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Key Steps to Developing Successful Global Undergraduate IT Teams Through Exchanges

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ABSTRACT

The United States Military Academy (USMA) at West Point has strived to maximize interdisciplinary and multicultural opportunities for its students. In the recent past, multi-cultural opportunities were open primarily for foreign language majors. However, changing dynamics in the world have prompted the need for all students to have international experiences integrated into their academic experience at West Point. As a result, the Department of Electrical Engineering and Computer Science (EE&CS) has searched for relationships with partner institutions in Panama, Chile and Tunisia. These relationships have borne several exchange trips for Computer Science, Information Technology and Electrical Engineering majors both in our department and our partner institutions. In this work, we describe our methodology for successful IT-related undergraduate exchanges. These steps have been developed from our collective experiences with executing exchanges over the past three years. In addition, they have led to not only meaningful project work, but also the opportunity for students to improve their language proficiency, regional expertise and cultural awareness in their host countries.

Keywords: International Exchanges

1. INTRODUCTION

Historically, international exchanges were limited mostly to foreign language majors and students studying in the humanities area. For students following engineering in the US, there was little encouragement to study their discipline abroad.

However, with the torrid pace of globalization, the need for engineers that are effectively multi-lingual and savvy multi-culturally is critical. Job marketability is increasingly being influenced by one's ability to operate in multi-cultural settings, especially in performing engineering specific tasks. As West Point graduates are immediately commissioned as Second Lieutenants in the US Army where they soon take charge of a forty person platoon. Accordingly, economic factors are not as a significant source of motivation for USMA compared to other civilian institutions. Nevertheless, the globalization trend has proven to be a major influence. Today, West Point graduates lean much more on their multi-cultural skills as they support the global war on terror.

Preparing undergraduate students for this brave new world can be daunting. Most would agree that providing students with immersive experiences is crucial. West Point is no exception. This work provides a series of steps that can serve as a guide for those programs that are considering short-term international engineering exchange programs.

2. BACKGROUND

In 2005 the US Department of Defense (DoD) produced a policy directive (DoD, 2005) that directed all services to ensure that new officers entering the armed forces would have increased cultural awareness and language skills. As a result of this initiative, the USMA was directed to enhance their education in these areas.

Historically, these activities had been almost the exclusive domain of the language, history and humanity majors. However, this changed with the directive from DoD. All cadets, whether engineer or language majors, could benefit from cultural and language education. The department of EE&CS benefitted from having a faculty member who had studied abroad. Based on his contacts, the department spearheaded various exchanges for engineers at West Point.

USMA's motivation then was based on DoD priorities and also a realization that military officers in today's world need to be much better prepared to function in a culturally diverse world. This varies somewhat from the standard motivation that most civilian universities proclaim. It is not uncommon to hear references to the globalized economy that has increased competition. These universities want their students to be as prepared and as marketable as possible to compete for employment. This is the case with the three institutions that the EE&CS department has entered into exchanges with. Although the motivations varied, the desired end-states were the same: we all wanted our students to be exposed to other cultures and languages.

The exchanges have occurred since 2006 with some being multi-phased and bi-directional. EE&CS has executed exchanges with students from the Universidad Diego Portales in Chile, Ecole des Mines de Paris in France, the Universidad Tecnológica de Panamá, and the Université Libre de Tunis, Tunisia. All exchanges have been technical, immersive, and multi-cultural.

3. PREVIOUS WORK

International exchanges have been growing in popularity in the last 15 years. The advent of the Internet enabled communications between academic faculty and researchers around the world. With the dramatic drop in global communications thanks to the Internet, the concept of globalization led to the realization that engineering students (not only language and humanities students) would benefit from international exchanges. By the mid nineties, universities were beginning to articulate those benefits for engineer students (Liew and Mendis, 1996), (King and Israel, 1999).

There were different opinions of what constituted international exchanges. Chaczko (Chaczko et al, 2006) and Doerry (Doerry et al, 2004) advocated using virtual exchanges as a means of providing a rich environment for teaching team oriented engineering. Their concept was to prepare students for developing projects with globally dispersed teams. Holland and Velasco (Holland and Velasco, 1998) took this concept a step further by integrating curriculums from partner international universities in a reciprocal arrangement via distance education. Both methods approached international exchanges from a 'virtual' perspective.

However, most literature is focused on actual student and faculty exchanges, citing the cultural, language and personal development opportunities as most tantalizing (Fuller et al, 2005), (Huggins et al, 2007).   For example (Owusu-Ofori et al, 2001), (Ramey and Steehouder, 2007) and (Fry, 2004) maintain that one of the primary benefits for engineering students and faculty is the cultural education from living abroad in another country. In addition, with the ever quickening pace of globalization and the resulting flattening of the world, engineers need to be versed and comfortable in other cultures.

Often, international exchange agreements are borne out of informal discussions and relationships developed at conferences (Cooley et al, 1993). Yet some international exchange programs are organized at the national and international governing level such as the ERASMUS program in the European Union (Alonso, et al, 1995) and the exchange program that evolved out of the National Science Foundation's SUCCEED Engineering Education Coalition (Marchman, 1998).

4. EXCHANGE METHODOLOGY

The exchanges between West Point, Université Libre de Tunis, Universidad Diego Portales and Universidad Tecnológica de Panama were multi-phased. Our intent was to enhance the multi-cultural experience through repeated exchanges. The three phases occurred over the summer, fall and spring.

4.1 SUMMER

During the summer, West Point cadets travelled to other countries under the school's Foreign Academic Individual Advanced Development (AIAD) program. Similar to a summer internship, its mission is to organize international educational and cultural opportunities for cadets at West Point.

Figure 1: Panamanian students and West Point cadet working on their IT-related project in Panama City, Panama.

These trips normally occur during the summer months for 3-4 weeks. Cadets normally travel abroad in small groups of three to four along with an officer lead to study various topics in countries around the globe. The Department of EE&CS used the Foreign AIAD program as a vehicle for cadets majoring in CS, IT or EE to work on technical projects with students and faculty from our partner institutions.

Figure 2: Chilean students and West Point cadets working on a joint, IT-related project in Santiago, Chile

4.2 FALL

After the summer exchange, both West Point cadets and students from the host countries would continue to work on the project that was started during the summer. In some cases, West Point cadets would transition their summer work into their senior capstone project. This gave cadets an advantage over other capstone teams at West Point who often spent a good portion of the fall semester identifying and narrowing their topic area. During the autumn, the international project teams remained in contact as they progressed with their work.

4.3 SPRING

During the spring semester, the Department of EE&CS at West Point hosted international students from partner institutions for a reciprocal exchange opportunity. Students visiting West Point focused on continuing their work on projects initiated over the previous summer. As this was a project-based effort, there was no class-work. Students worked in the Information Technology and Operations Center (ITOC), a research center associated with the department of EE&CS.

Figure 3: Panamanian CS student during the West Point phase of the project

During this part of the exchange, students stayed in the barracks with cadets and ate in the cadet dining hall. This extensively immersive experience afforded the foreign students a truly close up experience of not only the American culture but the unique West Point way of life. Over the three to five weeks students spent at West Point, they not only made exceptional progress on their project work, but made strong friendships that continue today.

5. PROJECTS

Projects have varied over years. The first year focused on network security via HoneyNets. Last year's project had the international student teams develop robot applications on the Parallax Boe-Bots®.

5.1 HONEYNETS

A HoneyNet is a virtual network used to monitor hacker actions. An entire virtual network can be located on a single computer. The information gathered from log files helped students understand hacker techniques and develop techniques to bolster security. Whereas a HoneyNet refers to an entire virtual network, HoneyPots are individual hosts on the virtual network. These individual hosts were either statically or dynamically spawned. We used VMWare® (VMware, 2008) to implement the entire HoneyNet on a single laptop. See (HoneyNet, 2008) for more details.

The HoneyWall, which acts similar to a virtual router connecting the virtual network to the physical network, was implemented with SNORT as an intrusion detection system (IDS) and SNORT in-line as an intrusion protection system (IPS). With these components, the Honeywall would let all packets from the outside network into the virtual network. However, we used SNORT in-line and iptable rules to filter exiting packets to keep any would be hackers from actually using a virtual host from doing something dangerous such as using the host to attack other networks. Each day, the logs were removed for archival and study.

5.2 BOE-BOTS®

International student teams also used Boe-Bots® in Chile, Tunisia and France. Each location had a slightly different mission. In Chile, students worked on a robot that would map a room using on board sensors. The group in Tunisia broke down into three project teams to build a leader robot, a follower robot and an autonomous robot. And the student in France decided to build a robot that would navigate a maze.

Figure 4: Tunisia students, West Point cadets and faculty mentors in Tunis

The Boe-Bot® platform proved to be an idea project for various reasons. It was very attractive due to its low cost ($149) and small footprint (3 ½ pounds for a full kit) (Korpela, 2007). In addition, the student could program functionality into the robot with either the Javelin Stamp™ module or the BASIC Stamp® module. The Javelin StampTM module is a microcontroller that is programmed using a Java compiler running on an Integrated Development Environment (IDE). Similarly, the BASIC Stamp® is programmed with a variation of the Basic language.

In addition to the microcontrollers, robot chassis and printed circuit board, teams also were provided a package of sensors that there used to navigate through their various tasks. Some examples include IR transmitters, a digital compass and ultrasonic rangefinders (Korpela, 2007).

6. STEPS

We present the steps that we have found important to ensuring successful international engineering exchange programs. Ensure you have a funding source for the long term.

6.1 FIND A FACULTY PARTNER IN THE FOREIGN INSTITUTION

You need to find someone who is of like mind and willing to put forth the effort to work with the student teams. This is often an additional task over and beyond their normal teaching and research responsibilities. The summer exchanges normally take a year to coordinate, with most effort focused on coordinating the logistics of the exchange. Later in the process, the effort is concentrated in the project details.

Through this coordination process, you need a reliable partner that will consistently complete tasks on time. For Chile, the initial coordination was between West Point and the Chilean Escuela Militar. The two military academies already had a healthy exchange program developed for foreign language majors at West Point. As the Escuela Militar does not have a CS or EE department, they put USMA in contact with Diego Portales University, which has a strong CS and EE program. The success in Chile is directly attributed to Dr. Sergio Mujica, the Chair of the CS Department at Diego Portales. He embodies Diego Portales' strategic commitment to increased international exchanges.

6.2 GET THE RIGHT PROJECT

As most of the foreign AIADs consisted of cadets from multiple disciplines, it was imperative that we chose projects that could leverage the talent pool available. Another key aspect in considering a project is the likelihood of student teams completing it prior to the end of the AIAD.

Given these desired attributes, the Boe-BOT® and HoneyNet projects were very suitable for the exchanges. In addition, faculty members crafted staggered goals that allowed successes at each step. Hence, if a team was not able to finish the complete project, they would experience success during the interim phases.

In addition, each project allowed students from various disciplines to contribute. Hence, neither project was a CS-only or EE-only endeavor. For example, the Boe-BOT® project leveraged CS students in the design and implementation of the software to control the robots and respond to sensor feeds. EE students exercised their skills in the actual hardware components of the robot.

6.3 ENSURE YOU HAVE A FUNDING SOURCE FOR THE LONG TERM

Once you have done the hard work of setting up an exchange, the last thing you want is for it to wither for lack of funding. Accordingly, before embarking on an exchange program, ensure that the funding will be available for the long-term. You want multiple exchanges to build rapport and avoid recreating the wheel.

Work out cost sharing agreements between the involved institutions. For example, Chile and Panama paid for the students to travel to New York for the spring phase of the exchange. But West Point agreed to host their students upon arrival to the US with room and board. There was a similar, reciprocal arrangement in Chile for West Point cadets.

6.4 START SMALL AND SLOWLY

The primary goal for the exchange programs is not an award winning research project. The opportunity to work on an IT project in a multi-cultural environment should be the measure of success. Hence, we recommend projects that are challenging enough to force students to bond together, but small enough that there is a high probability of completion. This applies also to the faculty advisors' attitude. The faculty advisor's attitude should also help keep students focused on working together for a common goal (whether it is actually achieved or not).

6.5 CULTURALLY PREPARE STUDENTS PRIOR TO EXCHANGE

Start early with student cultural preparation. This preparation (or the lack of) has a major influence on the success of the exchanges. Students that travel to the foreign institution should educate themselves on the language and culture of the host country.

At West Point, cadets were required to take language training prior to departure. In addition, they were provided historical and cultural background on the countries to be visited. This not only helped cadets adjust quicker to their new environment, but also showed their hosts that the cadets had an interest in their culture. This fostered a richer cultural exchange.

6.6 GET THE RIGHT STUDENTS

You will need students who are not only academically strong but with an open mind and an excellent attitude. This sensitivity goes a long ways in the cultural interchange as many things are new and strange to both the host and visiting students. With this proper mindset, the groundwork will be set for a very fruitful cultural exchange..

6.7 EMPHASIZE IMERSION

Faculty mentors were available throughout the AIAD and reciprocal visits to West Point. However, after setting the project azimuths, mentors would purposely kept a low profile. The intent was to have students spend as much time together as possible. Having team members work through challenges in the project helped forge a stronger bond, thus providing a deeper immersive experience. In addition, students normally stayed with host families or with their host students in the dormitory. This further enhanced their cultural experience by living day to day in the foreign culture.

7 FUTURE WORK

USMA will continue with the AIAD program in the summer of 2008. Discussions are ongoing with faculty members in the partner institutions to develop graduate-level, longer term projects. Masters and Ph.D students would work on the projects while smaller parts are parceled off for undergraduate projects. This top-down approach provides for a more continuous development process and opens up more opportunities for research publication at both the graduate and undergraduate level.

Further, USMA faculty members seek to continue and enhance exchange opportunities. In particular, there are plans to start semester abroad exchanges in Chile, Tunisia and possibly Panama. West Point has already begun semester abroad exchanges with France.

8 CONCLUSION AND FUTURE WORK

In this work, we have presented steps to develop effective cultural exchanges in the IT arena. In doing so, we also described our methodology for executing the exchanges. From both a technical and cultural perspective, the projects have been a tremendous success. Students have had real-world experiences on IT-related projects while learning first-hand about another culture. In addition, faculty members from the partner institutions have benefitted from various collaboration opportunities. As the world becomes smaller through globalization, these international exchanges will only become more important in the development of our future engineers.

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