Advising a Costa Rican Capstone Design Project by Distance

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A student-initiated Capstone Design project was conducted in Costa Rica by a student team with the advisors located in Massachusetts. The project was to improve the sustainability of a Costa Rican trail system by designing stretches with features to minimize erosion, and to design a river crossing that will provide access to the trails by mobility-impaired persons. Costa Rica is interested in promoting ecotourism, and this project will improve the La Marta Wildlife Refuge by enhancing tourism in the area. Communication between the students and advisors was enabled with the use of technology, including email, web conferencing, and Voice over Internet Protocol (VoIP). This project provided an opportunity for the students to tackle real world, open-ended problems and to develop solutions that incorporated sustainable design. The students learned to communicate in a global setting, and within a multidisciplinary team.

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Introduction

The project site is located in Costa Rica in a historic agricultural area. Much of the agriculture has ceased in this location leaving large areas reverting to natural habitat with regrowth occurring. The specific site for this project was the La Marta wildlife refuge located in Talamanca, Costa Rica (see Figure 1). Previously a coffee plantation, the site now consists of over 1,500 hectares of tropical rainforest with great biodiversity. Costa Rica is promoting ecotourism and this unique refuge has great potential for expanded tourist usage of the area. The main goals of this project were to provide a capstone design experience for the student team, and to provide engineering expertise to improve the living conditions in the area. This project was to design an all-persons sustainable trail system for the refuge. Due to the nature of this work, the students were required to spend weeks on-site with limited daily oversight. In order to ensure safety of the student participants, the effort had to be well organized, with safety and communication protocols put in place. This project well prepared the students for real engineering projects which are often global, and almost exclusively multidisciplinary[1].

The Project

As the Costa Rican government is promoting ecotourism as a growth industry for this area (and the country as a whole), the goal of this project was to develop a trail system that would be sustainable with minimal upkeep (i.e. minimal erosion) and which would be accessible to all persons, including those with physical disabilities. As with many trail systems that are first conceived, the nine miles of trails currently in the refuge were not initially envisioned as being used by mobility-challenged individuals. Many of the trails were "rustic" (such as shown in Figure 2) and would need some upgrades so that all persons would be able to enjoy this refuge.

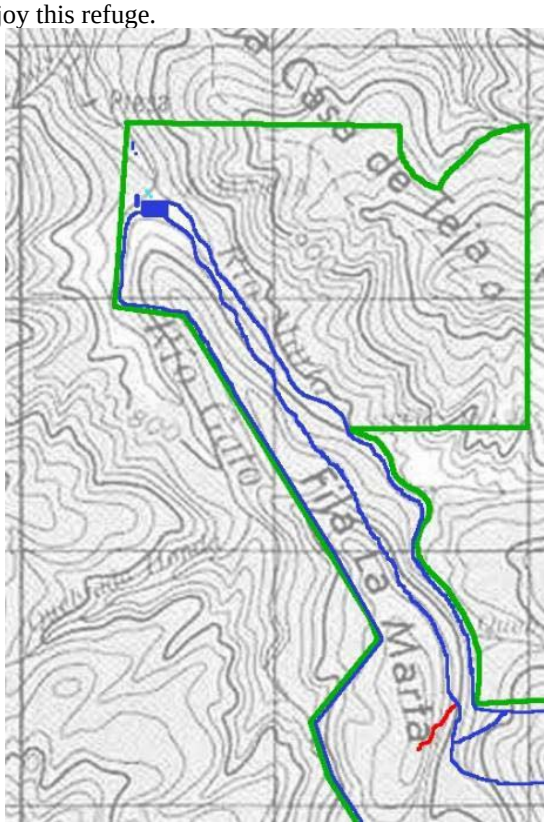

Fig. 1. The La Marta refuge[2].

Fig. 2. Plank bridge on the Puerto Viego trail[2].

One large part of the project that improved accessibility of the trail system to mobility-challenged people was the conception, design, and structural analyses of a transport system for crossing the Gato River which runs through the reserve. This human powered cable car will allow all persons to access a historic area of the refuge from the main parking area.

The administrators of the refuge were also interested in redesigning stretches of the trails so that the trails would be sustainable long-term with little maintenance and upkeep. The students performed water runoff calculations for the problematic trail stretches and recommended design changes to reduce erosion. The design changes included the addition of steps, water bars, culverts and armoring of trail surfaces with natural materials. At the completion of this design effort, it was estimated that these changes would result in a 90% reduction in erosion of the trail.

Capstone Design Needs

This project was completed to satisfy the capstone design requirement contained within the major Qualifying Project (MQP) at Worcester Polytechnic Institute. To satisfy the capstone design requirements, the team must apply engineering approaches to solve a problem considering economic, environmental, sustainability, manufacturability, ethical, health, safety, social and political constraints (ABET). For this project, the students needed to apply various engineering functions, including surveying, soils analyses, structural analyses, runoff estimation, and soil loss estimation (see Figure 3 for onsite surveying and site assessment). See Figures 4, 5, and 6 for some of the design deliverables.

Fig. 3. Taking measurements on site[2].

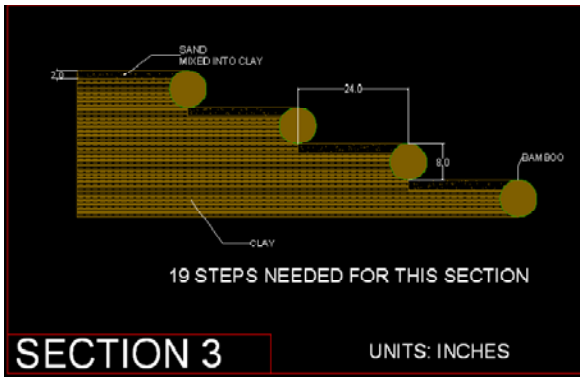

Fig. 4. Design of trail steps[2].

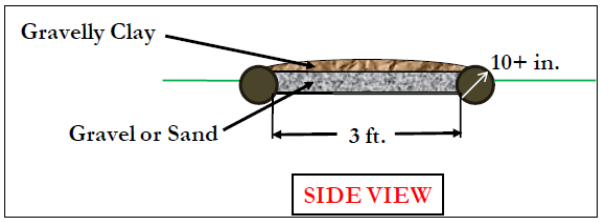

Fig. 5. Trail design[2].

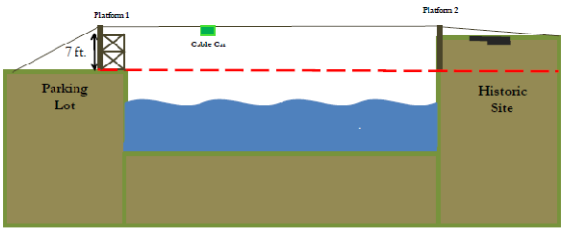

Fig. 6. Cable and platform concept[2].

The Challenges

This was a student-initiated project that almost did not happen once the difficulties of advising by distance became apparent in the planning stage. While the students were eager from the start, the advisors were cautious as safe housing and transportation arrangements were required. Fortunately, WPI's Interdisciplinary and Global Studies Division (IGSD) oversees a project center for Junior-level students in San Jose, Costa Rica. Personnel from IGSD were able to assist with the logistics of the project.

One of the major challenges that needed to be overcome was arranging for frequent communication between the team in Costa Rica and the advisors in Massachusetts. In a typical project, students and advisors would meet face-to-face in a conference room on campus, and thus obtain timely feedback ensuring progress. Of course, these types of meetings were not possible for this project where the advisors were not able to go to the project site. However, effective communication was achieved using email, web conferencing, and Voice over Internet Protocol (Skype™) at predetermined times. The use of Skype provided an effective medium for making decisions as a group (also reported by Karpova et al.[3]). Communication using these means occurred approximately twice per week, after an initial time lag when a small earthquake knocked out all communications for a while.

In a project such as this where some of the group members (the advisors) were physically separated from the rest of the group, a high degree of trust had to be developed among the team[4]. The students signed up for credit in the term immediately preceding the term in Costa Rica, and met on a regular basis with the advisors. This initial face-to-face contact built trust among the team that continued throughout the completion of the project.

Language barriers were also a concern. The students were native English speakers while Spanish is the official language in Costa Rica. Fortunately, one of the student team spoke some Spanish, and another had previously spent time in Costa Rica for a Junior-level project and had some knowledge of the Spanish language. They were ultimately able to converse adequately with all involved in the project, including the administrators of the reserve.

Conclusions

In this project, students completed capstone design in Costa Rica with advisors located in Massachusetts. The project was a success, with a cable car designed for use by mobility-impaired persons and the sustainability of the trail system improved through design of culverts, water bars, and proper trail surfaces. The communication hurdles were overcome through the use of technology and planning.

Completing this capstone design project outside of the classroom and within a global setting has provided the students with a richer undergraduate learning experience. The students tackled an open-ended problem and developed solutions that incorporated sustainable design, the use of appropriate technologies and considerations for societal issues. The students learned to communicate on different levels based on the interactions they had within the student project group, with the onsite liaison, and with the distance academic advisors. The engineering challenges the project team faced were even more pronounced when solving problems within a global environment due to a different language and culture.

References

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