

MQP in China: Extension of WPI Practice on Project based Engineering Education

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Abstract - With the development of global economy and the rapid shift of manufacturing to China, the demand for engineers with the ability to work in unfamiliar cultural environments is critically important for both Chinese and US companies. In response to a world in which science and engineering are increasingly global in scope, integrating international research experience into engineering education is essential. An exchange program of Senior Projects in Mechanical Engineering has been established between WPI and HUST. US and Chinese students work in mixed teams doing real world projects sponsored by global companies doing business in China. The students work on defining and solving real-world engineering problems in a very important and vastly different cultural environment. They gain knowledge and communication skills through conducting meaningful project, working in teams, and developing leadership skills in a multi-cultural environment.

1 Introduction

With the development of global economy and the rapid shift of manufacturing to China, the demand for engineers with the ability to live and work in unfamiliar cultural environments is critically important for both Chinese and US companies [1-3]. One result is leading to considerable redistribution of research, design, and manufacturing. In response to a world in which science and engineering are increasingly global in scope, integrating international research experience into engineering education is essential.

An exchange program of Senior Project Center in Mechanical Engineering has been established in a joint effort of Worcester Polytechnic Institute (WPI), MA, USA and Huazhong University of Science and Technology (HUST), Wuhan, China. About 10 senior students from each side go to the other side for a term of 7-8 weeks, working in mixed student teams with co-advisors and industry mentors, for doing their senior projects, usually sponsored by local industry, including US companies doing business in China. The students work on defining and solving real-world engineering problems in a very important and vastly different cultural environment. They gain knowledge and communication skills with technical colleagues and partners by conducting meaningful project, working in teams, and developing leadership skills in a multi-cultural environment.

Unlike most US students who study abroad, the students in the center become immersed in the local culture as they tackle important problems for sponsors and experience different education system and learning style.

2 Extension of WPI Practice on Project-based Engineering Education

With China emerging as the US's most important trading partner, the importance of preparing engineers in both countries to work with each other is becoming an important priority. The WPI/HUST collaboration, which involves mutual visits at both the undergraduate and graduate level, is designed to give the students the opportunity to gain cross-cultural experience while working on a professional project, as well as to develop an appreciation for the host country. The objective of the establishment of the Senior Project Center in Mechanical Engineering to provide WPI and HUST senior students an opportunity for international engineering research experience.

WPI is well known by its “two towers tradition” of focusing on both theory and practice, project-based engineering education and the global perspectives program. The junior year project, or Interactive Qualifying Project (IQP), focuses on the interface between technology and society, while the senior project, or Major Qualifying Project (MQP), is a research or design effort in the major area of study and is well recognized by the professional community [4]. WPI was one of the first technological universities to appreciate the need for students to be citizens of the world -- to understand other cultures, and to be able to succeed no matter where their paths take them. WPI students go abroad not to sit in classrooms or haunt museums but to solve important problems for agencies, organizations and corporations around the world. These experience has been primary in the junior project level (IQPs), aiming at gaining multi-cultural background through doing a non-major technical project [5]. In recent years, WPI has succeeded in learning how to conduct technical projects, the MQP, at our global project centers. This effort has been supported by National Science Foundation.

HUST is a major comprehensive university in China with outstanding engineering programs [6]. Recently, HUST has further developed its interdisciplinary programs in ME to broaden its research and education activities closely toward the international technology advances and making contributions to the rapid development of the national economy in cooperation with industry. Under the support of the Ministry of Education, major innovations in two disciplines, “Mechanical Manufacturing and Automation” and “Mechanical Design and Theory”, have been made to provide talented scholars with a challenging academic atmosphere and advanced research facilities.

The WPI-HUST collaboration on the Senior Project Center in ME has been well sponsored by industrial companies who are doing global business in China. Currently there are more than five western companies sponsoring projects through their China operations. Other sponsors include local companies, hospitals, and universities.

3 Doing Projects in Mixed Teams and with Global Companies

The exchange program between WPI-HUST was initiated in 2004 and first implemented in summer 2005. Four WPI students came to HUST working with five HUST on two projects of robot design, designated by HUST professors. The students worked in mixed teams, making partners and friends, and learning a lot from each other as well as co-advisors from both WPI and HUST.

The program was enhanced in 2006 when eight senior and one BS/MS students from WPI came cross the ocean joining twelve HUST students. Five projects with real world application background were identified. Among them two projects were sponsored by foreign companies running business in China.

These two companies enjoyed working with the project teams and requested to continue sponsoring more projects in next year. Together with another company, three western companies sponsored four projects in 2007, which bring up the total number of the projects in 2007 to seven, facilitating fifteen WPI students and twenty two HUST students for their senior projects.

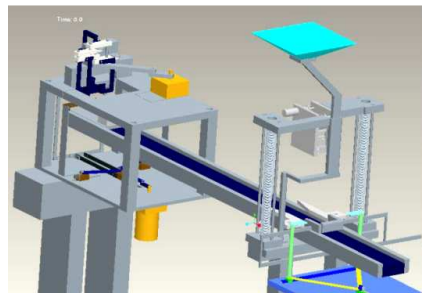
In 2007, the students started project preparation (named PQP at WPI) before the trip. During PQP, the communication among project partners, co-advisors, and sponsor company mentors were established. The students worked on problem definition, background knowledge and information acquisition, as well as making a project plan. Then the mixed student teams spent significant amount of time working in the project sponsoring company in full time with engineers to work out valuable results of the projects.

The MQP in China program has been expanded to involve more universities and companies, including the Kyungpook National University, Daegu, Korea, and two local companies sponsoring two projects. In 2008, fifteen WPI students will go to China and Korea, working with twenty one HUST students and six KNU students working on eight projects, all of them are sponsored by industry.

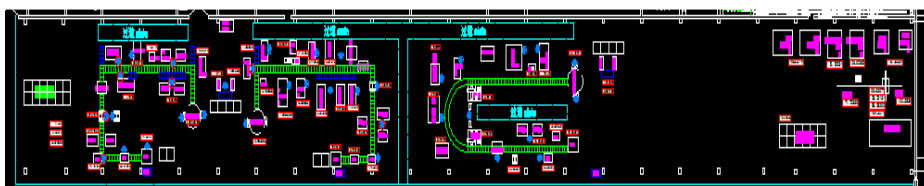
Figure 1 shows several teams (with engineers) of 2005-2007. Figure 2 shows examples projects the students did in 2006. And Table 1 shows the details of the projects WPI and HUST students have worked on in the first three years of the program.



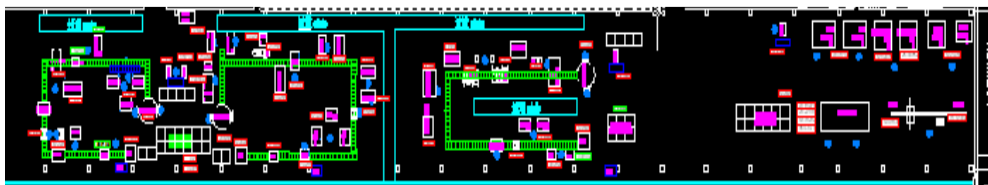
Figure 1, The WPI-HUST teams in 2005-2007



(a) A four-step paper clipper packing machine



(b) Original machine layout and materials flow



(c) New machine layout and materials flow

Figure 2. Example projects by WPI-HUST team in 2006

TABLE I. PROJECT SUMMARY

Time/ Location	Projects	Sponsors
2005 in China	1. Gas Pipe Climbing Robot Design	HUST
	2. Fast Food Service Robot Design	HUST
2006 in USA		
	1. Special Mini-Dynamometer Design	St. Gobain
2007 in China	2. Lean Manufacturing Implementation	Next Technology
	1. Multifunction Hospital Bed Design	Tongji Hospital
	2. Portable Intravenous (I.V.) Stand Design	Tongji Hospital
	3. Automated Packaging Machine Design for Paper Clips	Zhejiang Factory
2007 in USA	4. Assessment of roll forming practice	CIS
	5. Work Scheduling of Production	St. Gobain
2007 in China	1. Lean Manufacturing Implementation	Amphenol TCS
	2. Chip Recycling of BZZ grinding Processes	St. Gobain
	3. Signal Characterization of OD grinding	St. Gobain
	4. Evaluation of Industrial Robots Course	WPI
		CIS
		CIS
	1. Design Process for Slide Lock Mechanism	
	2. Value Stream Map for Lean Manufacturing Implementation	St. Gobain
	3. Production report system improvement	Amphenol TCS
	4. Lean manufacturing implementation for Connector and Backplane Production	HUST
	5. Humanoid Robot Development	HUST
	6. Welding Fixture with Active Position Adapting Functions	HUST
	7. Walking Robot Development	
2008 in USA	1. Supply chain management	
	2. Measurement systems analysis and capability study	
	3. Energy saving LED lighting	
	4. CAD based design of casting systems	Nypro
	5. Dynamics and noise control	Amphenol TCS
		REM
		GM
		WPI
2008 in China	1. Supply chain management	
	2. Lean manufacturing implementation	
	3. Design process implementation	
	4. Value stream mapping	Nypro
	5. Energy saving LED lighting	Amphenol TCS
	6. Robot development for automotive industry	CIS
	7. Automotive component design	CIS
		REM
		Hwashin
		Pyeonghwa

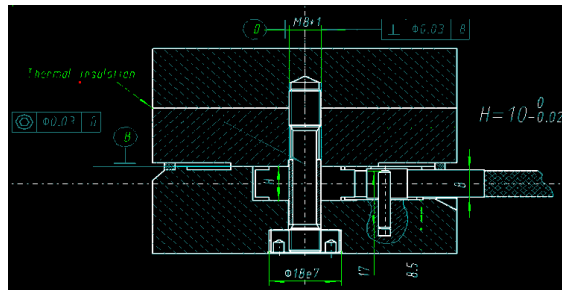
On the other side, four HUST students came to WPI campus in spring 2006 and worked on two senior projects. The projects were sponsored by Saint Gobain Abrasives and New Age Technologies, both located in Worcester MA area. This was their first time of doing real world projects for industry directly. They have learned a lot on the problem definition through the communication with people. The very useful results generated from the project were actually used by the companies. The HUST students gained their confidence of working in the real world from the project experience.

In the second year, seven HUST students participated in the exchange program at WPI in March-May 2007 and worked on four projects also sponsored by local companies. This time they had a chance to work with WPI undergraduate and graduate students. One group even traveled to Maxicali, Mexico to collect data from the manufacturing operations there. Figure 7 shows one of the project teams and Figure 8 shows an example of the projects. It is expected to have ten HUST students on WPI campus for their senior project. Figure 3 shows the project teams. Figure 4 and Figure 5 show the project outcomes.

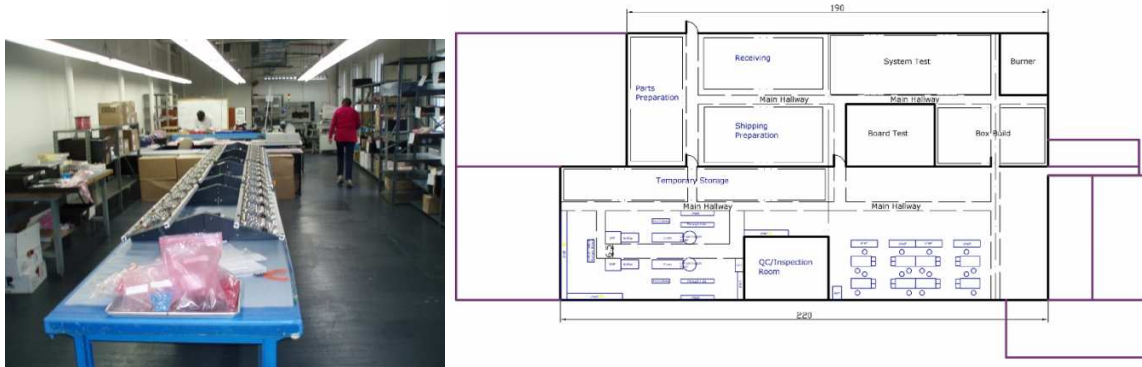
In 2008, nine HUST students come to WPI working with WPI students on five projects where four of them are sponsored by companies.



Figure 3. Project teams of HUST students at WPI in 2006 and 2007



(a) A special mini-dynamometer for grinding force test



(b) Lean manufacturing design of production flow

Figure 4. Projects by HUST students in Spring 2006

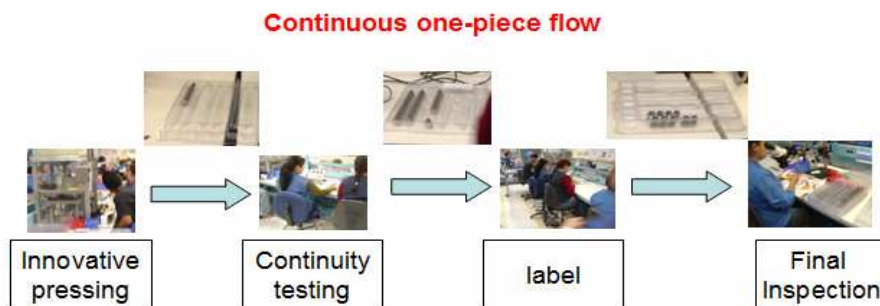


Figure 5. A project of lean manufacturing analysis

4 Doing Projects in Mixed Teams and with Global Companies

“It was a wonderful and eye-opening experience,” said by a senior at WPI. He, along with other mechanical engineering students spent seven weeks during the summer of 2006 at HUST, working on his senior project. The students lived on the HUST campus, working with HUST students on the projects. The projects included the design of a multifunction hospital bed and an automated paper clip packaging machine and were all supported by industrial sponsors.

“You start to realize although they live half way around the world and have a form of government completely foreign to you; they share many of the same ideas and concerns as you yourself do. You realize the spirit of the people is what makes this country great”, said by another WPI senior student participated in the program last year.

“My biggest gain in this project is to know a good procedure of doing a project”, said by a HUST senior student who participated the exchange program. “We learned how to start a project, how to discuss with people, how to come up with initial ideas of a new design, and how to present the idea/results of the project”, added by another HUST student. “Particularly, I learned how to represent myself, my idea, the work we have done, the results and conclusion of the project, and more importantly, the person I am.” This was the first time for many of them as undergraduate students doing real world projects.

The students brought different strengths to the teams. It is observed that for many real world situations, the problem and the project goals are usually vague at beginning and the WPI students, with their previous project experience, usually take the lead in developing the initial conceptual design. They ask a lot of ‘what if’ questions. But, the HUST students catch up quickly with their strong analytical and technical skills and become a real asset as the designs became more specific. All team members—both students and faculty— found it challenging to work on teams with students and advisors from different cultural backgrounds. Language is not a big issue since all the Chinese students are selected and fluent in English. It is, however, a rewarding experience. Both the co-advisors from WPI and HUST feel that both the WPI and the HUST students learned much about how to communicate with the project sponsors, the professors, and their partners to ensure that the project objectives were clear. The team members also gained an appreciation for the benefits of working in a diverse team.

From the quotes of student saying and the professors’ observation, it is already clear that the program is providing the students with exceptional educational experience. All people involved have gained a lot from the program.

The purpose of the WPI-HUST collaboration is to educate engineers who have the skills and attitude to work effectively in an international setting. In addition to sponsoring projects to help develop an internationally experienced workforce, the sponsors found that the student teams provided other benefits to their corporations: “The way the WPI-HUST team works in the company brings in a fresh air by showing that there is a scientific way to analyze the manufacturing process. This is an area that needs to be strengthened in many companies,” according to Al Barry, Former CEO of CIS, a US company with manufacturing operations in Wuxi, China.

5 Beyond the Projects

Although spending most of their time on the projects, the WPI students had the opportunity to experience China and Chinese culture. Bill Durgin, a former mechanical engineering professor and associate provost at WPI, who visited HUST while the projects were in progress, notes that “The students received a good dose of local culture even though they were totally absorbed in their project work. I was very pleased to see that the mixed teams had developed a remarkable esprit de corps. Indeed, several of our students visited the home-towns of the some of the Chinese students, post-project.” Or, as Chris Maskwa from WPI put it: “It’s hard to say what was more impressive, whether it was standing in the center of Tiananmen Square, climbing the Great Wall, hiking the slopes of a Taoist mountain, or looking across the

lake at the emperor's Summer Palace, but one thing is for sure, these are things I will remember for the rest of my life." After graduation, Chris joined a US manufacturing company and expects the work to frequently take him back to China. So far, at least four students took a significant advantage of the China experience which is highly recognized in their job hunting.

"You start to realize although they live half way around the world and have a form of government completely foreign to you; they share many of the same ideas and concerns as you yourself do. You realize the spirit of the people of the people is what makes this country great." Said by Jake Doucet, another WPI senior student participated in the program.

Similar stories are heard from the HUST side. Besides many students go to graduate school in either China and abroad, several HUST graduating students, who involved in the program, are working with western invested companies in China. "The biggest harvest I gained from this project is the way to do a project, especially how to start, how to define the problem and expected results, schedule the procedure, and also how to communicate with the leaders, engineers and workers in the company. Moreover, during the cooperation with WPI students, I experienced their different views on many things. The most impressive thing is the way they present ourselves (the team) and even the style of the PowerPoint. In all, this will definitely be an unforgettable experience in my memory", one HUST commented.

Besides the project work, the WPI students traveled in China, often with their project partners, to learn more about the Chinese culture and gain more understanding of the people. During the first three years, WPI students have traveled to cities of Beijing, Shanghai, Wuhan, Wuxi, Changzhou, Nanjing, Xi'an, and Luoyang, as well as Tai Mountain, Song Mountain, Hua Mountain, Three Gorges, and Great Wall. They also visited Tsinghua University and HUST campuses. The students gained a better understanding of China from these visits, particularly in comparison of the differences at coast and in land areas. The students have learned and practiced the respect of different culture, the understanding of different ways of thinking, and effective communication skills. They also enjoyed the warm friendship and rich culture of China. Figures 6 shows some pictures the WPI students took in China.

6 Assessment of the Program Effectiveness

The students from both WPI and HUST have gained a lot not only the knowledge and experience of doing project in China, but also the way to communicate and work with people for contributing to the business and industry. For example, students learn to solve open-ended, integrative problems, they make connections between classroom and experiential learning, and they come to appreciate the impact of the decisions on local cultures and communities, as well as the impact of culture and community on their decisions. The global project work is an eye-opening, confidence-building--and life-changing experience.

There are many stories on the success of the exchange program. However, in order to qualitatively evaluate the educational effectiveness and the impact on industry innovation, a comprehensive assessment needs to be conducted. Basically the following questions are to be studied and answered.

- How to measure the success of the center/projects
- How to measure student ability enhancement
- How to measure project quality
- How to target on students batch / market need
- How to measure the impact on education
- What assessment procedure to take.

This is one of focuses we will work on in next one or two years of the future.



(a) At Yellow Crane Tower in Wuhan



(b) A taste of Chinese food down the street



(c) Birthday celebration



(d) A big team at Three Georges

Figure 6. Pictures of touring in China

7 Summary

As author Thomas Friedman says, the world is now becoming flat. Every student must develop the attitudes and skills necessary to deal with real world problems with global background. The young engineers need to be ready to solve unfamiliar problems in an unfamiliar setting, and must accept that they will be working with a large number of people who come from a culture different background from theirs. Preparing young engineers to work in a flat world is no longer something that engineering schools can treat as an extracurricular activity, available only to those that have the time and resources to spend an extra semester abroad. Every student needs to develop such attitudes and the skills necessary to function globally, right from the time they first enter the workforce. The WPI Global Perspective Programs and the HUST International Study Programs provide and facilitate such an education to do so.

8 Acknowledgment

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