AC 2010-433: COLLABORATIVE TOOLS FOR GLOBAL DESIGN PROJECT MANAGEMENT: CASE STUDY OF AN ACADEMIC EXPERIENCE

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Abstract

The management of information and the capture of design ideas are very critical during the product development and product lifecycle management. They could be very challenging tasks when time, efficiency and quality are important and the concurrent design team is physically distributed in different locations. However, the existing technology for communication, the increase of tools over the Internet and the cloud computing model have made possible and accelerated the means of sharing information synchronous and asynchronously in a very effective way. This has facilitated the work of teams that in many cases are geographically dispersed around the world. Therefore, there is a need to start preparing the future engineers in the use of collaborative tools for global design project management not only to schedule and coordinate all the required tasks for the project but also to capture all the information, ideas and concepts generated during the design process which contains valuable data that supports design decisions. This paper presents the use of several tools for communication and project management used in academic collaborative global design projects. In these projects, students are required to work with international partners from different universities in coordinating activities and documenting the conceptual design for a given problem. The paper reports the experience using the tools and discusses opportunities and pitfalls in the use of them as they were identified by the authors.

Introduction

The complexity of products in terms of functions and manufacturing[1] and the need of improving quality and reducing product cost, which are critical factors to be competitive[2] in the global economy, require the participation of many specialists in the development process of new products. As a result, concurrent engineering and collaborative design have been the operating mode in recent years for the product development industries with the aim of optimizing design cycles, improving quality and reducing design and production time in bringing new products into the global market[3].

The process of integration of economies and societies as well as the rapid advances in technology are constantly changing the world's business environment. Outsourcing, in-sourcing and off-shoring design and manufacturing operations are very common practices nowadays for many industries, making the international collaboration not only a common but also a necessary activity[4]. This global collaborative approach requires permanent communication among the members of the product development team for project planning and execution, and for effective and efficient management of data throughout the entire lifecycle of the product. The concept of "Integrated Product Development" means the integration of all the activities, methods, information and technologies to conceive the complete lifecycle of the product[5]. All these activities have been greatly simplified by the fast development of information and communication technologies[6]. Now, several computer based systems have been developed to support integrated product development to provide valuable and powerful tools to make easy the

interaction between computers-users and users-users through the computers, facilitating the work of teams geographically disperse around the world.

Based on the evolution of group-work, and the different ways of interaction among partners in a team, Table 1 summarizes the different scenarios of collaboration. Due to globalization, current tendencies on engineering projects are requiring teams to interact in a distant synchronous or asynchronous way. This is forcing companies and engineering communities to start working with novel information and communication technologies in order to enhance engineering processes.

Tab. 1 Space vs. Time matrix[7]

		Time	
		Same	Different
Space	Same	*Co-situated Synchronous Interaction*	*Co-situated Asynchronous Interaction*
	Different	*Distant Synchronous Interaction*	*Distant Asynchronous Interaction*

The online collaborative environments are used to surmount the geographical boundaries during collaborative design to gather, organize, synthesize, share, and transfer data and information using different type of formats[6]. These environments are characterized by applications that allow synchronous and asynchronous cooperative work during the product lifecycle management (PLM) process by making possible audio-video conferencing, product data sharing, information exchange, ideation and concept discussions, project management, and CAD modeling among the most significant features. Many of the collaborative applications use the cloud computing model where computing resources are shared over the internet and used on demand by the members of the cooperative network.

Based on the rising mode of collaborative work and the increasing use of information and communication technologies in the industries, particularly in design and manufacturing, there is a need to start preparing the future engineers in the use of collaborative tools for global design project management. They should know how to use the tools not only to schedule and coordinate all the required tasks for the project but also to capture all the information, ideas and concepts generated during the design process which contains valuable data that supports design decisions. This paper reports the experience using several tools over the internet for communication and project management for collaborative global design projects. In these projects, freshman and sophomore students are required to work with international partners from different universities in coordinating activities and documenting the conceptual design for a given problem. The paper reports the experience using the tools and discusses opportunities and pitfalls in the use of them as they were identified by the authors.

The technology is moving at such a fast pace causing new and better tools for collaboration over the internet emerge frequently.

As part of the product development process, the collaborative design practice involves the participation of many specialists and requires the coordination of many activities and the

permanent communication among all the people involved in the process which in many cases are not physically located in the same working area.

Background

Penn State Brandywine is part of the Penn State University system. This is a commuter campus which offers the first two years of engineering after which students transfer to University Park to complete their degrees. As most of the commuter campuses in the US, the student population is formed mainly by local residents who are non-traditional students. These students hold part-time or full-time jobs while they are attending school. Besides that, most of them have no knowledge of another language or experience working in a diverse team. Additionally, it has been detected that most of the freshman engineering students coming to this campus have no previous experience in design projects, teamwork, and the solution of open-ended problems. There was a clear necessity of providing opportunities for the incoming students so they can develop and/or enhance global competencies.

The Latin American and Caribbean Consortium of Engineering Institutions (LACCEI) is a not-for-profit organization headquartered at Florida International University in Miami, Florida whose mission is to be the leading organization of Latin American and Caribbean Engineering Institutions that will bring innovations in engineering education and research, and emerge as a major force in this hemisphere to foster partnerships among academia, industry, government and private organizations for the benefit of the society and the nations, particularly in the Americas.

Since 2005, recognizing the importance of offering international experiences to engineering students, Penn State Brandywine has established collaborative partnerships with institutions in Latin America for the development of global design projects. These projects were incorporated in the freshman Introduction to Engineering Design course which is structured as a project-based course. These projects have been used not only to develop important skills such as project management, teamwork, global design, creativity, innovation, and problem-solving abilities but also to foster cultural awareness, understand diversity, and master the use of technology for communication. All these are important global competencies required to educate world-class engineers.

Collaborative Design Projects

The criteria to select the appropriate type and level of collaboration depends on the general objectives, rank and content of the course in which the project will be offered, the level of commitment of faculty and students, and the resources available. The international collaborative project described on this paper follows the parallel design project approach. In this approach, the teams in each country work on the same design proposal and they have to share and discuss data and ideas with their international partners to enrich the final solution. In order to reach this goal, teams of students are formed on each institution participating and then each team is paired with at least one corresponding partner in a foreign institution. Therefore, each team has at least one international partner to discuss the project and share ideas using collaborative tools. During fall semester 2009, six campuses from USA, Colombia, Dominican Republic, Ecuador, and Venezuela participated in the project. The collaborative network established for this collaboration is shown in Fig. 1.

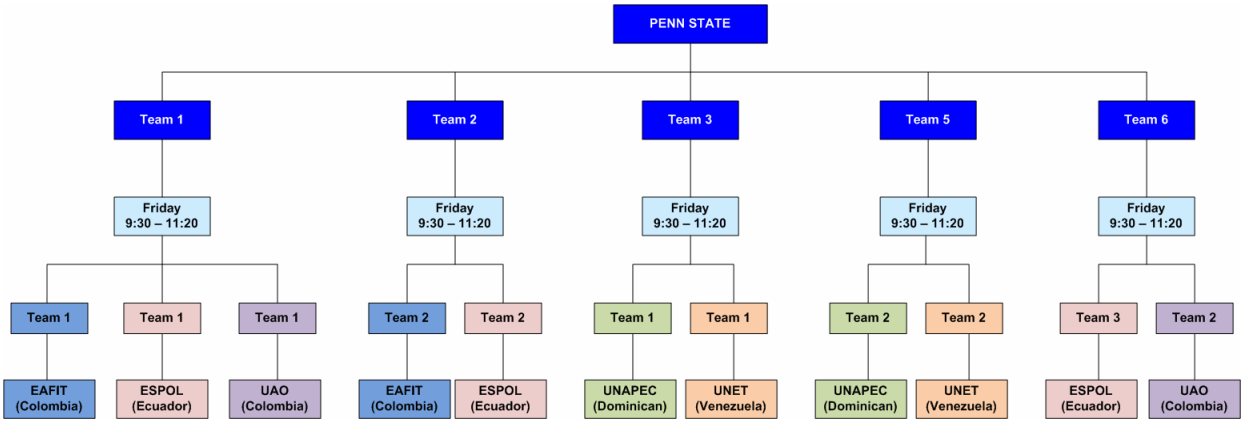

Fig. 1 International collaborative network

The international collaborative design projects are short multi-team projects running as part of a course that usually last for eight to nine weeks. The mandatory international interaction is required to last around five weeks but students are encouraged and allowed to interact beyond the minimum required period. The chronogram of activities for the project is shown in Fig. 2.

Activity		OCTOBER				NOVEMBER				DECEMBER			
		W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4
1	Assign the project												
2	Understanding the project locally												
3	Test the equipment for AV conferences												
4	AV-1 Conference: Establishing personal relations												
5	Understanding customer needs												
6	AV-2 Conference: Discuss customer needs (objectives, functions, constraints)												
7	Functions and specifications												
6	AV-3 Conference: Discuss function decomposition and design specifications/ Preliminary Concepts												
9	Concept generation												
10	AV-4 Conference: Discuss concept ideas												
11	Concept selection												
12	Share concept selected												
13	Develop 3D Model												
14	Prepare final report and presentation												
15	Submit final report and presentation												

Key	
Local Collaboration	
International Collaboration	

Key Dates			
Oct 5	Assign project	Oct 30	AV-3 Function decomposition
Oct 16	AV-1 Personal relationship	Nov 6	AV-4 Concept generation
Oct 23	AV-2 Customer needs	Nov 13	Share concept selected

Fig 2 Chronogram of activities for international project

The project is assigned to the students in the different countries simultaneously. The design task during the Fall 2009 was the design of a collapsible and portable housing for refugees. The desired solution was expected to be inexpensive, safe, durable and able to protect the occupants against inclement weather. The housing required to accommodate minimum four people, and be able to be installed in any type of surface by no more than two people. The housing was intended to provide a safe area for the occupants to stay and sleep, and maintain the dignity of the users. Participating students are asked to understand the problem and discuss the design methodology and the scope of the project at a local level first. Then, they are asked to discuss the problem and share information with their international partners throughout the different steps of the design process to enrich the final solution of the problem. The overall design methodology used for the collaborative conceptual design project is shown in Fig. 3. This figure illustrates the local development and the international interaction among the participants.

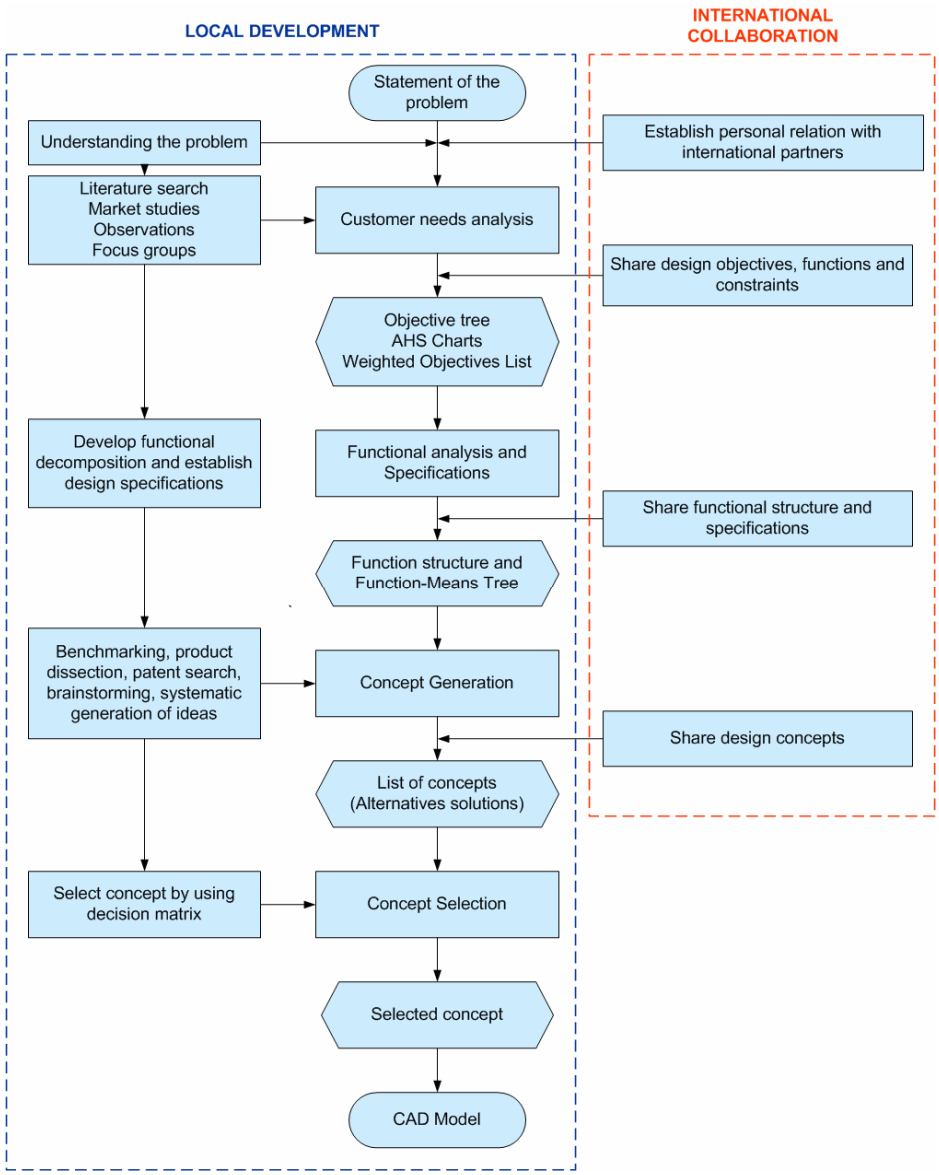

Fig. 3 Design methodology for collaborative project

Collaborative Tools

The establishment of global collaborative projects has brought the necessity of using effective tools for communication. During those projects, students are asked to work collaboratively with partners geographically disperse synchronously and asynchronously. The first collaborative tools used on these projects were MS Messenger and Skype for audio conference and chatting during the synchronous meetings for communication and the Penn State course management system for sharing and saving files. However, there were many problems during the audio-video conferences using Messenger and Skype. The communication interrupted frequently, the quality of the voice and video was very poor, and there was no easy access to technical support for those tools. Students complained frequently about the tools and most of the time reserved for the virtual meetings was spent trying to get the tools working. Since those communication tools were not reliable, they were replaced by Adobe Acrobat Connect which is a web conferencing tool. This tool provides voice and video capabilities, more security, private meeting rooms for the teams, and technical support from Penn State. Besides that, it offers more features since students can share files and other applications synchronously. The downside of this tool is that is hosted by Penn State and other users have to register to obtain a user id and password from Penn State, and only the Penn State instructor can create the meeting rooms and open them to other users which limits the flexibility required by the teams participating in the project.

Another problem emerging from this collaboration is the repository of the shared work. The documentation of the project is critical and the contribution of each team member is important and needs to be tracked. This new development brought another challenge to the whole collaboration. The next question was: what is the best and most effective way to document the project, track its progress, and determine individual contributions? This question made the instructors to start looking for other collaborative instruments that can be incorporated into the project and the learning experience. The first attempt was to use Google Documents. This is a free application where users can work simultaneously on the same document and save it in a virtual server that can be accessed by all the users invited to share the document. This tool provides great benefits since the document can be tracked in history and the individual contributions can be easily assessed. However, this was a great repository for files but this application is limited to asynchronous collaboration.

The instructors looked for cloud computing applications that were accessible to the teams and that have the capabilities of integrating multiple applications under the same working platform for distance collaboration. The instructors decided to introduce Collaber into the projects. This is a collaborative tool that allows user to communicate online and offline. It has the advantage of integrate project management activities such as calendar, assign tasks, create events and database, and share folders and files, with communication capabilities such as discussion forums, blogs, chat session and e-mail; however, this platform does not have capabilities for audio-video meetings. This virtual office can be accessed online from any computer connected to Internet which provides a lot of flexibility. Some of the main functions of the tools that were used in the pilot program with the students are shown in Fig. 4.

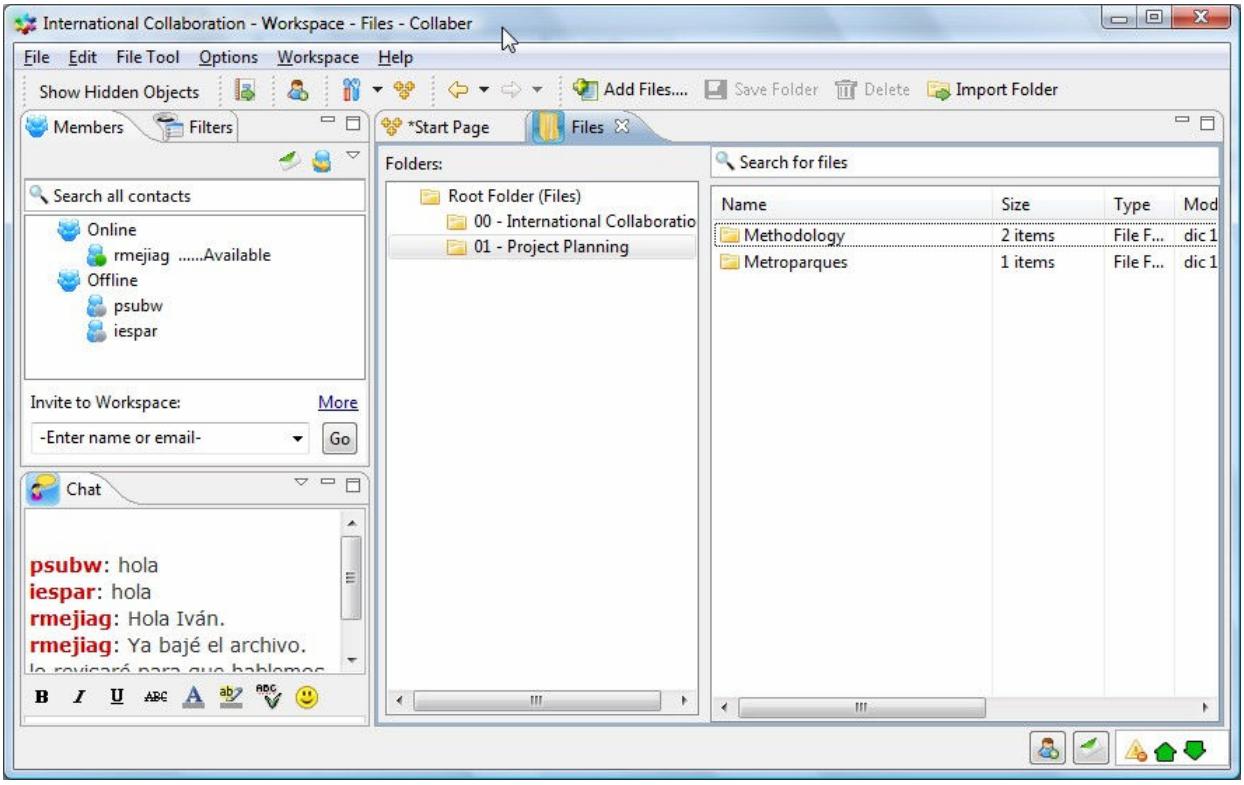

Fig. 4 Collaber working environment

Managing the Project

There are many activities that have to be planned and coordinated in the development of this type of international collaboration. During the planning process all the tasks must be scheduled and the necessary resources determined. During the project execution, it is important to coordinate and facilitate the interaction between the teams and establish contingency plans in the case of inevitable events mainly when technology problems arise.

Some of the most significant issues that have to be taken into account in the project planning include: conciliate academic calendar since not all the institutions have the same calendar for the semester; coordinate time zones since the collaboration is among institutions in different time zones, and follow different daylight saving time patron; select the course and students at each institution since not all of the institutions have a courses devoted just to engineering design; and establish language requirements although English has been used as the standard language for the collaboration.

The use of this online instrument facilitates many of the tasks described here since all participants have access to the project management tools. For example, the calendar makes easy to assign activities to the project and coordinate meetings based on the availability of the participants. Another great feature is the task assignments. The project manger can assign tasks to any member of the team and keep track of them using the tool. This helps to monitor the progress of the project. The file share pod does not offer the same flexibility as Google documents since this feature does not allow you to have a live document; however, it is a great

repository and also tracks the history of a document and the contribution of individual participants.

The use of these tools gives the students a new perspective and a new meaning for the interaction online. They have found web conferencing and online project management tools very valuable means for collaboration with partners abroad. Besides that, students have started recognizing and understanding the collaborative tendency in the corporate world where employees interact with co-workers and partners geographically distributed around the world.

Opportunities and Pitfalls

Difficulties are anticipated in using online tools for joint international projects and most of them are of technical nature. On one hand, there are challenges in setting and using project management collaboration software, but on the other hand these collaborative instruments offer many opportunities for myriad applications including education, research, and business. These contemporary gadgets are here to stay and are now widely used by educational institutions, the industry, and the government to carry our multiple tasks inherent to each group.

Some of the most notorious difficulties identified while using Collaber for the multinational projects and the actions taken to minimize their impact are summarized here:

- Accessibility: Many problems for the students setting the free accounts.
  - Solution: Faculty leader contacted directly the Collaber support team and worked with them in fixing this problem.
- Familiarity: Students had a reasonable knowledge of free software available for online communication such as MS Messenger, or Skype but very little knowledge of Collaber. Much time was spent by the student discovering all the features of the software before they could start using it.
  - Solution: No formal training for this tool was provided and the introduction was very basic. Faculty assumed students can become easily familiarized with this tools based on their knowledge using other computer applications. Therefore, more training is required for the students before using the tool.
- Technical Support: Very slow response from the technical support team of Collaber.
  - Solution: Faculty contacted the support team and worked with them in fixing some issues.
- Reliability: There were a lot of problems probably for using the tool for the first time. The online version was in the Beta testing version and was very unstable. The downloaded, desktop version was a much better tool.
  - Solution: Students were advised to use the download version instead of the online. The Collaber development team should provide a robust online version of the tool. The collaborating team might consider trying another project management tool that provides better online solution.

However, the proper use of this tool provides great benefits and opportunities for distance collaboration. Some of the most notorious benefits and opportunities are summarized below:

- Integration: Several applications under on single software.
- Repository: A virtual repository for files and work that can be easily accessed online.

- Security and Privacy: Access only by a given account and to the working spaces authorized.
- Professional environment: Collaber provides a very professional environment for the interaction providing a realistic and mature work setting for distance collaboration.

Conclusions

One of the great advantages of Collaber as tested in the collaborative design project is the ability to integrate project management and communication tools under one simple application. Its virtual repository is a great means to store and access information about the project over the Internet. It is evident that the product described here makes a tremendous contribution to the establishment and execution of international collaboration. Since this instrument does not have audio-video conference capabilities, Adobe Acrobat Connect is also used in the collaborative projects for the video conference meetings scheduled during the project.

Products like Collaber are bringing a set of collaborative tools and functionality to education that just a few years ago were only available to the business market. One goal of the global design projects is that the students have a positive learning experience using online collaborative tools so that, once they are in the professional world, they can make intelligent decisions as to which tools would be needed to best collaborate in a virtual environment.

In this kind of collaborative projects there will always be a combination of formal tools (e.g., Collaber, Adobe Acrobat Connect, etc.) and informal tools (e.g., MSN Messenger, Google docs, Skype, etc.). Students, by nature, tend to ignore formal tools as they presume they are more complicated and also because they feel more comfortable using the friendly tools they are used to employ in their personal life. However, the transit from one to the other will be possible by showing the students the real benefits of using formal tools.

The effectiveness of Collaber, for example, or a similar tool in a class project depends on the reliability of the instrument and the proper training given to the students. Most of the students feel more comfortable using Google docs, social online groups, and other online communication and application tools than using a project management collaboration platform. Breaking students' resistance to explore new distance collaboration instruments is a challenge. The new application must be appealing, useful and reliable, and it must be well explained to gain students' attention.

As a future work, the tool PROCEMM (http://www.plastia.com/products/collaboration) has been also acquired by the collaborating team. This tool will be used for the collaborative projects starting in the fall 2010 with the purpose of comparing functionalities with those of Collaber and evaluating its features to determine which instrument offers more benefits for the students and the projects.

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