

# STUDENT LED INTERNATIONAL DEVELOPMENT OF INFRASTRUCTURE FOR SENIOR DESIGN PROJECTS AT ROCHESTER INSTITUTE OF TECHNOLOGY

Student Paper  
International Collaboration

## **Abstract**

Rochester Institute of Technology (RIT) in Rochester, NY is expanding overseas to a new campus in Dubai, U.A.E. Since the campus in Dubai has a new student body, of all undergraduates, the senior design curriculum had not yet been developed. Future senior design groups will be comprised of students that are located in Dubai as well as Rochester in order to expand students' experience in a global environment. The senior design program has been well established at RIT and focuses on integrating engineering theory with practical implementation in order to successfully create an innovative solution to a customer need. RIT's overall goal in Dubai is to develop a parallel senior design curriculum by transferring the knowledge base developed in the United States to the newly formed Dubai campus. A group of six mechanical engineering seniors were selected to pioneer the first multi-national senior design project at RIT. Three of these students spent a term abroad at the new campus while participating in this collaborative project. One of the deliverables for this project was the team's insight into the problems and solutions encountered while the team was divided between the two campuses. The students were tasked to provide active technical feedback to the faculty in order to complete the project while documenting recommendations for future development of the senior design program. This paper will focus on the firsthand knowledge the six member team gained from working on a multi-national design project as well as suggestions for a successful international senior design curriculum.

## **Introduction**

Although an internationally faceted senior design project can present numerous obstacles and issues to those who undertake it, there is a plethora of opportunities for growth that can benefit the students in their professional careers. Internationally collaborating teams are becoming more prevalent as government, academic, and industrial entities develop. The need to effectively collaborate on projects over multiple time zones and national boundaries is critical for success in these projects. The skills necessary to do so are often developed over time and require several experiences for an individual to become comfortable in the dynamic setting of a multi-cultural project. The Rochester Institute of Technology is expanding globally through many outlets, including opening a new campus in Dubai. The Institute increasingly encourages students to participate in global opportunities in order to expand their perspectives and develop first-hand experience with this type of working environment.

Through exposure to these multi-national senior design groups, engineering students are able to extend the development of interpersonal, technical, and communication skills to a global arena. Senior design is a capstone class for most engineering curriculums that allows students to operate

in a team setting to develop interpersonal and communication skills. These projects require the integration of all previous engineering coursework into one complete development and analysis of a design that will fulfill a customer's needs.

RIT's undergraduate and graduate programs currently operate on a quarter system with each term approximately 11 weeks. In particular, senior design is a course that is divided between two terms with the objectives of a project separated between these terms. The first term is dedicated to planning, defining customer needs, translating them into engineering specifications, recognizing different design solutions and collectively deciding on the most appropriate design. From this the team learns to work together, the importance of proper management skills, and develops an innovative technical solution to the needs identified. In the second term the team is responsible for fabricating a prototype of the selected design. This includes CAD drawings, a complete bill of materials, manufacturing plan, testing plan, building, and testing of the prototype. Throughout both terms the teams are responsible for holding weekly meetings, holding regular presentations for the faculty guide and customer, and submitting a final technical report.

This was the first group to participate in a senior design team that was divided between nations. The team was composed of six student engineers, all of which were students from the Rochester, NY campus. Half the team studied abroad in Dubai U.A.E for the first term of this project. The members returned for the second term as the objectives could not be completed in Dubai. This allowed for the fabrication portion of the project to be completed in one location, simplifying the second half of the project greatly.

## **Project Setup and Initiation**

Given no initial information, the team was tasked to collaboratively work on Senior Design. Upon arrival, the team members in Dubai found no faculty guide, class time, outline of expectations, or support there and as a result struggled to determine what was expected from the course. The schedule on the school website still even listed TBA for the Instructor, Room, and Time. As Dubai members searched for information they found that there were no resources or infrastructure in place in Dubai to support their efforts and therefore turned to the Rochester team members as the primary source of information. Rochester members experienced standard RIT Senior Design kickoff including class time, which explained expectations and taught project management basics, and meetings with a faculty guide. They also quickly found themselves relaying all the information they received to the group members in Dubai. This was especially difficult for all members due to the nine hour time difference between the locations and communications issues. It was immediately evident to all members that more than email communication was required to meet the demands of the project. Addressing this need a time was allotted for weekly Skype meetings which allowed the group to communicate more effectively and update all members. This in itself was a challenge due to technical limitations in Dubai, time difference, and student schedules which resulted in the Rochester members waking up for 6am meetings each week. In addition to communication and support gaps Dubai members were also tasked with identifying or creating an infrastructure of vendor network, tools, hardware to support fabrication of future projects in Dubai. Members in both countries worked through the initial challenges to create open communications in the group, initiate communications with

faculty in both Dubai and Rochester, and create necessary infrastructure and procedures necessary for the project.

## **Technical Challenges**

The project was conducted using multiple independent technologies over the internet, rather than packages developed for international projects or telephones. It was decided early on that international phone calls and satellite meeting packages were prohibitively expensive in Dubai. Cost for satellite meetings were in the range of 1000 USD an hour and traditional internet meeting software packages are blocked by the government. Nearly the same functionality as the unfeasible commercial packages, apart from the internet speed, could be assembled from freeware. This required a combination of multiple programs; the methods used were Skype, E-mail, Google Documents, and Tortoise SVN.

Through the duration of the international collaboration, two hour Skype meetings were held once a week as well as two design reviews. This software proved invaluable to the project, yet it is actually banned in the U.A.E., which heavily regulates its internet use. Skype could only be downloaded before entering the country or through a virtual private network. The internet speed and quality was the most detrimental factor in our operations and often cut into the limited time for Skype meetings and sometimes even brought them to a premature close. The internet quality in the off campus housing was insufficient for the load put on it making it unreliable and limiting meetings to Campus locations. As a result meetings could only be held Monday through Wednesday from 8am to 6pm Dubai time, which translated to 11pm to 9am Eastern Time. The other collaboration methods required less bandwidth therefore were less affected by slow internet. There were, however fundamental problems relating to the time difference that impaired communication. E-mails and tasks usually took overnight due to the difference in working hours. Google documents was used as a primary format for collaborative documents until the project required more complicated file formats, such as cad drawings and Matlab models. These were shared infallibly with tortoise SVN over the project website. Overall communication proved critical to project success as the team moved from stage to stage in the design process.

The new campus in Dubai was not prepared for students above 2<sup>nd</sup> year and therefore did not possess some of the resources taken for granted at the main campus. Despite already having undergraduate students for a term and graduate students for even longer, a library had not been established, there were no machining capabilities, and there were only two mechanical engineering professors. Machining capabilities were not an issue for the first term of the project involving the system design but would be prohibitive if the project continued into the build phase. The lack of physical resources necessary for system design was compensated for by using available resources, primarily faculty. One of the resident faculty was an expert in solar thermal energy collection and became a very valuable resource.

The software packages available in Dubai were limited and geared toward lower level engineering courses. The Dubai campus lacked several of the leading engineering software packages such as Matlab, SolidWorks, and ANSYS (or any finite element analysis software). The software packages available were not applicable to the project and thus limited the work that could be completed by team members in Dubai. The only resource available to Dubai members

were the programs that one of the members had on his personal computer. This resulted in an imbalance between the two parts of the group with regards to the ability to complete technical work.

## **Logistical and Cultural Challenges**

Beginning an engineering project requires brainstorming design prototypes and supporting these design considerations with theoretical calculations. The success of this design and producing acceptable theoretical results both rely on units of measurement. Examples of unit conversion errors are prevalent and the results can be disastrous. It is important to note that in the United Arab Emirates the dominant unit of measurement is SI units whereas the United States prefers English units. The fact that both countries use a different measurement system is not an issue as long as there is a consensus among the group as to what unit of measure to use. Addressing this difference early in the project of time eliminated confusion and potential issues.

In the design and build of the project it is important that the prototype correlates closely with the drawings and that the experimental results are within reason of your expected theoretical results. In the United States it is a fairly simple task to contact distributors about a part but this practice is rarely done in Dubai. There is little interaction between distributors and consumers because contractors are usually hired for all projects. As a result local hardware stores such as ACE have a limited stock of supplies. Acquiring goods from outside the country is also challenging because U.A.E. has no standard address system and the government has significant regulations. Obtaining materials needed for the second term of Senior Design will be difficult task.

Cultural differences and logistics presented many additional challenges. Coping with a limited bus schedule to campus proved very challenging for the students studying abroad. Taxis were expensive but flexible and therefore did not yield a feasible solution. Gender issues were also encountered as male team members could not be on a female team member's floor, making impromptu meetings difficult at times for the international students.

## **Benefits on Multi-National Student Project**

It is inevitable that as companies send their employees to new locations around the world for work assignments there will be a period of culture shock that these employees will encounter. The RIT students who studied abroad in Dubai were no exception. In order to have a successful senior design project, they had to overcome their differences with the Dubai culture and effectively adapt to their new environment. While RIT students were submerged in Dubai culture they maintained blogs in order to document their experiences. These experiences will be an invaluable asset to their respective companies moving forward.

The infrastructure of a particular company can present numerous challenges to an international project. The RIT students discovered that they were not able to do certain tasks with ease as would have been the case in United States. They quickly developed a very self-sustaining approach; seeking information and solutions from people familiar with Dubai. As with any project, time was a crucial factor in senior design. The RIT students adapted to the guidelines of Dubai government, security, economy, geography, and other legalities by seeking dynamic

solutions. The skill of being agile in a new setting will prove indispensable as they work in United States or abroad.

International projects bring uncertainty and risk, and often times the risks cannot always be foreseen. Therefore, these projects require members to continuously work on overcoming obstacles encountered along the way. Group members quickly adapted a logbook of issues they encountered, and documented the different approaches to solving each issue. The ongoing solution seeking method proved very efficient in solving the majority of problems. International projects can present similar categories of issues, but the solutions may vary from one region to the next. RIT students learned that it often takes multiple attempts to solve a particular issue when working in an international setting. More importantly, they saw the importance of documenting these issues and attempted solutions. As companies further pursue international projects, they will need individuals who are able to convey the issues they encountered and subsequently document them for future project teams to use as their base foundation.

## **Faculty Perspective**

As a member of the faculty team teaching Multifunctional Senior Design at RIT, I provided guidance to the first multinational team which was divided to be located both at the Rochester and Dubai, UAE campuses. Their project is focused on the sustainable desalinization of water intended to serve a global market of customers who do not have an adequate supply of potable water. A second goal of the team was to establish a working relationship with remote members who had first hand access to foreign conditions and potential customers but were also half a world away. The Dubai team explored the existing desalinization methods, available material and informational resources, logistics and cultural limitations associated with the project but also the day to day coping tactics such as eating, transportation, and communication. They generated a set of guidelines for US born students to function in Dubai and more specific to this project, they assembled a list of contacts, specific data about water quality and availability and solar energy in Dubai. The entire team developed protocols to accommodate the nine hour time difference and they began the development of formal collaborative working processes for video conferencing, documentation control, assignment distribution, etc.

This team is an extraordinary group of students. All of them are high performers but with different personalities, strengths and weaknesses. Their cooperative nature allowed the team members to push each other, consider more options, apply more analysis, and still maintain discipline to their work process and plan. This enabled them to really explore the multinational opportunities, constraints and working options to accomplish their objectives and establish a strong beach head on which future teams can build. It has been a very rewarding experience to work with them.

-Gerald Garavuso, Faculty Guide

## **Important Considerations for Future Recommendations**

The overarching goal of this group is to develop an outline of recommendations for future teams to improve the probability of success in similar environments. Both teams encountered issues that had immediate solutions, if previous knowledge of the problem had been public knowledge. Based on experience from group dynamics, each team subset should have at least one individual with some familiarity in project management. This will ease communication, assist with scheduling, and cut down inter-team dependency on the strengths of one of the team subset to manage the logistics and scheduling.

From a technical perspective, the team needs to understand what hardware and software tools will be available to them. An in-depth discussion before departure is highly recommended to understand the capabilities of each team subset. This information is critical in determining the goals for each team subset, what review gates/checkpoints each team member is responsible for, and the efficiency of the group as a whole.

From a students' perspective, the team needs to have experienced guides available to facilitate the process. The design implementation process is unique to most students at this point in their academic career. The practical implementation of a technical idea on a large scale has not been accomplished in most cases. It is highly advisable for a faculty guide to be available to both domestic and international teams, no matter their country of original origin, in order for an effective learning experience to take place. Frustration is part of the learning experience, but too much poorly affects the team chemistry and overall team goals. An experienced mentor who understands the modes of team building, the technical design process, and the components of an effective team will contribute greatly to a positive learning experience.

From a logistical perspective, issues are much less related to the overall design process, but rather more directly to the impedance of an effective working atmosphere. Learning bus schedules, securing transportation, gender specific areas, and adjusting to a new academic environment all play a part in decreasing the effectiveness of the technical design process. Unarguably, the team is developing culturally and individually through these tribulations, but difficulties when working internationally do not encourage effective teamwork. To counteract this, the team needs to be realistic about setting meetings, be prepared to sacrifice when necessary with respect to project scope, and also be as prepared as possible before voyaging abroad. The following is an example of architecture developed to categorize issues for future students.

**Table 1: Documented Issues and Solutions during Multi-National Senior Design Project**

<b>Issue</b>	<b>Solution</b>
Confusion about MSD, expectations, class instruction and location	Pre-departure meeting with all group members, guide and customer
Difficulty finding rooms for weekly meetings between Rochester and Dubai	Get appropriate room and reserve for the quarter
Free communication software not available to download in the UAE	Make sure that software is downloaded in the US
Uncertainty sharing documents	Google docs for working documents Tortoise SVN for other files, and upload finished format documents to team website
Trouble scheduling meetings	All team member get google email and use/share google calendars
Skype lags during meetings	Allow breaks in conversation and so understanding during meeting by using the thumbs up sign
People not getting documents before meetings	Send documents for meetings the day before to all members
Problems getting to the Dubai campus when busses are not available	Get prior approval and receipt for taxi reimbursement
Difficulty hearing people during Skype meetings	Use mobile mic that can be passed around for each person to hold

## Conclusions

The overall goal of developing the ability to operate effectively in an international team setting was accomplished through this design project. The international members of this senior design team learned to cope with culture shock, adapt to an infrastructure of a new country, and learn the most suited approach to overcoming the obstacles in a foreign environment. The team developed an understanding of technical, logistical, and personal issues encountered in an international team setting. Both team subsets actively pursued key objectives and overcame unique challenges that were shared through the team. These skills are completely transferrable to a corporate workplace. The skills acquired are difficult to quantitate, but are extremely valuable. Many of the techniques that were used by the team to share documents and communicate ideas can be found in many offices that have substantial work done around the world. The team as a whole successfully identified many solutions for working on a single project on two different continents. The goals of the senior design project were accomplished through effective teamwork that overcame the logistical, technical, and societal issues associated with unique foreign entities.

RIT plans on implementing multi-national senior design teams into future curriculums, and the transition from single site teams to multi-national teams will be smoother if the recommendations from the team for additional support are followed. By being placed abroad with limited support for the senior design class, the team was able to identify the aspects of the

course that must be implemented in Dubai in order to have a productive senior design experience in the future. The major recommendations are as follows:

- (1) Attempt to divide team skills to have minimum one group member in each country with a good understanding of project management.
- (2) Before team subset departure, develop an understanding for the capabilities of team subset and a form of communication protocol.
- (3) Strive for a faculty guide for both domestic and international teams, with excellent communications skills
- (4) Clearly state that team members must be willing to compromise, be realistic about setting meetings, and be prepared to limit project scope when necessary to successfully meet deadlines and the customers' needs.

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