

# Assisting Rural Panama with Appropriate Technology Development through Capstone Design

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The *idesign* program builds off a long history of successful international development research, education, and service at Michigan Tech, yet provides a substantial offering at a time when many undergraduates feel ready to contribute their engineering skills to the world. This program positions students to assist rural communities in Panama through a three course sequence, one preparatory to, and one synthesizing after a two week in-country field experience. Working on small teams, students are tasked with planning and executing field engineering, culminating in design recommendations to project partners and community members. The 2009 offering produced two water projects and two bridge projects in four small communities in western Panama. Preliminary assessment analysis shows that program yielded positive impacts on students' intercultural, professional, and personal development. Findings also suggest program improvements should focus on language, cultural, and community studies prior to the in-country phase.

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## Introduction

This paper describes the program design, administrative challenges, and student outcomes of a dramatically modified international capstone design program at Michigan Tech called *idesign* (i=innovation, international, insightful, etc.).

## The *idesign* Program

This section introduces the motivations for the general program design, key features, and implementation for the 2009 calendar year.

## Program Design

The *idesign* program was built upon the eight-year history of a former capstone design program at Michigan Tech, international senior design (ISD). The resignation of the ISD faculty champion provided an opportunity to review the features, administration, and outcomes of the program, eliminating problem areas and adding elements where needed. In addition to talking with all stakeholders, ISD alumni proved to be an invaluable source of information. Coupled with more than 20 years of combined international development engineering experience among the faculty team asked to build the new *idesign* program, the body of evidence suggested several major program changes:

- A shift from South America to Central America to reduce travel costs
- Capitalize on existing partnerships with reputable development organizations to elevate chances of team acceptance by community
- Extend the amount of preparation prior to departure to yield a more holistic design

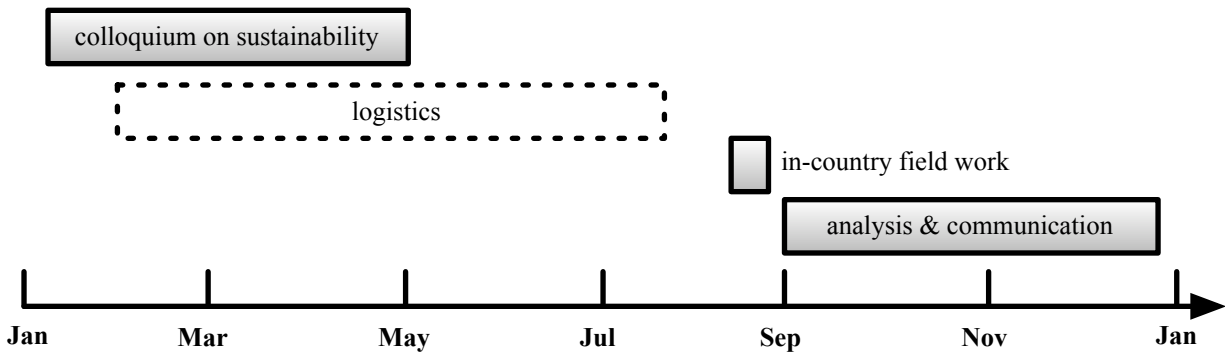
- Extend the amount of time allocated to analysis and communication of work to improve the quality of the final products
- Enhance the opportunities for implementing design recommendations through stronger partnerships to increase the commitment of all stakeholders

Based on the above recommendations, the *idesign* program debuted in 2009, and currently has the flow depicted in Figure 1.

The general components of the *idesign* program include three courses over the calendar year: (1) ENG3530 Colloquium on Sustainability is strongly recommended to all students and is taken in Spring semester, (2) CE4915 International Field Engineering is a required two-week long field work experience in Panama in August, and (3) CE4916 International Senior Design is taken during Fall semester and allows the students to further analyze their field work, build towards design recommendations and prepare all communication media (reports and presentations). Collectively, these courses are seven semester hours of credit (1, 3, and 3, respectively). Starting in February, a series of meetings (in person through the end of April) then online, prepares the student teams (approximately five students each) for their time abroad and focuses on safety, culture, field engineering techniques, and project expectations.

## Program Features

While there are features of interest within the Spring and Fall courses, this section will focus on the international field engineering experience. This section is held in early August to best accommodate the schedules of all involved (students, faculty, NGO



**Figure 1.** *idesign* program flow. Gray boxes depict courses taken, the recommended ENG3530 Colloquium on Sustainability (spring), and required courses CE4915 International Field Engineering (summer), and CE4916 International Senior Design (fall). Travel, team, and project logistics are covered in biweekly and online meetings.

partners, and community members). Unfortunately, this is a rainy season in Western Panama and makes travel, living, and work conditions exceptionally more challenging (and perhaps more memorable in the end). The teams arrive in Panama City and use the City of Knowledge (CoK) as their base of operations (the CoK is on the site of the former U.S. military base and has been renovated to a complex of offices for NGOs and research institutes). This facility was selected based on existing research connections with the CoK, as well as the presence of the offices for the U.S. Peace Corps in Panama. The Peace Corps is the primary NGO partner for *idesign*, building off the nearly 15 year history of Michigan Tech's Peace Corps Master's International programs. The students spend two days in the CoK getting acclimated to Panama, meeting with NGOs and project partners, and having engineering tours of infrastructure projects around Panama City.

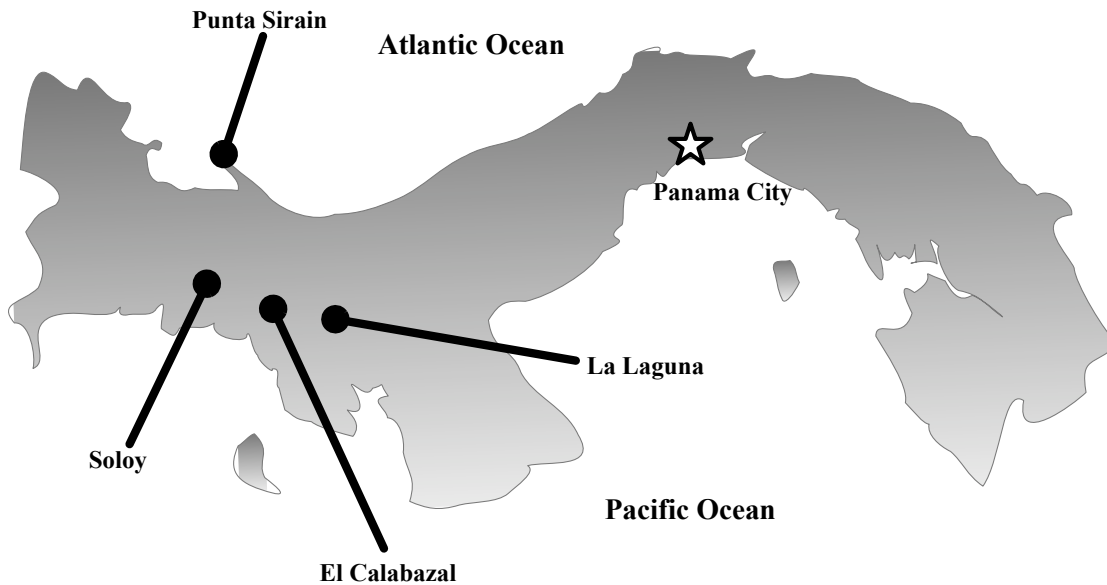
Following the acclimation period, student teams travel out to their project sites, accompanied by a project mentor (either a senior/graduate student or alumni of one of Michigan Tech's many international development programs within the D80 Center<sup>1</sup>). The teams then are met by the Peace Corps volunteer (PCV) working in the community where the project is to be undertaken. The PCV is critical to the success of the project, serving as a culture and language intermediary (Spanish is not spoken by all community members in some of these communities), local technical advisor (on appropriateness, availability of materials, local practices for community contributions, etc.), and facilitator of resources for construction following the design work by the students. All projects came from the community's own prioritization and needs assessments facilitated by the PCVs far in advance of the arrival of the *idesign* teams (these needs are communicated during the logistics stage of the program and facilitate team formation). The students spend approximately one week in the community conducting field work (e.g. water testing, surveying, community interviews, etc.) then return to the CoK to assess preliminary findings, share

assessments with the other teams, and resolve next steps and a timeline with their PCV partners.

### Program Implementation

Nineteen students were involved in the 2009 *idesign* program. Of these seniors, majors included civil engineering (12), environmental engineering (3), chemical engineering (1), electrical engineering (1), geophysics (1) and chemistry/Spanish (1); nearly 40% were women. Based on professional interest, coupled with a self-evaluation of international skills (Spanish proficiency, travel experience, international project experience, and motivations for participation), students were placed into teams (four or five students) in April, established contact with their PCV project partner and commenced preliminary project assessments. Four teams emerged, two focused on water supply, two on pedestrian bridge projects (see Figure 2). All projects were located in small (few hundred people or less), rural communities, each served by a PCV. Over the week in-community, students executed their plans for appropriate field data collection (e.g. technical measurements, identification of local materials suppliers, local building practices, interviews, etc.).

Upon return to campus in late August, student teams met regularly to continue the analysis of their field data, narrow prospective solutions to design recommendations, and prepared technical reports and presentations. In mid-October, each team presented their preliminary work at the 3rd Annual D80 Conference; this presentation serves a secondary purpose of promoting the program to the hundreds of students in attendance. It was also at this conference that the bridge teams received a promise for supplies to construct their projects via the conference keynote speaker, the executive director of a national NGO. The Fall semester culminated in final reports detailing recommended design(s) to be delivered to the respective partnering PCV. The plan for each project is that the PCV, in cooperation with their community, will find the resources to construct the project.



**Figure 2.** Map of Panama highlighting the four *idesign* project sites; Soloy and Laguna bridge projects, and water projects in Calabazal and Punta Sirain.

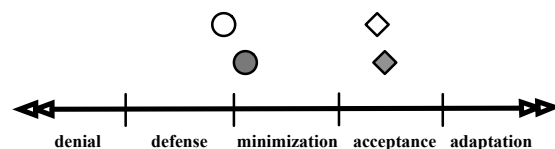
### Program Assessment

For students, the highlight of the *idesign* program is the international experience, especially the time in the project community. About half of the students had participated in other international programs prior to *idesign*, and the challenges of this program are a primary attractant for these students. The living conditions are rough (some communities can accommodate six visitors, some cannot resulting in students sleeping in tents or on the floor of the PCV's home), but the awareness of the need for engineering assistance plus the intercultural exchanges seem to outweigh any short-term discomforts. To move from anecdotes to measured observations, a mixed methods assessment scheme was instituted for *idesign*, involving: (1) an emergent content analysis of technical communication products, (2) pre- and post-program intercultural awareness, (3) pre- and post-program self-assessment, and (4) in-country daily wellness indicators. These methods will be briefly described and a few preliminary results shared next.

Where possible, course deliverables were used as assessment tools. This approach limits the additional burden placed on students. In this case, presentations and technical reports created during the Fall semester were analyzed for word content. When mapped against keywords important to intended student outcomes (ABET a-k<sup>2</sup>, ASCE Body of Knowledge<sup>3</sup>, plus measures of intercultural competence, sustainability, appropriate design, etc.), a better understanding of the professional development of students can be obtained. A downside to this method, in addition to the analysis time (no results are yet available), is that individual student "voices" are lost in the teamwork needed for the creation of these documents.

Intercultural awareness was measured with the Intercultural Development Inventory (IDI)<sup>4</sup>. The IDI is

based on the Developmental Model of Intercultural Sensitivity<sup>5</sup>, has been rigorously developed over two decades, and creates a quantitative estimate of intercultural competence. The IDI is a 50-question survey, followed by several contexting questions, generally takes about an hour to complete, and requires a trained administrator. This tool allowed some determination of the cultural impacts on the students, and the group's average results are shown in Figure 3. Based on the IDI quantitative results, a slight improvement (about 3% gain) was found by comparing post- to pre-program results. Most students showed gains, although 20% regressed slightly. On average the group moved from a state of Defense (usually a state of Reversal, indicating a perception that the host culture is somehow better than their own) to a state of Minimization (a belief that there are many similarities among people).



**Figure 3.** Average Intercultural Development Inventory results for the *idesign* students (n=15). White symbols are pre-, gray are post-program; circles are actual intercultural competences, diamonds are perceived intercultural competences.

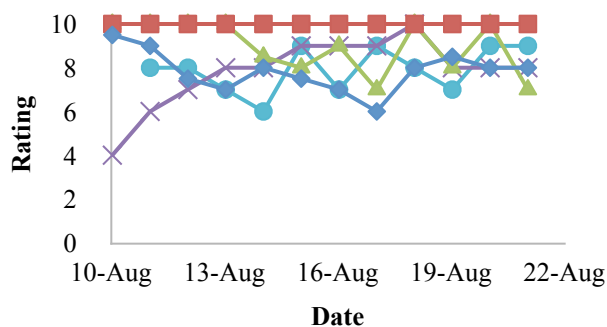
The self-awareness survey was developed at Michigan Tech and is a simple self-reporting instrument of the following topics: (1) what skills do you need to improve to be most effective in the *idesign* program?, (2) why did you want to participate?, (3) if you were to design the next program what would it be like?, and (4) how

has your *idesign* involvement influenced your education, career, and personal futures? This method created an opportunity for the students to think about the bigger context of their involvement. Table 1 reveals some findings from this study. Few changes in responses were found between pre and post evaluations (except an increase in the perceived need to develop foreign language skills); nevertheless, student opinions are valuable for future program marketing, design, and administration.

**Table 1.** Average results from *idesign* student self-awareness survey (n=15)

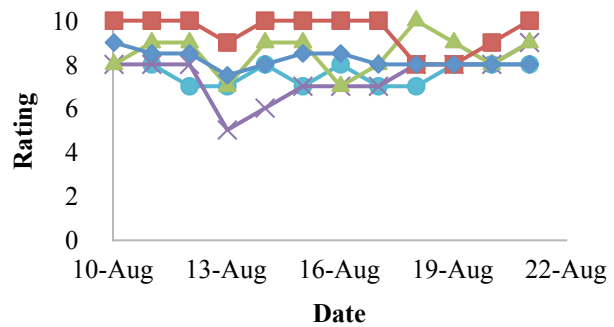
Question	Top Responses
Reasons for participation	1) do something meaningful 2) cultural experience 3) help others in need
Skills needing improvement	1) project resource acquisition 2) community assessment 3) cultural understanding
Next program design	Location: South America Duration: 1 month in-country Focus: community service
Influence on future plans	Education: connection to international issues Career: type of work Personal: interest in traveling internationally

Lastly, a simple in-country wellness survey was administered by the project team mentors. This survey asks each student to evaluate the following on a scale of 1 (horrible) to 10 (fantastic): (1) how are you doing physically?, and (2) how is the project going? This method was used primarily to engage the students in a near realtime evaluation of how things are going, and when necessary, open a conversation among project mentors, partners, and teammates to make mid-course adjustments. Figures 4 and 5 show results of this



**Figure 4.** Daily physical wellness survey results during time in-country for five students in one *idesign* team.

method for one team. Each student reports a unique timeline, often based on their past international experience, misfortune (e.g. food or water borne illness, sunburn, etc.), or temperament for discomfort (e.g. heat, insects, lack of hygiene, etc.) and change (e.g. diet changes, communication challenges, living conditions, etc.). Team morale and management challenges often occur during periods with high variability in the scores reported among individual team members.



**Figure 5.** Daily project wellness survey results during time in-country for five students in one of *idesign* team.

### Conclusions

The *idesign* program provides a vital curricular offering within the suite of international programs at Michigan Tech. Based on student feedback it provides an important opportunity to put disciplinary knowledge to work for the benefit of others; yet based on the assessment program it is clear that the student participants also benefit. These same assessment data hint at program improvements, including enhanced language, culture, and community studies prior to departure. Not surprisingly, students working in real communities on projects with substantial constraints have discovered that engineering education falls short without augmented learning in the humanities, social sciences, and complex systems analysis.

### References

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