Student Team Formation, Management, and Collaboration in PACE Global SUT Project

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Abstract

The General Motors (GM) Company and several of its major partners have set up a consortium called PACE to involve students from several countries in a collaborative design process for vehicles of the future. In this article, we describe the activities of the PACE Global Team 2 on the 2010-2012 sustainable urban transport (SUT) Global Project. Students from six universities in four countries worked closely together and designed a production ready SUT. The PACE Program provided a broad outline for the SUT project at the beginning of the project. Each team was charged to define the specifications for their own project that is compatible to the guidelines set by the PACE Program.

The biggest challenge was in forming a team across various time zones at the beginning of a project. We managed our large team (29 undergraduate students and 5 faculty members) quite successfully using the SMART - Specific, Measurable, Attainable, Realistic, and Timely- methodology of George T. Doran to evaluate our strategic plans and project milestones.

We divided our team into eight groups comprising 4-5 members, having at least one industrial design and one industrial engineering student in each group. We elected a group leader for each development area to help stay focused on the goals. Every two months, each group exchanged results and provided feedback to each other. We set a deadline for each task to enable continuous progress on the project. We used a hypothesis-analysis-feedback process to design the final product. To create a well-designed SUT, six elements were required: Innovative features, Performance, Safety, Market, Plant, Cost.

We communicated using six channels including e-mail, blog, Google Docs, Adobe web conference, social networking system (SNS), and cloud computing. We arranged regular meetings and communicated steadily, using these channels to share ideas and developments in the project. By participating in this project, students learned the process of creating a brand new car constrained to work in a complicated environment. Students also learned how to collaborate with their peers from a different cultural environment residing in different time zones.

Introduction

Universities have the responsibility to educate their engineering students in such a way that they are able to provide effective and responsible solutions to human-social-environmental needs as an individual as well as a member of a team after graduation with a BS degree in engineering. Engineering capstone design projects are typically taught by forming a team of several students from the same discipline. However, it is not enough to make them competent workers in today's global market or to act as a better workforce. Universities need to prepare students to be able to work in a diversified environment so that they can interact in teams with members of different backgrounds. Universities and industry must work together to identify and eliminate barriers to effective teaming and communication[1]. Universities can accomplish this task through a partnership with industry as well as through collaboration with students and faculty members from other universities, both in the US and around the world. This will also fulfill several student outcomes of US ABET engineering accreditation criterion 3 as provided below[2].

- *c.* an ability to design a system, component, or process to meet desired needs.
- *d.* an ability to function on multi-disciplinary teams.
- *f.* an understanding of professional and ethical responsibility.
- *g.* an ability to communicate effectively.
- *h.* the broad education necessary to understand the impact of engineering solutions in a global and societal context.

It has been reported that students learn material better when learning takes place in a team context[3]. Team-based learning facilitates the students to build team working skills, enhance communication skills, and develop positive interdependence and accountability[4]. Students also learn the social benefits from working in a group[5-6]. Most of the studies on team-based learning found in the open literature are related to in a classroom-setting or in a multi-disciplinary team environment within a single university.

Persistent globalization is happening throughout the world especially in the area of product development and marketing. This globalization is reshaping and redefining the world due to its nature of integrating cultures, societies, and economies[7-11]. Corporations are consistently exploiting their intercultural teams to meet the rising challenges and opportunities of operating on a global scale all over the world[12]. Hence, cross-cultural and remote collaboration in design learning is increasingly becoming important for students to become competitive in the global market[13]. Similarly, scholars from the academia are following these trends in the traditional university educational curricula recognizing the importance of globalization[14-16]. Therefore, faculty members are trying to prepare students for the global market providing them not only with product design skills but also with skills for intercultural communication and distributed collaboration[17-18]. Global virtual team-based programs might be scalable programs that can provide students with international and intercultural experiences. Collaborative global teaming projects are less costly for the college as well as for students compared to sending students and faculty overseas. In addition, more students can be accommodated through this method than through many of the other program types[19]. However, very little is documented on virtual global team-based learning challenges and effectiveness in furthering education of engineering students.

Global team design projects take advantage of modern communication technologies to enable students to participate in common design projects with students at other universities. These programs can be small, consisting of only a few students at a couple of universities, to large-scale projects coordinated through multiple universities. Through collaborative global teaming projects, students have the opportunity to interact with students from another country and culture. Depending on the program, students may or may not have the opportunity to meet face to face with their peers at other participating universities. Examples of this type of program include Partners for the Advancement of Collaborative Engineering (PACE) sponsored projects[19].

As technology opens borders, educational and professional exchange opens minds. In essence, peace and prosperity around the world depend on increasing the capacity of people to think and work on a global and intercultural basis[20]. This paper describes issues and challenges experienced by the team, necessary initiatives to overcome the challenges, and success in the global team design project in a virtual environment in terms of various time zones, languages, and cultures while collaborating and working towards a common goal.

Background of PACE organization and purpose

PACE links GM, Autodesk, HP, Oracle, and Siemens as its partners, and 3DCONNEXION, Altair, ANSYS, CD-adapco, CEI, DCS, DS SIMULIA, dSPACE, GAMMA Technologies, LSTC, MathWorks, MSC Software, RTT, STRATASYS, TRUBIQUITY, and Wacom as its contributors in its global operations to support strategically selected academic institutions worldwide to develop the automotive product lifecycle management (PLM) team of the future. PLM is an integrated parametric-based approach to all aspects of a product's life-from its design inception through its manufacture, marketing, distribution and maintenance, and finally into recycling and disposal[21].

PACE strives to educate and inspire students on the necessity of global collaboration and to foster awareness of current social and economic pressures. In keeping with these objectives, the PACE Global Leadership Committee (comprising of members from GM, Autodesk, HP, Oracle, and Siemens) defines a product development project each year by providing an industry-like collaborative project experience[22].

The PACE projects enable students to work in distributed virtual teams, advance their project planning and execution skills, and experience the same challenges that industrial designers, product engineers, and manufacturing engineers encounter in industry. By engaging students in collaborative activities, the projects also stimulate innovation[22]. Students get the opportunity to work with people from other disciplines and present their projects to industry representatives. They also benefit from being exposed to industry work practices prior to entering the workforce.

PACE is currently focusing on the following engineering work practice:

- Planning - concept development
- Styling - conceptualization
- Product engineering - detailed engineering design
- Simulation - validation, optimization
- Manufacturing engineering - tooling, machining, 3D plant layout
- Managed development environment - product data management, supply chain collaboration, digital collaboration)

These work practices are communicated to students through the generous help of PACE partners, contributors, and supporters who provide computer hardware and software, automotive parts, industry projects as well as industrial training to PACE institutions around the world.

Background of SUT project

By 2030, urban areas will be the home for more than 60% of the world's 8 billion people. Figure 1 shows the projected world population. This will create tremendous pressures in the form of

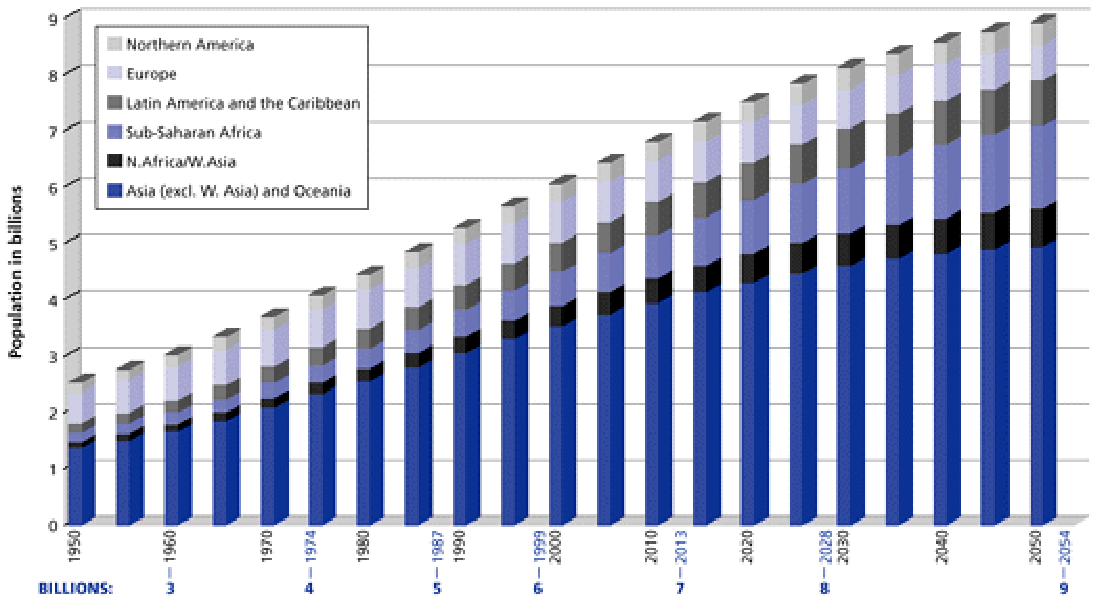


Figure 1: Projected World Population Growth[23]

pollution, congestion, energy security, and traffic safety. This will also challenge a public infrastructure that is already struggling to meet the growing demand for transportation and basic services. The megacities will be so dense that the space for the traditional car will rapidly decline. With population increases, global warming, depletion of natural resources, and vastly improved connected networks, the transportation and automotive industries are currently seeking solutions to these challenges by considering alternative modes of mobility[23-24].

The PACE global team (composed of GM, Autodesk, HP, Oracle, Siemens, University of Cincinnati, and University of Sao Paulo) announced the 2010-2012 PACE Sustainable Urban Transport (SUT) project with the theme "Facing Global Challenges-Solutions for the Future" in the 2010 PACE Annual Forum in Seoul, Korea. This project addresses the future of urban transportation and encourages students to design and engineer an SUT solution for a specific urban area.

Sustainable mobility refers to any means of transport with low impact on the environment that includes using some combination of walking, cycling, and green vehicles that are fuel-efficient and space-saving. This requires development of new transit oriented systems infrastructure. Thus, sustainable transport systems make a positive contribution to the environmental, social and economic sustainability of the communities they serve. In essence, development of SUT will meet the needs of the present without compromising the ability of future generations to meet their own needs[25].

The thrust of the SUT design process is summarized below:

- Identify student teams at partner universities
- Engage in team building activity to foster collaboration
- Research the location and transportation needs
- Brainstorm solutions with design and engineering teams together
- Decide on alternative SUT concept proposals
- Select a single personal urban mobility solution
- Define the mechanical, electrical, and controls requirements for the selected concept-vehicle technical specification (VTS)
- Define the environment or infrastructure to support the selected personal urban mobility solution

Formation of Team 2: members, roles, timing

More than 80 engineering and industrial design students from 28 PACE Institutions undertook the project in the 2010-2011 academic year, forming seven teams. Each team was composed of at least one industrial design institution and a maximum of four engineering institutions. Each team targeted a specific urban area and developed a sustainable transport solution customized for that city. The urban areas selected reflect the geographically diverse nature of the teams: Ahmadabad (India), Seoul (Korea), Shanghai (China), Monterrey (Mexico), and Cincinnati (USA). Each team was responsible for its own team organization, project management, interim deliverables and timeline, communications, and team-building activities. The Global Judging Team (comprising members from GM, University of Cincinnati, and University of Sao Paulo) defined the project deliverables. The judging criteria involved four areas: 1) market research, 2) design, 3) engineering, and 4) manufacturing.

Our team was Team 2, composed of teams from Inha University-Engineering (South Korea), Monash University-Industrial Design (Australia), Northwestern University-Engineering (USA), Hongik University- Industrial Design and Engineering (South Korea), and Tuskegee University-Engineering (USA). Each group had at least one industrial design and one industrial engineering student. Our industry, design, and engineering mentors were selected from GM-Korea, University of Cincinnati, and University of Sao Paulo, respectively. Our targeted city was Seoul, Korea. Seoul was chosen as a target city because it has the features of a megacity. Moreover, Seoul is expected to install electrical charging infrastructure systems in the near future. Existence of wide electrical charging infrastructure is the core requirement for extensive public use of electric cars. Currently, driving low-speed electric cars is permitted on the roads in Seoul. However, there is no standard for batteries or chargers.

Initial approach to collaboration

The initial approach to collaboration is presented in Table 1. It was developed with suggestions from the PACE Global Leadership Team as well as the PACE Global Team. However, it was soon determined that this communication format needs to be changed.

Table 1: Initial Approach to Collaboration

Method of Collaboration	Interval	Responsible Team	Target Customer	Purpose
PACE Webinar	3 times per project year: kick-off, midterm, and final	PACE Global Leadership Team	Students and Faculty	Discuss overall objectives, review each team's presentation, provide critical review and feedback, and guide each team in the right direction.
Conference Call	Bi-Weekly	PACE Global Engineering and Design Team	Students	Review team progress and provide feedback to the team for better team formation, management, and collaboration.
Conference Call	Weekly	Student Team and Faculty	Students	Discuss project update among each members of the team.
Conference Call	Weekly	Industry mentor	Students	Discuss project updates, answer questions, give general guidance to the students related to design and engineering.
Conference Call	Weekly	Team Faculty Members	Students	Provide leadership to students and teams, create project timelines, and collect presentation materials related to the project.
Conference Call	Weekly	Student team leaders	GM mentor and students	Collect questions and concerns from the team and report to the GM mentor. Report back to the team to provide overall guidance to the team.
E-mail	Whenever needed	Student Team and Faculty	Student Team and Faculty	Students and professors discuss ideas, questions, answers, comments, meeting schedules, design updates, analysis, and progress report

Issues/challenges with the initial approach (First Year)

Four universities (Tuskegee, Hongik, Inha, and Monash) use the semester system and Northwestern University uses a quarter system. Even for schools using a semester system, the timings are different. For example, spring semester starts in the first week of January at Tuskegee University while it starts in the last week of February at Hongik University. Hence, it was nearly impossible to collaborate with all team members on a weekly basis.

Moreover, it was difficult to find a common time to hold conference calls or web meetings since our universities are located in three subcontinents spanning widely different time zones. There were very few options for a conference call that did not take place between 11:00 pm and 5:00 am for at least one team. Therefore, collaboration through conference calls was not realistic and students lost valuable time without any significant outcome in the project. E-mails were found to be not a realistic substitute for conference calls because students do not check e-mails regularly. Also, large data files needed to be transferred among teams and e-mails were not an appropriate medium for transferring very large files. In one of the meetings, it was suggested that communication via blogs might overcome the deficiencies inherent in communications via conference calls and e-mails. Blogs enable students to share text, information, data, images, or video with their peers through the internet[26-27].

Solution of communication problems

In January 2011, one student from Monash Univesity started a blog[28] and it was through this blog that most of our team communication was accomplished successfully. Following the creation of the blog, Team 2 worked hard to gain ground on the lost time. During this period, market assessment, product alternatives, engineering analyses, manufacturing assessment, non-functional scale models, and the proposed SUT product was developed. Although the use of the blog enabled us to communicate well, it was found that many postings on the blog were somewhat disconnected from the issues at hand. Hence, we did not want to rely on only a single source of communication tool. We discussed various methods of communication that can be used to improve communication than could be done by the use of blog alone. We decided to explore Google Docs, Web conference, Social Network System (SNS), and Cloud computing as additional methods of communication.

Changes made to project management in second year

All teams presented their project work at the 2011 PACE Annual Forum in Vancouver, Canada. Our team was awarded the third and second prize in the market research and design, respectively. More importantly, faculty members and many students had the opportunity to have the first face-to-face meeting at this conference to get to know each other and to plan work schedules for the second year.

During our conversations at Vancouver it was realized that a stronger project management was needed as we began the second year of the project. Our goal was to rank first in at least one category in the next PACE Annual Forum competition. At this time, Aachen University from Germany requested to join our team. Also, Monash University was no longer in our team since the industrial design was finalized during the first year and the focus of the team from Monash University was industrial design. Hence, we had to accommodate some changes in our team structure. Moreover, we had to incorporate the comments made by the judges to improve our project. The judges provided scores on engineering components of our project in a 0 to 5 scale and on manufacturing components in a 0 to 3.5 scale. The engineering components were judged on innovation, vehicle technical specifications (VTS), computer-aided design (CAD) models, computer-aided engineering (CAE) analyses, non-functional physical scale model, team collaboration, and project management. The manufacturing components were judged on affordability, manufacturing analysis, CAD model, business plan, safety, physical scale model, and team collaboration. We converted these scores on radar charts for easy visualization. The charts also included minimum and maximum scores obtained by other teams for comparison purposes. These charts are presented in Figures 2 and 3, respectively.

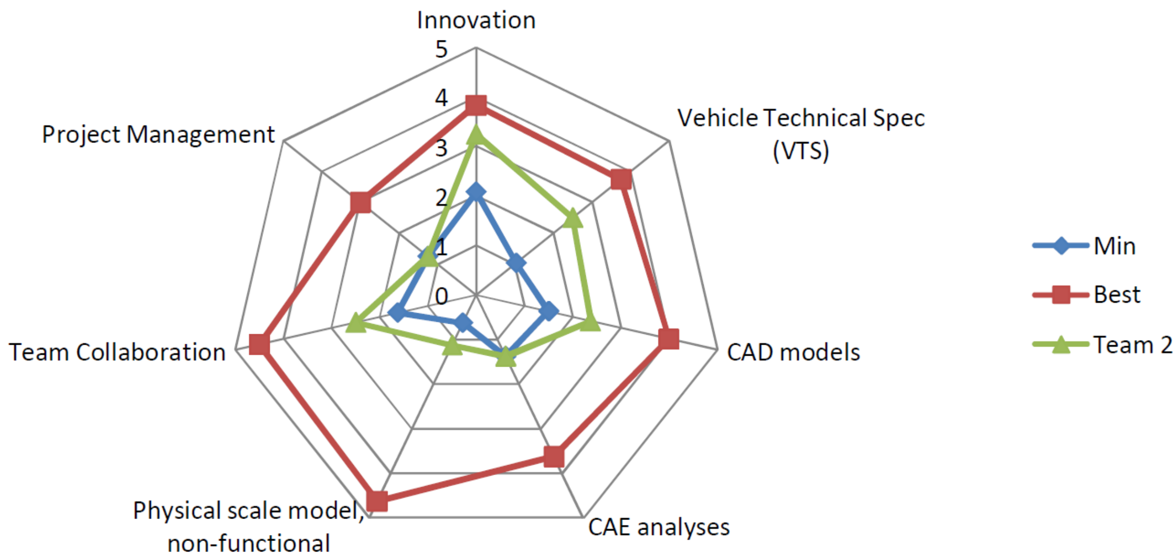


Figure 2: Radar Chart of Team 2's Engineering Points

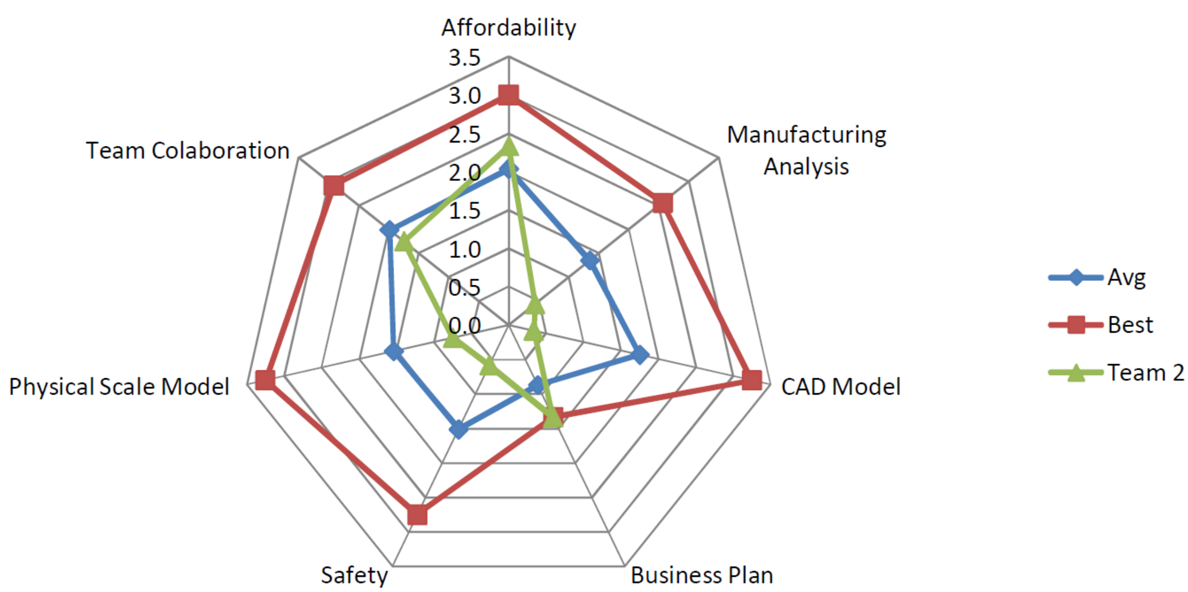


Figure 3: Radar Chart of Team 2's Manufacturing Points

Students sorted the components of the project to develop the SUT working breakdown structure and organize the work for the second year. This is presented in Figure 4.

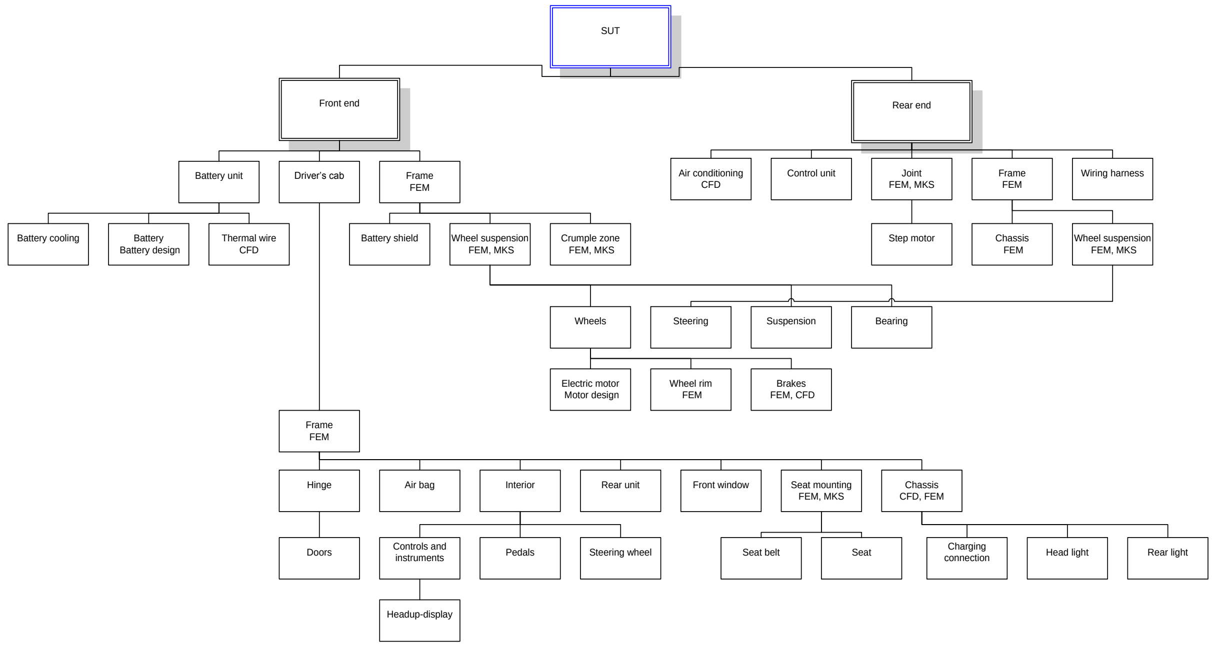


Figure 4: SUT Working Breakdown Structure

Students followed the SMART (Specific, Measurable, Attainable, Realistic, and Timely) methodology of George T. Doran[29] to manage our tasks successfully. The necessary steps taken to manage the project are given below:

Management

Specific: We established the need for a specific goal over a more general one. The goal of the second year project was to establish specifications for each component of the SUT shown in Figure 4.

Measurable: We decided to measure the following processes that comprise the project.

1. The groups exchanged mid-term results every two months and feedback was provided.
2. We went through three processes: Hypothesis-Analysis-Feedback.
3. Six communication channels were used for collaboration. These were: E-mail, Blog, Google Docs, Web conference, Social Network System (SNS), and Cloud computing.
4. Six elements were required to complete the project. These were: Innovative features, Performance, Safety, Market, Plant, and Cost.

Assignable: Each group worked on more than one component to meet the project deadline. The entire team was divided into eight groups comprising 3 to 4 students each group. A team leader for each group was selected by the students of that group in consultation with the faculty member in charge of that group. The team leader was assigned the responsibility to communicate their progress with other team leaders as well as faculty members.

Realistic: Since students lack the skills required to complete all tasks, some realistic constraints were set for the project by the faculty members from the very beginning. Through team conferences, the scopes of the project were slightly adjusted every two months depending on the progress made by the students.

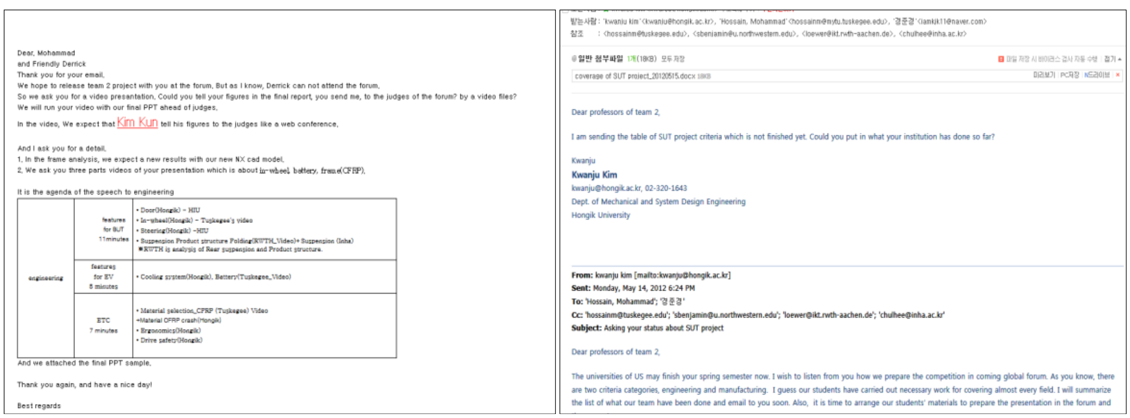
Time-bound: Students also lack the experience to realistically estimate the time needed to accomplish a task. Hence, the faculty members set a time-limit for every task. Frequent meetings were conducted to assess if the project is progressing satifactorily and in time. For example, group leaders' meetings were conducted every two weeks, individual group meetings every month, and a conference every two months.

However, in a project of this magnitude, many obstacles were encountered. Nevertheless, by using this SMART management technique, a reasonably efficient working process was established.

Collaboration

Six communication channels were used for this collaboration as described below.

1. E-mail: Students relied on e-mails for announcements, primarily from GM and the faculty members. One example of email communication is shown in Figure 5.



Dear, Mohammad
and Friendly Derrick
Thank you for your email,
We hope to release team 2 project with you at the forum, But as I know, Derrick can not attend the forum,
So we ask you for a video presentation, Could you tell your figures in the final report, you send me, to the judges of the forum? by a video files?
We will run your video with our final PPT ahead of judges,
In the video, We expect that Kim Kun tell his figures to the judges like a web conference,

And I ask you for a detail,
1, In the frame analysis, we expect a new results with our new NX cad model,
2, We ask you three parts videos of your presentation which is about in-wheel, battery, frame(CFRP),

It is the agenda of the speech to engineering

engineering	features for SUT 11minutes	• Door(Hongik) – HIU • In-wheel(Hongik) – Tuskegee's video • Steering(Hongik) –HIU • Suspension Product structure Folding(RWTH_Video)+ Suspension (Inha) ※RWTH is analysis of Rear suspension and Product structure.
	features for EV 5 minutes	• Cooling system(Hongik), Battery(Tuskegee_Video)
	ETC 7 minutes	• Material selection_CFRP (Tuskegee) Video +Material CFRP crash(Hongik) • Ergonomics(Hongik) • Drive safety(Hongik)

And we attached the final PPT sample,

Thank you again, and have a nice day!

Best regards

받는사람 : 'kwanju kim'<kwanju@hongik.ac.kr>, 'Hossain, Mohammad' <hossainm@mytu.tuskegee.edu>, '경준경'<iamkjk11@naver.com>
참조 : <hossainm@tuskegee.edu>, <sbenjamin@u.northwestern.edu>, <loewer@ikt.rwth-aachen.de>, <chulhee@inha.ac.kr>

일반 첨부파일 1개(18KB) 모두 저장
coverage of SUT project_20120515.docx 18KB
미리보기 | PC저장 | N드라이브

Dear professors of team 2,

I am sending the table of SUT project criteria which is not finished yet. Could you put in what your institution has done so far?

Kwanju
Kwanju Kim
kwanju@hongik.ac.kr, 02-320-1643
Dept. of Mechanical and System Design Engineering
Hongik University

From: kwanju kim [mailto:kwanju@hongik.ac.kr]
Sent: Monday, May 14, 2012 6:24 PM
To: 'Hossain, Mohammad'; '경준경'
Cc: 'hossainm@tuskegee.edu'; 'sbenjamin@u.northwestern.edu'; 'loewer@ikt.rwth-aachen.de'; 'chulhee@inha.ac.kr'
Subject: Asking your status about SUT project

Dear professors of team 2,

The universities of US may finish your spring semester now. I wish to listen from you how we prepare the competition in coming global forum. As you know, there are two criteria categories, engineering and manufacturing. I guess our students have carried out necessary work for covering almost every field. I will summarize the list of what our team have been done and email to you soon. Also, it is time to arrange our students' materials to prepare the presentation in the forum and

Figure 5: Collaboration through E-Mail

2. Blog: The blog was originated and maintained by one student from Monash University in Australia. An example of a collaboration using blog is shown in Figure 6.

March | 2012 | GM 2010-11 PACE Project https://gmpaceproject.wordpress.com/2012/03/

GM 2010-11 PACE Project

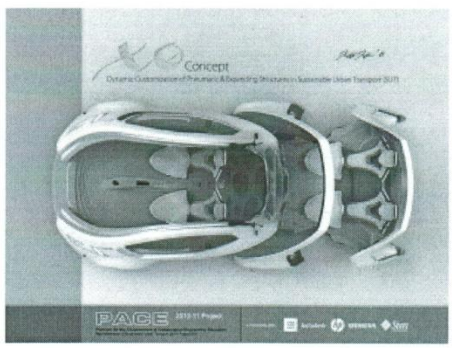
Global Team # 2 Collaboration Center

Monthly Archives: March 2012

March 27, 2012

Final Design

By Team Member



Dear All

First post after a year and a bit from the end of the project feels nice, I hope the blog was a successful tool for everyone!

I thought it would be appropriate to showcase the final design from Monash University's graduation show in late 2011. Here you can see my final outcome with more slides and images for the SUT project: http://grabcad.com/library/gm-xo-concept (http://grabcad.com/library/gm-xo-concept)

Best wishes from Melbourne
Ali (Jeff) Jafari

Leave a comment | posted in Uncategorized

1 of 2 3/14/2013 8:51 PM

Figure 6: Collaboration through Blog

3. Google Docs: Students used Google Docs to input the management documents such as Gantt chart. Samples of Google Docs used for collaboration are shown in Figure 7.

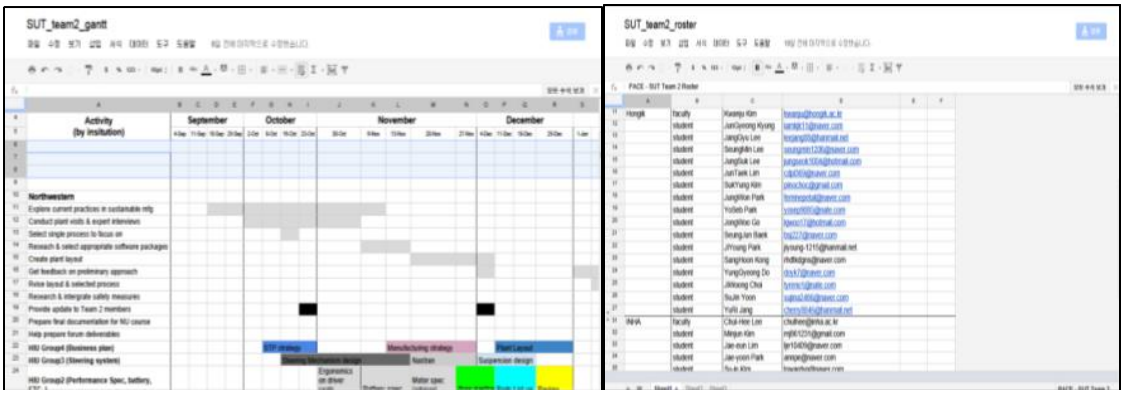


Figure 7: Collaboration through the Google Docs

4. Web conference: A web conference was held every two months to discuss the progress in the project and provide feedbacks. Aachen University managed the server. An example of collaboration via web conference is presented in Figure 8.

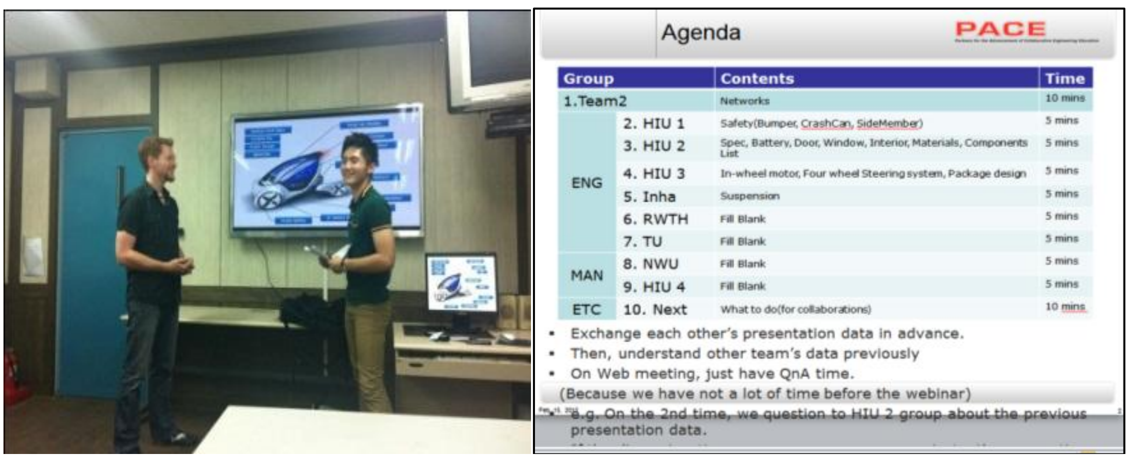


Figure 8: Collaboration through Web Conference

5. Social Networking System (SNS): For real-time communications, students used Facebook. An example of Facebook group page is shown in Figure 9.

Figure 9: Collaboration through Facebook Group Page

6. Cloud computing: Students shared an extensive amount of data through cloud computing by using a shared Dropbox. An example is given in the Figure 10.

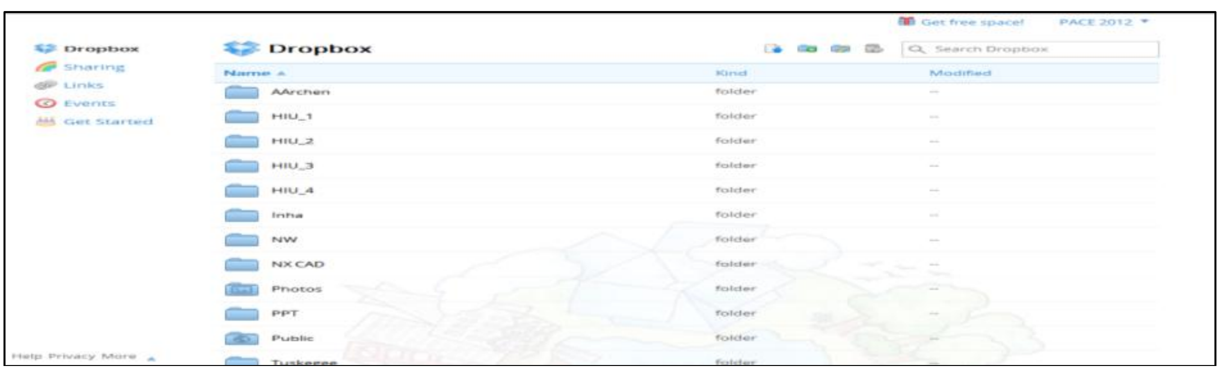


Figure 10: Cloud Compounding

Distribution of project activities

To create a well-designed SUT, six elements including Innovative features, Performance, Safety, Market, Plant, and Cost were required. We divided these elements into sub-phases and distributed them among universities is shown in Figure 11. The interaction points between the universities is presented in the Figure 12.

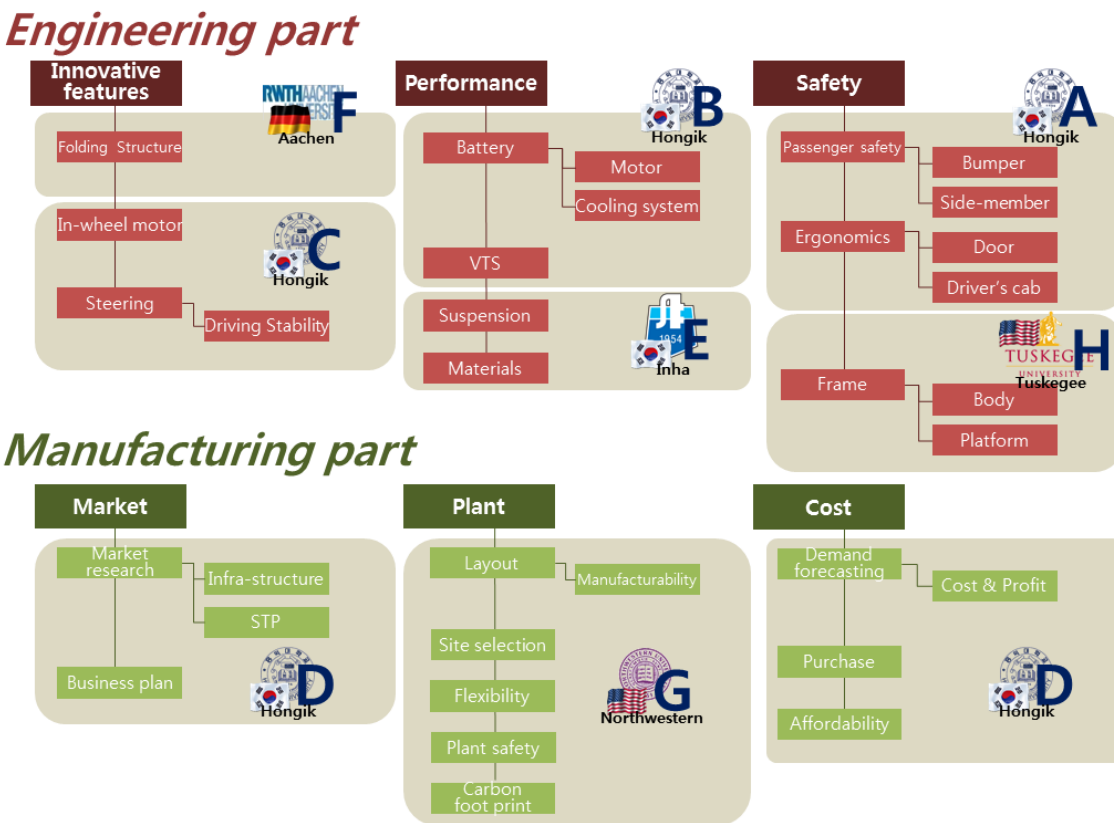


Figure 11: Distribution of SUT Six Elements among Universities

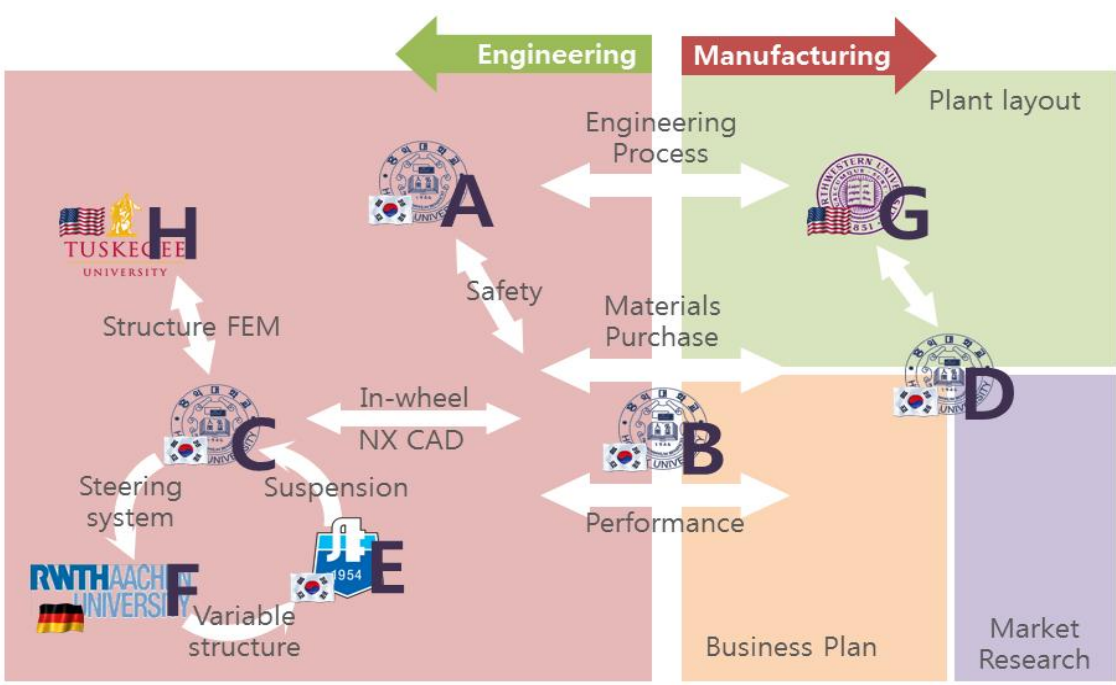


Figure 12: Working Relationship among Universities

Success and challenges in second year

By the end of the second year, we were successful in developing effective management, collaboration, and design of an SUT in a virtual global team environment. We presented the SUT design at the 2012 PACE Annual Forum at Shanghai, China. Our team was awarded the first prize for the production-ready SUT and outstanding success in collaboration[30].

Challenges in the second year were much less compared to those faced in the first year. This was primarily due to the use of multiple communication channels in the second year. Management of the project was also much easier because key faculty members were able to meet face-to-face in the PACE Annual Forum at Vancouver. In spite of these, there were minor challenges faced by the students related to semester/quarter system as well as opening and closing time conflicts among the partner universities.

Summary of lessons learned

Based on observations of the SUT team collaboration process, we identified several issues that future teams should take into consideration as they plan collaborative projects. These can be grouped into two categories: 1) establishing and maintaining communication; and 2) creating alignment on deliverables.

Establishing and maintaining communication. Getting people connected is more complicated than sharing email addresses and establishing shared file spaces. Our SUT team created an Excel spreadsheet that listed everyone by group, with e-mail addresses, and this spreadsheet was shared by e-mail. However, even after a few weeks, not everyone seemed to be receiving and responding to e-mails. During this initial period of getting connected, the students were less productive since it was difficult to know what the other teams were doing. Once the use of multiple communication channels, especially SNS, was added, collaboration improved.

An approach to try in the future would be to assign one person from each participating group to begin acting immediately as the Primary Contact in charge of connecting to the other groups. These Primary Contacts can start communicating through email to make sure that information is being shared. At the same time, they can also identify what other communication approaches will be used and set those up.

It also helps to define different collaboration channels for different tasks, to take advantage of the strengths of different tools, as well as adapt to students' work styles. The channels used by Team 2 in the second year are summarized below in Table 2.

Table 2: The channels used by Team 2 in the second year

Channel	Purpose
E-mail	Announcements from GM and faculty members
Blog	Conversations about the design
Google Docs	Management documents, such as Gantt charts
Web conference	Bi-monthly status updates
Social Networking System (SNS)	Real-time communication
Cloud computing (Dropbox)	File sharing

Creating alignment on deliverables. It is important to align the entire team as early as possible, and to encourage use of the collaboration tools. By defining a deliverable early in the process, it will encourage everyone to get to work quickly and to share that work using the collaboration tools. It also gives each group within the collaboration a chance to calibrate their work. When the groups have different backgrounds and experiences, they tend to interpret the nature of the deliverable differently. An early comparison allows the groups to come to a common understanding which will help them to be more consistent as they move through the project.

In addition, creating frequent deliverables helps to push teams to continue making progress, as they also develop a common approach to sharing their information. It is not enough to simply schedule periodic conference calls or video meetings. Each group should also prepare material to share at that meeting. The content and the format of the material should be clearly defined in advance. Identifying how and where the material should be shared before the meeting, if applicable, will also enable the team to manage the project effectively.

In the first year of the SUT project, the members of Team 2 shared their progress through the blog, but there were no formal interim deliverables prior to the final paper and presentation for the annual forum. When different groups within Team 2 began to combine their materials to create these deliverables, it took a lot of effort to create something cohesive. In the second year, we added web conferences every two months. For these conferences, the teams each created presentations to share their progress, and these were posted to Dropbox as well as shared during the web conference. This made it easier for the teams to share different formats for visualizing the information, as well benchmark their own level of contribution.

Conclusion

The process of making an automobile is, by necessity, a multi-disciplinary collaboration. Our team had members from three disciplines: mechanical engineering, industrial engineering, and industrial design. By participating in this project, students learned the process of creating a brand new car constrained to work in a complicated environment. Students also learned how to collaborate with their peers from a different cultural environment residing in different time zones.

It was observed that the SMART management technique, if applied appropriately, can be an effective management tool. In the design process, students were able to incorporate a variety of computer-aided engineering tools available through the PACE program. By working on this design project, students also learned about aspects of various manufacturing techniques associated with building an automobile.

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