complete product according to one specific operation in the assembly line, automation of some products or some types of humanitarian products which are useful to a disabled person.

The instructor then plays the role of a facilitator bridging and connecting all information, managing student's teams to conceive the idea, guide and trigger more technological, engineering aspects to help them complete their engineering conception. Based on schedule of each student's team, the instructor will monitor it so that all students during Project must plan their work load and manage their time through all stages.This is because they have many meetings, seminars, workshops, presentations with different partners in limited time and placed.

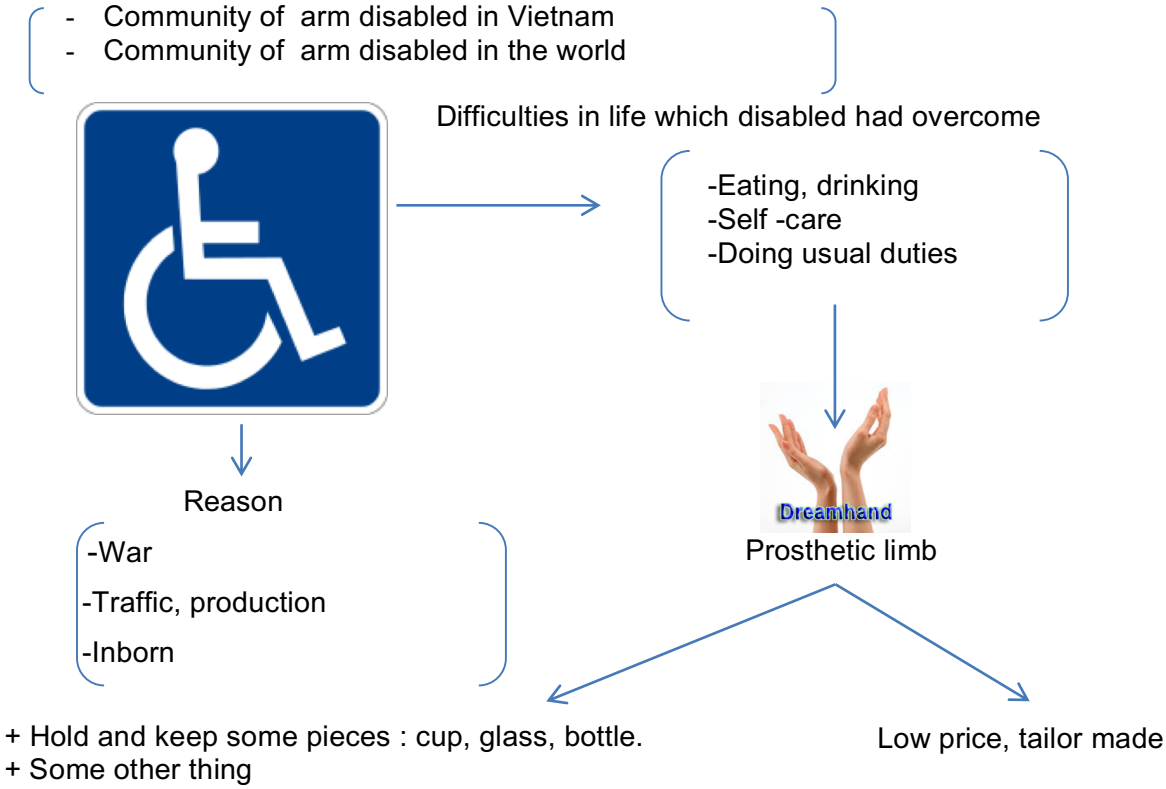

Figure 1. Mind map providing data on low price prosthetic limb for disable person.

The prosthetic limb was created by our students using the above mentioned cycle. The idea was initiated from practical demand of disabled persons not only in Vietnam but also in the world. Even though more than 45 years have passed since the Vietnam war it still has impact on our lives in many ways. The horrific memories caused a lot of mental effects to this date and produced thousands of victims who had become disabled due to exposure to toxin, bombs and other weapons of mass destruction. According to some estimates from the Department of Defense (DOD) USA, more than 15 million tons of ammunitions was used in Warfield of Vietnam and there is more than 10% that which did not explode after utilizing. This appalling figure makes people worried even in peace time.

Figure 2: Ammunition remaining from the war and its consequences

From this community many peoples lost all or most part of their arms therefore their mental and physical state decrease so strongly it affectes their quality of life. They face heavy difficulties with eating, working, self- care, and their dream is to have prosthetic limb

to help them do homework. On Fig.1 the mind map synthesizes all information, collected by one team of students (standard no. 1- CDIO Standards v 2.*0-2010*).

On the stage **design**, this student's team was contacting with disable Association of Da Nang city, Quang Nam province and families to reach out to their relatives who have arm disability.They also collected additional reference , specification type of hand disabilities and started sketching design for robohand (Martin Vincent Bloedorn -2015). The youth organization of DTU is responsible for arranging contact with disable association, their families to help with the student's investigation and survey.

Fig 3. Students from DTU surveying in family of Hieu and Khoa,

Quang Nam province

Based on data collected in on-site meetings, the student's team begin the analysis, anatomy study of human hand and propose first design of prosthetic limb. At this stage besides complete teamwork requirement, all students should be proficient in specialized knowledge and advanced skill with software as Microsoft Visio, AutoCAD (Sham Tickoo- AutoCAD 2016), Autodesk Invento (Sham Tickoo- Autodesk –Inventor 2016) to develop, simulate on mechanics as well as Altium Designer to calculate the circuit board. Result of this stage is to create well thinking, technical resolutions , which meet required specification and operation of prosthetic limb –Fig 4,5,6.In the meantime,the instructor monitors and consults or answers student's questions in term of mechanical and dynamical calculations, method of data processing from sensors, to regulate limb movements. These activities are to support students to train on engineering prototype, processes and system design.

In conclusion, through communication with people with arm disability help them simultaneously learn skills in contacting, interviewing and data collection, observation, evaluation and technical proposal.

Nevertheless, the instructor also encourages students to implement AutoCAD and Autodesk to model, then create 3D printer to make the prototype. This is a very basic skill integrating in curriculum (Enelund, M., Wedel, K. M., Lundqvist, U., Malmqvist, J.-2012) to design- implement the product (standard no. 2,3- CDIO Standards v 2.*0-2010*) and could also be used as a necessary entrepreneurial skill. All students are stimulated to continuously improve on their design model together with metrology and quetionary by talking to peoples with arm diability.The studens are also encourage to find way to cut down the production cost by using alternative technology to traditional 3D in the future.

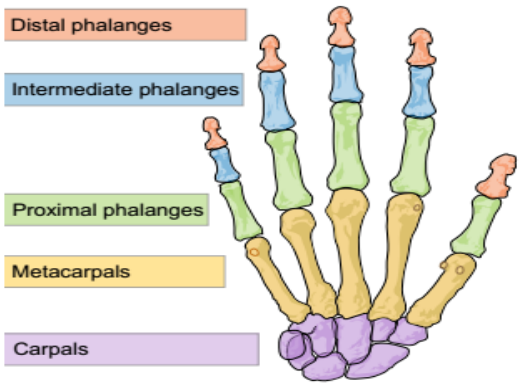

Fig. 4. Anatomy and analysis of the human hand

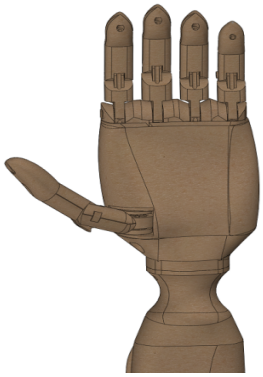

Fig. 5. Human hand design on Autodesk Inventor

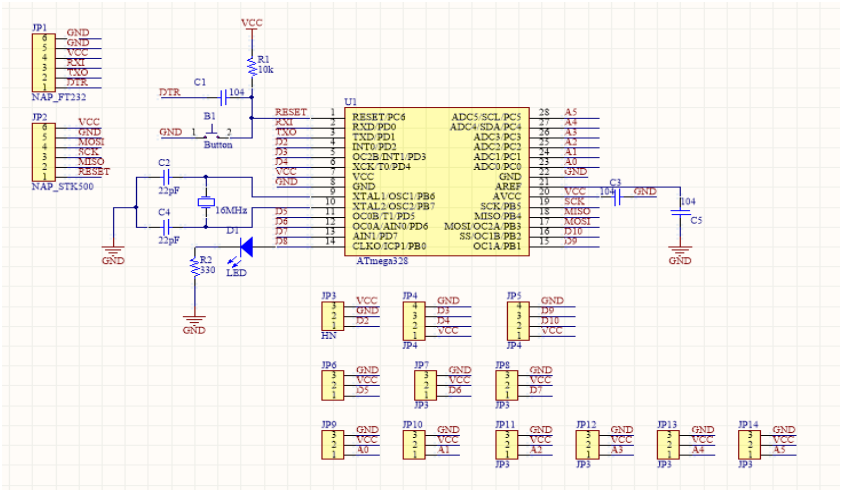

Fig. 6. Circuit Design by Altium Designer

3. REFOCUS OF STANDARD No. 6,7,8(CDIO Standards v 2.0-2010) IN IMPLEMENTATION & OPERATION STAGES

Following chain of training activities, all students are being willingly and actively suggested to ***implement*** *models, fabrication proposal, product analyze in small team collaboration, discussion, cementation each other and feed back in practice.* This stage provide students with the experience; assignment in fabrication prosthetic limb for improving practical and professional skill; the problem solving skill (standard no.8),but the instructor only guides and suggests through connection with Center of Electrical Engineering –CEE (one of engineering division of University, having facilities for mechanical manufacturing, programming, simulation…) so that some experts at the CEE support the students to realize their ideas. The students acquire syntactic ability by themselves in one assignment including product analysis*,* engineering and especially being responsible for social obligations of designer (Prosthetic limb*)*.This is quite an unique teaching and learning activity(standard no.7) in CDIO Project which we apply in recent semester due to working technical space for students according standard no.6.All students having acquired Center of Electrical Engineering take the initiative contact with technical staff, to show their proposal and then they are allowed to use technical instruments, modern software, practical production

processes right in CEE to try manufacturing of prosthetic limb – Fig- 7, 8. This methodology had some advantages as follow:

- The space in CDIO class was extended, the students are sitting not only in teaching separate rooms, but also moving to workshops, laboratories of Center of Electrical Engineering entirely close to families of disabled person. The learning in open space helped students apprehend affectively and more attractive in comparison with traditional classroom.
- Student communicated directly and worked with specialists(Thomas Erekson and Steven Shumway-2006) so it improves professional experience. The fabrication under the monitoring and surveillance of experts eliminated an mistakes , shortcoming of students due to lack of practical experience, increased the reliability of product, out coming device. Namely the Prosthetic limb could exactly operated and stably against design calculations.
- University explores maximum equipped technical facility , as research tool, to make business ,also for training. Taking advantage available machinery , materials of Center of Electrical Engineering partly helped student save research expenses.

Fig- 7. Students are printing limb parts on 3D printer which made in CEE workshop

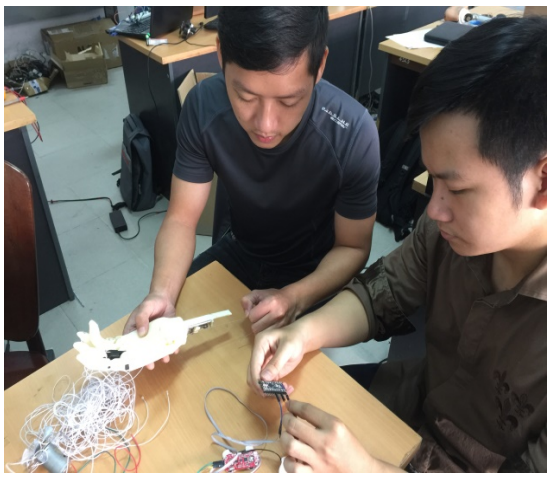

Fig- 8. Students are assembling mechanical components and electronic automation for Prosthetic limb

On stage - **operation**, the students are requested to test prosthetic limb under conditions right in company workshop. In former Projects we do not request students do this because almost results of CDIO Project was just limited on grading completeness of volume theme based on target set fort and valuated knowledge content, gaining during its execution. In advanced CDIO Project, targeting on additional arming student some more experience and entrepreneurial skill, so we got more criteria for evaluation practicability, fullness and flexibility in production conditions. Normally one Project is evaluated by complex of criterions as relevance, fulfillment of objective, efficiency, effectiveness, impact and sustainability. As an instructor we follow all criterion but we pay some more attention on entrepreneurial skills and integrated approaching in assessment.

This time, for testing prosthetic limb in workshop of company, students have been themselves establish company relation to get test permission .This helped students train confidence , independent in their carrier after graduation (standard no.8).

Fig- 9. Students taking the initiative contact with company for testing permission

Fig- 10. Testing in disabled kid family

4. CONCLUSION

The Project engineering prosthetic limb for disabled person is an typical example motivating the perfect integrated and simultaneous implementation of complex of some CDIO standards to strengthen, upgrade entrepreneurial skills for students in general,

especially in Mechatronics. This is one new approach for circumstance analyze practice to set the social obligation for students in market study and constructive implement, combining inter branch knowledge in integrated education environment, extended space, taking advantage technology improving. It's target for low price practical product ,paying attention on humanitarian scene. These are important knowledge and skills , arming students before joining labor market.

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