# Educating for the 'Out-Sourcing & Out-sourced' Workplace

**M. Javed Khan**[1], **M. Ali** [2]

***Abstract***

The paper argues the need for exposing engineering students to the salient features of an out-sourcer/out-sourcee interactive environment. A background is provided to highlight the characteristics of the workplace of the near future. The availability of open source and low-cost software providing collaborative project management, capabilities of synchronous data-sharing, data markup, data manipulation and instant messaging, voice-over and video provides an opportunity to implement the concept. A framework is proposed for developing a collaborative course between geographically and culturally dispersed academic institutions to model the out-sourcer/out-sourcee environment. The anticipated administrative, technological and curriculum aspects of such a framework are outlined.

## *Introduction*

The world has transformed from the 'Industrial Age' to the 'Information Age' in the last decade of the 20th century. This transformation has been a consequence of the PC and the Internet, the coal and the steam-engine of the information age. The number of Internet users worldwide crossed the 600 million mark according to a Sept 2002 survey [6]. The number of households in USA with Internet access exceeded the 50% mark in 2001[7]. In the Western societies, the number of individuals employed in collecting, handling and distributing information exceeds those in any other occupation [12]. This proliferation of dissemination and access to information has profoundly affected society in general and the professional communities in particular.

The 'Information Revolution' has spawned new careers, resulted in changes to professional practices and raised challenging ethical issues in the engineering profession. E-commerce, information security, web conferencing, distance learning/education, information archiving/retrieval, data mining, etc. has revolutionized the concept of the engineering workplace. These aspects are being inextricably woven into the practices of the engineering profession making it almost incumbent upon engineers to learn these emerging skills sets to ensure relevance to the work place. The usual practice by organizations of outsourcing aspects of a service or manufacturing to local/regional/national partners has rapidly crossed national boundaries and has been stunningly successful; and an important element of this success is the ease and speed of information exchange. Of course, such a shift has brought into sharp focus the various ethical issues e.g. privacy, rights, access, exploitation (the proverbial software sweatshops) etc. Successful implementation of the concept of 'outsourcing' is a paradigm shift therefore not only in manufacturing but in design and the business process in general. Thus, for example, it has been predicted [Swearengen, 8] that engineers will be 'free agents in a professional services market'.

This then poses the question: Are the engineering students being educated to efficiently and effectively function in the 'Information Age'?

Engineering education over the years has successfully been adapting to the opportunities of the workplace, moving from an empirical/experienced based model to a science-based approach, acknowledging the need for

[1] Associate Professor, Aerospace Science Engineering Department, Tuskegee University, Tuskegee, AL 36088, Member ASEE

[2] Assistant Professor, Computer Science Department, Tuskegee University, Tuskegee, AL 36088

multidisciplinary and team work through the incorporation of capstone design courses. However, in view of the transformed workplace, there is a need for taking a fresh look at the engineering education pedagogy.

This paper addresses the inevitable that manufacturing outsourcing is being followed by design-outsourcing, emphasizing the need to enhance our engineering curricula by incorporating the competencies and skills needed for such a workplace. It is proposed to model the out-sourced workplace environment through a course structured towards out-sourceable' projects. These projects are envisaged to be undertaken by multi-disciplinary teams of students belonging to geographically, culturally and technologically diverse universities collaborating over the Internet using various tools, in order to successfully complete the project.

## ***What is Outsourcing & Why Outsource?***

The essence of a myriad of definitions of outsourcing is the transfer of provisioning of services or production to another party internal or external to the organization albeit without abdicating responsibility for the services or products.

Outsourcing is not a new phenomenon especially in the manufacturing sector. Some of the drivers of outsourcing have been economies of scales, lack of internal expertise, utilization of industry's best practices etc. However, such activities were primarily limited within countries e.g. the United States. Easy access to cheap labor in third world economies changed the paradigm. Most of the labor intensive tasks have in the last two decades been exported out to these third world economies. As has been reported [Hymowitx, 5] classical management issues suddenly gained added dimensions and the dynamics of the process has given rise to newer challenges. Management of such outsourced activities has spawned the development of, for example sophisticated quality control and supply chain management processes.

The wide-spread use of high speed internet connectivity has played a key role in strengthening the out-sourcing business model. As a consequence a self-amplifying system has resulted in the rapid improvement of infrastructure of the 'out-sourcee' environment and increasingly sophisticated services and production are now being outsourced. Tasks such as software development, call-centers or plastic injection molding etc. which were the earlier stages of phenomena are now being complemented by higher-end tasks such as system design and engineering etc. (e.g. GE R&D centers in India & China etc.). This is requiring the 'out-sourcer' to refine and re-invent its business management processes to deal with this new 'virtual' bi-polar enterprise which is rapidly evolving into a more complex and highly interactive cellular environment with cyber-bridges.

There is a classical argument between industry and academia about what should be taught to engineering students. However some organizations have acknowledged that they have a stake in the engineers that are being graduated from universities. An example is the Partners for the Advancement of CAD/CAM/CAE Education (PACE) program [14] whose objective is to develop the *automotive product life cycle management* team of the future. This program sponsored by General Motors, EDS and Sun Micro Systems has donated hardware, software and training to a number of institutions to incorporate Unigraphics into its curriculum. Tuskegee University is one of the PACE institutions. Introduction to design, engineering and manufacturing through the Unigraphics environment is a win-win situation. However, as pointed out earlier, the business environment has moved much further and the industry needs to be cognizant of the need to support Universities in their efforts to expose students to the rapidly growing and changing needs of the information age.

## ***Brief Review of Relevant Work***

Various models have been proposed for collaborative engineering which need to be considered when developing a teaching model. For example, technologies needed for an environment for a collaborative product development virtual team have been reported [Stavash, 7]. Evaluation of emerging technologies and their integration for a collaborative engineering project (Madefast) have been detailed on the web [Cutkosky, 3]. They determined that

there was a need for 'better methods for navigating and organizing on-line documentation, for coordinating and managing the efforts of cooperating groups, and for helping groups to assimilate the cultures of their virtual team-mates'. This effort provides a good insight into the challenges of such a project. The concept has been implemented at various levels in academic environment as well. Collaborative tasks by geographically distributed teams have been investigated [Kirshman, 8]. However, this work was primarily oriented towards brain-storming, co-editing reports and negotiating agreements etc. They used four different interaction methodologies (audio, video, file-transfer and applications –sharing) and determined that audio was the most effective of the four. Similarly, a multi-university design project across campuses has also been reported [Kumar, 9]. The collaborative interaction was asynchronous through the internet, e-mails and had at least one video-conference per phase of the design and physical meetings. It has also been proposed that traditional design rationale cannot be applied to a collaborative design environment due to the complexities of technical decision-making as well as the social interactions in the design environment [Lu, 10]. A 'Virtual City' concept proposed [Su, 11] has two of the basic modules i.e. geometric modeling and its real-time manipulation and real time chat required for the teaching of an out-sourcer/outsourcee interactions, while the third essential element of project management is not implemented.

## ***Objective***

This paper highlights some of the characteristics of the proposed environment to simulate the out-sourcer & out-sourcee interactions and a frame work for a course in essential knowledge areas to which engineering students need to be exposed.

## ***Environment of the Outsourced Engineering Design Project Course***

There is a plethora of software now available in the open source/freeware as well as proprietary domains which have documents sharing, CAD files sharing, markup and manipulation and virtual project space etc. capabilities in one combination or the other. phpCollab [15] is one such software available in the public domain. This package provides a virtual project space in which various projects can be created, team members assigned and tracked. The system has two parts, Team Project Site and the Client Project Site. The Team Project Site can be used by the out-sourcers. There can be several levels of access at this site, eg. Administrator, Manager, and User. The Client Project Sites are used by the oursourcees. Each oursourcee has its own Client Project Site, and cannot access Client Project Sites of other out-sourcees, nor the Team Project Site. An example of proprietary software is Microsoft Enterprise Project Management. This software has the functions that can be utilized for out-sourcing based project management. The above are packages which support an integrated set of collaboration tools. Many of the functions supported by the above packages can also be obtained by using widely used popular communication tools, such as Instant Messaging (with support for text, audio and video). Tools such as NetMeeting also provide white-board support.

OneSpace.net by CoCreate [2] and Alibre [1] are other examples of proprietary well-integrated environments for collaborative work. On the higher-end are e.g. SmarTeam [13], ProEngineer WildFire [16], Unigraphics Team Solution [13] etc. providing collaborative engineering capabilities. However, the authors are not aware of any software in the public domain for sharing, mark-up and real-time collaborative editing of CAD files.

A review of the literature on the teaching of collaborative engineering and industry case studies brings out the following basic characteristics of an environment for teaching collaborative engineering in a global engineering village. Obviously, the environment has to be web-based and should have synchronous and asynchronous interaction capabilities.

### ***Ease of Use***

The environment must be simple and easy to use by the students. This will focus the effort on learning the essentials of collaborative engineering and not be distracted by having to navigate through an overly complex environment.

### ***Sharing Capabilities***

There should the capability to share folders/documents and applications. The environment should have markup and real-time editing abilities.

### ***Meeting/Discussion Center***

To facilitate real time discussion and brainstorming, the ability to use chat/instant, messaging and video-conferencing should be available.

### ***Engineering Focus***

The environment should have an engineering design module sufficiently powerful to be useful. Thus, it should be able to develop solid models, assemblies and be able to determine component/sub-assembly clashes and clearances. This module should also have the ability to manipulate the models synchronously without excessive overheads for efficient use over the internet.

### ***Administrative Controls***

Aspects of access are essential elements of the environment of collaborative engineering to which students must be exposed. In a real life situation, there would be various projects, handled by a number of teams and team members who may not be allowed access to different parts of the projects for reasons of security, intellectual property right issues etc. Also aspects of project management e.g. projects, teams definitions, work tracking and instant notification of changes etc. need to be available as part of the environment.

In our opinion the most effective medium for teaching the characteristics of an out-sourcer/out-sourcee relationship would be a suitably chosen commercial software primarily due to the availability of low-cost commercial software. A package needs to be selected that has a project management architecture which is amenable to the out-sourcing model and has the requisite sharing, manipulating and virtual meetings capabilities to capture the essence of out-sourcer/out-sourcee interactions.

## ***Framework for the Outsourced Engineering Design Project Course***

There are three major aspects to be considered for successful offering and conduct of an Outsourced Engineering Design (OED) Project course:

(a) Administrative aspects: Department/faculty level agreements amongst the collaborating departments, prior to the offering and conduct of the course. And, continual collaboration between faculty members for the smooth conduct of the course

(b) Technological Aspects: Selection and establishment of appropriate hardware and software environment

(c) Curriculum Aspects: The elements of the course

Unlike a typical capstone project course, which is supervised by one faculty member, without any participation from department administration, an OED course will require an agreement between the participating departments. If the courses are to be offered on a regular basis, two levels of agreements will be required. At the higher level, the

agreement will cover the general rules and guidelines for the departments to cooperate with each other. Such agreements can be formulated along the lines of agreements made for long-term research collaborations between departments. At the second level, the agreement will provide guidelines for designated faculty members in the various departments to co-ordinate the simultaneous offering of particular OED courses at their respective departments. Some of the important aspects to be considered for the higher level agreement would be:

(a) Determination of a collaborative administration structure for the offering and conduct of OED courses. This may be as simple as designating a course coordinator for each course offering. At a given time there will probably be a course coordinator for the OED course in progress, and one for the OED course to be offered next year.

(b) Guidelines for resource allocation for each OED course. It may not be possible to list the actual set of collaborative tools in the agreement, since the technology is changing at a fast pace and it is important that latest collaborative tools be used for each course.

(c) Sharing of the cost for collaboration technology. This issue would most probably be best taken care of by each department meeting the expenses at its end.

(d) Periodic virtual video conferences for resolving problems.

The second level of agreement would cover the offering of particular OED courses. There is a lead time of at least one year for the offering of a particular OED course. This is necessitated by the fact that the documents for pre-registration for Fall courses is made available to students in Spring semester etc. Thus the administrative details for the course would have to be worked out during the previous Fall semester, and finalized by the beginning of the Spring semester. This phase is very critical to the successful offering and conduct of the course. The actual project title, and technical details can be worked out during that Spring semester and following Summer semester. Some of the important aspects to be considered for the lower level agreement would be:

(a) Guidelines for designating a coordinator for a particular OED course.

(b) Time line for offering a particular course.

(c) Guidelines for collaborative investigation into the latest tools available, and negotiating deals for academic use of these tools.

(d) The number of projects to be offered per semester, and the rotation amongst departments for playing the role of ‘outsourcers’ and ‘out-sourcees.

(e) Guidelines for designating outsourcers and out-sourcees for a particular course.

(f) Time table for virtual video conferences to be held for that course.

A typical OED course will cover the following broad topics:

(a) Basic project management

(b) The outsourcing paradigm

(c) The selected collaboration environment

(d) Issues relating to collaboration across large geographical distances/cultures

(e) The execution of the selected project

It is advisable to include project management topics in the course addressing issues pertinent to collaborative design across time-zones and cultures. The use of collaboration tools may be discussed in general. The outsourcing paradigm should be covered in reasonable detail. This includes developing sensitivity for cultural differences. There are also problems of widely differing time zones. Virtual conferences need to be scheduled during times that are convenient to all parties. The students who participate will most probably never meet each other. Students need to learn how to overcome the problems associated with the lack of face to face contact.

Each project will be based on a set of selected collaboration tools. The students need to be taught these tools before they can start collaborative work on the project. A 3 to 4 credit hour course is considered adequate for providing experience as out-sourcers and out-sourcees. It may not be possible to cover the broad topics listed above in a sequence, since that will leave less time to do the actual project. Some of the topics can be taught in parallel with the conduct of the project. The course syllabus should be designed to reflect this.

There will be a team of students from each participating department. One of these teams will be the outsourcing team, while the others will be the out-sourcees for that project. This designation need to be done at the beginning of the course, so that each team can start preparing for its role early in the course.

There will be a faculty team with members from each department, which will be supervising the project. The team members will cooperate with each other, under the guidance of the coordinator, to resolve administrative and technical problems that are beyond the scope of the students to handle. The faculty team activity will be continuous and in parallel with the student activities, opaque to the students. The students can then focus on the project.

## ***Summary***

A definite need exists to provide exposure to engineering students to the out-sourcer and out-sourcee work environments as such would become increasingly commonplace in the near future, Such an exposure is proposed through a collaborative engineering course between geographically dispersed and culturally diverse academic institutions. The framework of the course would consist of administrative aspects of collaboration, establishing a web-based environment to model the out-sourcer/out-sourcee interactions and development of a curriculum and projects. The web-based environment should have three modules i.e. project management, data sharing consisting of solid-modeling/design and its synchronous manipulation and documents sharing/markup, and a meeting center with real time chat with audio and video. The availability of open-source collaborative project management software and low cost commercial software incorporating these requirements makes the implementation of such a course a practical proposition. The course itself should have elements of project management pertaining to the out-sourcer/out-sourcee model, socio-cultural aspects based on the participating teams' origins and the outsourcing paradigm based projects.

## ***References***

1. http://www.alibre.com/products/

2. http://www.cocreate.com/

3. Cutkosky, M. R., Tenenbaum, J. M., Glicksman, J., ' Madefast: An Exercise in Collaborative Engineering Over the Internet', http://madefast.stanford.edu/ACM_paper.html#1intro

4. http://www.eds.com/products/plm/teamcenter/

5. Hymowitz, Carol, 'Executives must endure outsourcing challenges,' The Wall Street Journal Online, http://www.careerjournal.com/columnists/inthelead/20031022-inthelead.html

6. http://www.infoplease.com/ipa/A0882184.html

7. http://www.infoplease.com/ipa/A0880773.html

8. Kirschman, J. S., Greenstein, J. S., (October 2002) 'The Use of Groupware for Collaboration in Distributed Student Engineering Design Teams,' *Journal of Engineering Education*

9. Kumar, V., Kinel, G., Wei, S., Bengu, G., Zhou, J., (Jul 2000) 'Multi University Design Projects,' *Journal of Engineering Education*

10. Lu, S. C-Y., Udwadia, F., Burkett, B., Cai, J., 'Design Rationale for Collaborative Engineering Design in Socio-Technical Framework,' Engineering School, University of Southern California, CA 90089

11. Su, Q., L., Granoll, K., (2001) 'Internet-based Distrubured Collaborative Environmrnt for Engineering Education & Design,' Proceedings of the 2001 ASEE Annual Conference & Exposition, Session 2468.

12. http://www.misq.org/archivist/vol/no10/issue1/vol10no1mason.html

13. http://www.mscsoftware.com.au/products/software/smarteam/collaboration/cad.htm

14. http://www.pacepartners.org/

15. http://www.php-collab.com/

16. www.ptc.com

17. Stavash, J. P., Welsh, J., Chadha, B., (2000) 'Collaborative Prototyping and Product Development on the Web,' Mission Critical Enterprise Symposium, Lockheed Martin

18. Swearengen, J.C., Barnes, S., Coe, S., Reinhardt, C., Subramanian, K., 'Globalization and the Undergraduate Manufacturing Curriculum,' (April 2002) *Journal of Engineering Education*

***M. Javed Khan***

Javed is an Associate Professor in the Department of Aerospace Science Engineering at Tuskegee University. His research interests are in aircraft design, aerodynamics and incorporating innovative ideas in undergraduate curriculum to enhance students understanding and motivation. In addition to teaching, his experience includes field engineering, aircraft major modifications implementations and as a ranking member in a multi-national aircraft development program. He received his PhD in Aerospace Engineering from Texas A&M University and MS in Aeronautical Engineering from the United States Air Force Institute of Technology. He graduated with a BE in Aerospace Engineering from Karachi University, Pakistan. He is a Fellow of the Royal Aeronautical Society (UK) and member of the AIAA and the ASEE. He also is a flying enthusiast and has a private pilots' license.

***Muhammad Ali***

Muhammad Ali is Assistant Professor in the Dept of Computer Science, Tuskegee University. His area of interest is High Performance Computing, focusing on developing undergraduate courses and experiments, based on low-cost laboratory infrastructures. This is of significance to smaller institutions, including minority institutions. He received his DSc(Computer Science) from George Washington University, USA, and MSc (Electronic Eqpt Design) from Cranfield Institute of Technology, UK. He has a BE(Avionics) degree from Karachi University, Pakistan. He is a Councilor of Mathematics and Computer Science Division, Council on Undergraduate Research, and member of IEEE, ACM and Sigma Xi.