International Aerospace Design and Manufacturing Technologies for Engineering Students in Competitive World: An Experiment

Sergey Dubikovsky[1], Siddharth K. Jabade[2], Hemant K. Abhyankar[3]

[1]Assistant Professor, Department of Aviation Technology, Purdue University, USA
[2] Assistant Professor; Vishwakarma Institute of Technology, Pune, India
[3]Professor and Director; Vishwakarma Institute of Technology, Pune, India

sdubikov@purdue.edu[1]

Abstract

The turf on which today's engineers have to operate has undergone a dramatic change in this flat world of globalization. The role of an engineer has transcended the narrowness of geographical boundaries. It has become imperative to develop skills in engineering students so as to effectively operate in this trans-national and cross-cultural competitive world. The challenge is how to seed, nurture and bring about these skills and abilities in the students from diverse countries and institutions therein and yet be in the establish frame work of educational system / curriculum of the respective institutions. To this effect, the unique model was developed during inspiring moments of ICEE 2008 in Hungary by the authors who hail from USA and India. This was further pursued and experimented for one year in the respective institutions. The paper presents learning of this unique experiment.

The model is developed with an objective of first motivating student groups from respective institutions of authors to meaningfully interact with each other and eventually work together on an academic platform in a manner such that the students are naturally drawn in the learning process. This enables to dovetail this model in their established curriculum without introduction of separate subject. The deliverable of this model is the intercultural aspects one should imbibe in an established technical education so that the students upon initiating global career seamlessly merge in trans-natural and cross-cultural competitive world. The work acknowledges efforts of iNEER because of whom authors got networked and conceive this model.

Index Terms: Globalization, International Collaboration, Manufacturing Technology, Student Design Project.

1. BACKGROUND

Engineering educational institutions are well springs of human resource and knowledge. In this competitive flat world of globalization, it is imperative to nurture the spirit of innovation by creating responsible partnerships across diverse cultures and nations during the process of undergraduate education itself so that students are ready for these challenges. The development of aircraft during the first part of the 20th century has change compare to the early days of aviation. At that time planes were German, French, British, or built and the aircraft industry represented a country's engineering innovation and pride. It is different now. For example, many consider Airbus to be a European aircraft manufacturer; however, half of its financial investments for aircraft manufacturing are made in the United States. Many Americans [1] consider Boeing to be an American company, but companies in China, India, Japan and Europe make many parts for Boeing planes. This change will result in much needed breed of engineers imbibed with open, inspired, innovative and ever-greening minds ready to take challenges in the cross-cultural and trans-national environment by seamlessly adapting themselves irrespective of their own culture, country and religion to meaningfully contribute in the value chain for societal growth. Engineering students during undergraduate study are segregated into aggregates in terms of clusters of educational institutions across various continents. The need is felt more to make them work in tandem irrespective of geographical boundaries.

Generally, engineering curriculum comprises of subjects related to technology, mathematics and management wherein students have to earn credits to complete particular course. The challenge is how to introduce the aspects of exposing undergraduate students to innovative thinking while partnering with students from diverse culture geographically distant so as to provide inputs regarding working in diverse groups so as to get the pulse of working in a global team. The United States National Academy examined the globalization issue in a recent report entitled Educating the Engineer of 2020: Adapting Engineering Education to the New Century, concluding, "United States engineers must become global engineers .... The engineer of 2020 and beyond will need skills to be globally competitive over the length of her or his career [2]."

Introduction of new courses to this effect has limitation as there is a natural process of rejection or ineffective completion of the course out of compulsion because it is examination based. On these lines, a unique approach to integrate Intellectual Property Right in established curriculum is reported by two of the authors in the model is known as IPRinternaliseTM [3, 4]. In order to address to the need for new breed of engineers, the faculty of the Aviation Technology Department at Purdue University is working to introduce a balanced combination of theoretical and practical engineering aspects in a curriculum. The goal of a new accredited engineering program is to prepare graduates to fill entry-level positions as design, technical support, and liaison engineers at aerospace companies such as Boeing, Pratt & Whitney, Cessna, etc. A significant percentage of AT graduates work side-by-side with engineers, fulfilling engineering functions and wearing engineering titles. To be successful, these students must have an understanding of design processes and philosophy, as well as globalization issue [5, 6].

The present work explores an approach to seamlessly integrate the aspect of stimulating innovative thinking in students along with encouraging to work and meaningfully interact with students from other culture irrespective of geographical boundaries during undergraduate study yet being in the formal education system of respective countries.

2. GENESIS

The idea of developing this model spurred during inspiring moments of ICEE 2008 in Hungary. The authors did not know each other before this conference. The authors could interact during this conference, thanks to iNEER for providing this platform. During the interactions, it came out that in India and USA the education system, perspective and approaches are certainly different. However, after graduation students have to work in the companies wherein essentially they have to work in teams wherein team members are drawn from various countries. It then becomes hindrance to adapt each of them to the thinking of each of the group members and work towards common goal as the background and the perceptive of each of the member towards the problem solving is based on his/her way of nurturing in the respective country and the engineering institute therein. The authors brainstormed on the approaches on overcoming this problem and how to prepare students for this challenge.
The model is developed with an objective of first motivating student groups from respective institutions of authors to meaningfully interact with each other and eventually work together on an academic platform in a manner such that the students are naturally drawn in the learning process that seeds and nurtures creative minds. This would go a long way to normalize and harmonies the jerks student may face so that he/ she seamlessly merges in any of the cultures across the world.

3. THE APPROACH

The present practical and pragmatic model in contrast to earlier efforts, is not a born out of the collaborations of the two institutions of the authors. The model is developed by collaboration of the thinking of the authors out of inspiration of the ambiance of the conference we attended in Hungary. The underlining aspect therefore is it is workable as collaboration between the institutes that is many times a long drawn formal process with lot many modalities is not required. Thus the model is independent from these formalities and hence any two faculty members from different institutes can exercise the same. Further, the model is student centric and not the educational institute or faculty centric wherein the later plays a role of facilitator. This has helped to seamlessly integrate this endeavor in technical

education of the respective institutions in a well-structured manner to that provides an experience-lead framework with value added learning.

The unique aspect of the model is to provide group of students from the participating institutes of the respective faculty that are from different countries a common technical problem. First, student groups are to be identified from the respective institutions. There are at least 4 students in each of the group. Further, a crisp problem statement is provided to the said groups. The groups are initially not allowed to interact with each other. Each of the student group has to come up with at least three innovative solutions to the said problem and need to specify merits and demerits of each of the solution with respect to each other. Further, the groups are told to specify and list down the criteria on which the merits and demerits are decided to select the best solution.

The students are told to conduct prior art search that includes patent search to establish novelty and inventive aspects of the respective solutions. Upon completion of this activity, student representative from each of the group is to communicate with the student representative of the other group. The students are monitored while creating the solution as well as the way they communicate with the other group. Further, the students are told to come up with the best of the solution out of each of the three solutions each group has already conceived. The idea is that the students interact with each other to make each other understand merits and demerits of the solutions they have come up with. Each of the groups prepares presentation of the entire work done.

The two groups interact with each other to arrive at the basis for solution and consolidate the same based on each of the groups initial inputs. Further, the groups come up with the best solution out of the six solutions based on the criteria. Techno-economical analysis of the solution is must in this process to establish real life workability or usefulness of the solution. The groups are told to self evaluate their presentation against other groups and list down the learning from the presentation as to what is missing in theirs. Further, the two groups work together to discuss and brainstorm on the aspects of the best solution out of the six conceived solutions. The groups could establish interaction using communication means such as telephone, email, voicemail, video conferencing etc.

What is monitored in the entire process is the approach towards problem solving of each of the group along with the way of communication. Further, the perspective of each of the on the criteria for selection of the best solution out of their three solutions can be easily related to the approach of each of the educational system in which students are groomed.

The expected learning in this unique model is that first students come up with their own solution independent of other group. This simulates situation wherein when employed in a company, the student comes up with his/ her original thinking and is ready to work in a group that constitutes people from various nationalities. Further, interaction of the groups with each other to arrive at a common solution which may not be the one which particular group has conceived imparts indirect training of assertive negotiation. This helps in inculcating the ability to appreciate others work and dispassionately evaluate the same based on the logical reasoning. Further, targeted interactions with the groups from different cultures, background and technical streams provide students much needed exposure of the intercultural aspects. Self evaluation of each of the groups provides them ability to study others work, appreciate the same and learn through it.

Since students conduct patent search and analyze patents in view of establishing novelty and inventiveness of the solution, they are naturally get the exposure of aspects of protecting their intellectual creation. The exposure of intellectual property rights is provided indirectly through this process. The faculty involved in the project also gets a chance to learn from each other on various aspects. The technical problem and solution to the same arrived at by the two student groups from respective institutions may seed a joint research project wherein both the faculty can continue joint research.

4. IMPLEMENTATION OF THE MODEL IN PURDUE UNIVERSITY,

USA AND VISHWAKARMA INSTITUTE OF TECHNOLOGY, PUNE INDIA

The problem statement, as an initial step in a process, was created by the authors related to the luggage handling system in the aircraft. The groups were formed from volunteers most of whom wanted to have a greater exposure to collaboration in the global environment.

The first milestone of the project was the conceptual design review (CDR). The CDR requires a presentation in which each group discussed progress on their project and their plan for the semester. It includes identification of the customer and specific design requirements for the project; the problem statement; a brief explanation of the assigned project; three unique design concepts; a decision matrix that quantitatively compared the concepts versus the customer's design requirements; a cost analysis of the projected completed, manufactured cost of each concept; the design concept pursued and justification of the decision; a time action plan. The idea is to have an oral presentation of each team using modern technologies such as email, phone and the Web conferencing.

The second milestone was the detailed design review (DDR). It was similar to the CDR in format. The content of the DDR differed from the CDR in that the detailed presentation showed the completed final draft of the design as well as a brief review of the chosen concept and the CDR presentation; a cost analysis of the materials required for the design; a detailed labor-hour breakdown of the estimated manufacturing time; tooling requirements for manufacturing; final CAD drawings of our component using 3D software; an assembly summary explaining the subparts of the system and how they would be assembled [7]. And again, the best way to present would be through the Web conferencing or/and other modern technologies.

The third milestone was the final presentation and written report. This presentation not only demonstrated the final component but discussed the actual approaches and manufacturing methods used during the manufacturing process. At that time the final assembly or/and proof of design would be presented as well.

5. STUDENTS' TESTIMONIALS FOR THE INTERNATIONAL PROJECT WITH PURDUE UNIVERSITY

Namo Jain, Senior, Department of Mechanical Engineering, Vishwakarma Institute of Technology, Pune, India:

> The project turned out to be a BRAIN STORMING one initially, which involved a lot of thinking process. It taught me the importance of the essential things like presentation, techno-economical aspect, documentation and quantitative technique. It provided us with an opportunity to work on a cross cultural platform where we could see their method of approach towards the problem statement and their dedication in achieving the same. Though we managed to bring about some good solutions through this activity, their practical implementation still needs to be seen. The activity turned out to be an extremely interesting one and a good learning experience.

Kaustubh Surdi, Senior, Department of Mechanical Engineering, Vishwakarma Institute of Technology, Pune, India:

> With the realization of a very basic problem faced by the passengers in commercial flights, finding a solution for it was a challenging task. A collaborative project between the two universities across the globe, this successful effort gave us an insight on the working environments of our counterparts and their way of thought-process both technical and economical. It provided us with the view of looking towards any solution quantitatively as well as qualitatively. The project is in its final stages and practical implementation of the solution will be the final goal. This has proved to be an excellent learning experience for all of us.

Sanjay Kumar, Department of Electronics Engineering, Vishwakarma Institute of Technology, Pune, India:

> This project was more application based. We came up with two major concepts. The concept of Pugh Matrix of analyzing a feasible solution was definitely a new approach we learned. Our entire approach on how we actually presented our idea was definitely a learning experience. On the whole it was an exciting experience with the prospects learning something new throughout.

References

01. [1] W. Garvey, “Manufactured in _____ (Fill in the blank) paging through the handbook is a journey in global innovation, and that’s good”, Business & Commercial Aviation, Vol. 96, pp. 6-8, 2005.
02. Committee on Engineering Education,Educating the Engineer of 2020: Adapting Engineering Education to the New Century. Washington, DC: Nat. Acad. Press, 2005.
03. S. Jabade, H. Abhyankar, P. Ganguli, “Model IPRinternaliseTM – Integrating Intellectual Property Rights in Technical Education”, World Patent Information, Vol. 30, pp 220-224, 2008.
04. S. Jabade, H. Abhyankar, P. Ganguli, “Seeding and nurturing creative minds, Integrating Intellectual Property Rights in Technical Education”, Research Global, June 2007.
05. S. Dubikovsky, T. A. Goodrich, “Experience in Working with Industry Practices and Design for Safety Prepares Graduates for Careers in Aviation”. In W. Aung, J. Mecsi, J. Moscinski, I. Rouse, P. Willmot (Eds.), Innovations 2009: World Innovations in Engineering Education and Research. Arlington: iNEER/Begell House Publishing, 2009. In Press.
06. R. Sterkenburg, S. Dubikovsky, T. D. Ropp, ”New Initiatives for Aviation Study Abroad Programs”, Journal of Aviation Management and Education, Vol. 1, 2008.
07. B. Vlasman, S. Dubikovsky, J. Schwartzkopf, D. Vallade, “Learning Aerospace Design and Manufacturing Processes to Demonstrate ABET Program Objectives” 2008 IAJC-IJME International Conference on Engineering and Technology. Nashville, Tennessee – November 17-19, 2008.