Learning conceptual design using a community development project in Papua New Guinea

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***Abstract**: Humanitarian engineering comes in many forms. This paper describes a case study of how an engineering design subject was transformed by basing the assessment on a call for funding for a development aid project. This, in conjunction with the opportunity for students to participate in an extra-curricular site visit to the community of Ilahita in Papua New Guinea which was the target of the project form a learning environment where students were extremely highly motivated to engage in humanitarian engineering. The case study presented is not intended to be a report of a carefully conducted piece of educational research, but to tell a story about a series of events that led to an extremely rewarding educational and life experience for the students and academic involved. Guidance on what are considered some essential aspects of organising a humanitarian engineering project involving a student site visit is given.*

Introduction

Project-based learning is an ideal way for students to develop skills in conceptual design. This paper describes a case study where a humanitarian engineering project was used to provide the opportunity for student to learn design skills that incorporate strong social, environmental, and ethical themes in addition to technical design challenges.

The use of projects as the basis for learning engineering design is common. At first year university level, the Engineers Without Borders Challenge (EWB, 2011) provides students with an opportunity to undertake projects directed towards humanitarian engineering goals. Universities have a great degree of latitude in how to use the EWB support, but there is no opportunity for students to make a site visit or to communicate directly with the community stakeholders. In North America, service-learning projects are common in many degrees. Coyle et.al. (2005), for example, describes a multidisciplinary projects where students learn through community development projects mostly in their local area.

For over decade a project based learning approach has been used for 3rd year environmental engineering students to learn design skills at the University of Melbourne. Previously aspects of the web based communication platform for the subject was reported in (Moore, 2000). Before 2007, problems were chosen that involved a local industry partner who provided data, access to a field site and facilitated a community consultation workshop with local stakeholders. A typical problem involved refurbishment of water and wastewater services in a small rural town.

This paper describes an interesting phase of the offering of the subject (at The University of Melbourne a *subject* is a basic unit of work. Thirty two subjects comprise and engineering degree *course*.), which I hope will provide inspiration and advice to engineering educators to try something a little different, that can lead to interesting outcomes for the educator and life-changing experiences for the students.

Incorporation of humanitarian engineering

In 2007, a representative for a small Papua New Guinea NGO, the Ilahita Melbourne Community Association (IMCA) approached the University to seek assistance in understanding issues of environmental sustainability and community development in a remote village called Ilahita in East

Sepik Province. This provided an opportunity to rethink the underpinning project basis of a 3rd year environmental engineering design subject and provide new challenges for both the students and staff.

The UN Millennium Development Goals (United_Nations 2008) were well established by this stage although on first reading were not necessarily appealing to scaffold an engineering design project. For example, the goal on child mortality seeks to reduce by 2/3 the child mortality rate in 2015 using the rate in 1990 as the basis. While child mortality could be construed as a health problem, a systems approach to thinking about it quickly reveals that it is actually a wicked issue (Rittel and Webber 1973). Progress is only likely to be made on such problems if a systems thinking approach is used to examine the various facets of the issue and engineering aspects of the issue are solved in conjunction with other aspects such as education, health support, and improved livelihoods.

While the opportunity for a site visit to PNG was not apparent, the IMCA was able to provide support by way of rudimentary data and access to people who grew up in the village and nearby areas, but now lived in Melbourne while studying. These interactions were used to simulate community consultation activities. In the 2007 offering of the subject, the design brief was framed in relatively simple terms of provision of water for household use. The existing means of water supply relied on people from the household, usually women and girls, carrying large cooking pots of water on their heads from groundwater springs. It was known that this was very hard work and it was suspected that poor water quality contributed to the poor health status indicated by the high child mortality rate. For the whole of PNG the child mortality rate was 65 deaths of children under 5 per 1000 live births. By way of comparison, in Australia it was about three.

Students worked in groups of four during the information gathering and divergent phases of the design. Samuel and Weir (1997) describe the divergent phase as that part of the design process when the problem is being defined, background knowledge documented and alternate solution ideas being generated. In the final four weeks of semester the focus of assessment changed to require individual project reports. While available published data about Ilahita were very sparse, the scarcity of data did provide some interesting opportunities for students to apply analytical modelling skills. For example, a limited set of rainfall records spanning 17 years between 1946 and 1975 with many gaps provided sufficient evidence to make estimates of statistical properties of the data. This provided the opportunity to stochastically generate sequences of rainfall events to enable security of supply estimates of rainwater harvesting schemes to be made. A second example that took students into an area that had interesting historical perspectives was a topographic map that had two keys. The first was a part of the regular information one finds on Australian topographic maps, but this map had been overprinted with additional information and a second key was entitled “Information from captured Jap maps”, harking back to the Second World War history of the area.

The class of 2007, around 35 students in total, produced 35 different designs addressing the design brief. While some of the designs were truly creative and came to grips with the context of the situation, others transplanted developed country solutions into a developing country context. A selection of the better (in my opinion) design reports was provided to the NGO and the representatives of the village. I think it is fair say that none of the designs were immediately appropriate, but they did lead to an unexpected emergent situation and an exciting new phase of the interaction.

First Hand Experience

Having seen the design reports, the IMCA approached me and indicated that they would be willing to sponsor a visit by me to spend time in the village assessing opportunities for community development. I spent one month living in the village learning of the way of life of people who led an almost totally subsistence lifestyle with virtually no cash economy. While there, I also collected fundamental data for engineering design purposes such as a GPS survey and household water use survey.

On return to Melbourne at an Engineers Without Borders meeting, I was discussing some of my experiences with a group of students, some of whom were destined to do the environmental engineering design subject the following semester. On hearing my plan for the subject the immediate question was “are we going on a site visit”. My immediate reaction was NO – with images of carjacking in Port Moresby, civil aviation and vehicle accidents on the long journey to the village, and

a range of tropical diseases of which I had first hand experience springing into my mind. The thought of doing battle with the University's Occupational Health and Safety system to gain approval for a site visit seemed to have little chance of success.

On reflection, I came to the view that if the extraordinary enthusiasm displayed by those students was latent in the whole class maybe this was a learning experience that should not be missed. This was borne out when an email seeking expressions of interest in a site visit during a mid-semester break that would almost inevitably entail significant discomfort, health risks and financial pain resulted in almost half the enrolled students indicating strong interest in a site visit.

From conceptual design report to humanitarian funding proposal.

For the 2008 offering of the subject several new opportunities were now in play. A significant group of students (10 students representing 1/3 of the class) had shown a firm commitment to visiting the village that formed the context of the design brief. Following my visit a richer array of data, images and videos were available for the students. Finally, an unforeseen opportunity emerged in the form of the European Union and their Rural Water Supply and Sanitation Scheme (EU RWSSS) development fund aimed at Papua New Guinea. This final point was important because now there was a 'client' for the design who had demanding criteria with regard to humanitarian objectives.

The process for applying for funding from the RWSSS involved completing a substantial form that centred on demonstrating that various engineering design and humanitarian objectives were met, and that rigorous technical feasibility was demonstrated in appendices to the application. This form provided an ideal and authentic framework for structuring the assessment of the design subject. If students could complete the form using the criteria set by the UN, with the instructor as a pseudo assessor of the funding application they would have met all the learning objectives of the subject as well as gained a valuable insight into how funding of humanitarian projects occurs. I consider this an invaluable graduate attribute gained during the subject.

From an equity point of view, a visit to the village could not be a required component of the subject because not every student was able to participate. Consequently, the site visit was scheduled for outside of the normal teaching time in the mid-semester break. In the subject, groups were arranged such that every group in the class had one member who intended to visit the village. Group members who were not travelling were asked to brief their companion with questions they would like to be answered during the community consultations that were planned for the visit. These issues were collated and used as targets for the community consultations that were done by pairs of students meeting with various clan groups in the village. The results of these meetings were documented and made available to the rest of the class immediately on return to Melbourne.

Apart from the formal contribution of the community consultation data to the class, there is no question that those who travelled to the village gained new and unique insights into village life that informed their university work. However, this was not unlike the range of prior experience and learning that students inevitably bring to their studies.

The Student Experience.

Students were asked to keep a journal to reflect on their learning experience at four stages during the subject. Overwhelmingly the comments in the journals in the later stages of the subject, after the site visit and feedback on a draft report, were positive. I have selected some comments and grouped them into two classes. The first are from five students who visited Papua New Guinea.

> *The trip to Ilahita was a fantastic experience. The people were great and visiting PNG was really good fun. In terms of this subject, it was very beneficial to be able to get immersed in some of the problems facing Ilahita, and to talk to people directly.*
>
> *I am back from Ilahita and what an experience it was. The biggest culture shock I felt was returning to Melbourne and reality hit me. My prelim report was inadequate at best and coming back from Ilahita I feel like I'm under pressure to produce a much more proficient report, though I also feel inspired.*

Okay, after the most amazing trip I've ever been on, I'm more motivated and feel much more like this problem is understandable, but doable. There is still so much work that needs to be done for the final report but my main issue now is how can I possibly make it good enough! Now that I've seen the reality of all of the numbers and issues faced by these people, …

This design project pushed me in terms of encouraging me to address problems with different ideas from different angles. There is never only one way of doing something and this assignment taught me to address a complex issue from many angles taking into account the all stakeholders and solutions.

Finally I feel the subject gave me a greater understanding of the complexities involved in solving and designing solutions for engineering projects. It showed that no solution can simply solve a problem straight away, but that solution is an ongoing process that needs to be monitored, maintained and sustainable for future generations.

The spirit that comes through with these comments are the life changing experience of the trip and the complexity of solving what appeared to be such a simple problem. Another theme that emerges is the pang of guilt about their personal efforts before the trip and the motivation to produce a final report that was worthy of the people that they had engaged with during the trip.

Some comments from seven students that did not participate in the visit are also very insightful.

I think this subject has been great, the most relevant to my environmental engineering degree so far in the course. It has really opened my eyes into seeing what is required in designing a project. It has shown me that just because you design something that will succeed technically, doesn't mean the project will be successful. It takes people management, the changing of perceptions, and the acceptance of the project by who it is be implemented for.

I began to give more thought to the fact that in writing a proposal, detail is not necessarily the main factor, but it must be concise and convincing to be approved. I have enjoyed working on the design and am keen to find out what happens to Ilahita in the future, I will be willing to be involved with assisting the design where possible.

The field trip to Ceres [a local Melbourne educational park] *didn't really help the final project at all, but got me thinking about sustainability as a manner of going about things rather than an aside to the way things are managed.*

At first I was thinking with my self that why should we have to focus on irrelative things like micro enterprises and some other topics that we have to present during the semester. But when I was finishing my report, I found out that Graham teach us in the best way that I can ever imagine of. And it makes me feel how to design by my self and I am proud of it.

At this stage I have completed the final design; I found the expectation of this design is more community orientated rather than technical orientated at the end of the design. At the beginning I have put too much time on technical solving the problems but ignored the community importance and implementation of the designed project.

What I in particular liked about the EU form is that it really exposed me to the issues related to the implementation stage of design projects and how important it is to get the implementation steps right. The main thing I have learnt is that regardless how great your design solutions may be if they don't take into consideration the social, economic and environmental factors the project can result as a failure.

This subject has been the most useful, practical, challenging and educational that I have completed in my engineering degree. It is education and useful in the sense that it has prepared me for some of the requirements and challenges of my final design project while giving me an idea of how design projects are completed in practice. It is practical in a sense that it was a real life problem, real life application form with real life beneficiaries. This gave an understanding of some of the non-engineering based challenges of the project.

It is plain from these comments that students have had their eyes opened about what balancing environmental, social, economic and technical aspects really means. I read from the comments that despite being 'taught' these aspects earlier in their degree, it only really hit home with this project. The level of effort sustained in completing the project reports was great, with many students offering to continue assisting the village after the subject was complete.

You will notice that there is no mention of lectures in the comments. That probably stems from the fact that there were only around 8 lectures given in the subject and only two of these would be truly classed as a traditional lecture. For the most part, the designated lecture time was used to explore the rich information that was widely available and to 'join-the-dots' on the information and techniques that students have already learnt but did not know how to apply in practice. The journal entries in the middle of the semester revealed some trepidation at this style of learning, which disappeared as the students received feedback on their early pieces of assessment and wrote their final reports.

Recent developments

The environmental engineering design subject was offered again in 2009 with a similar format and similar outcomes as described above. Due to curriculum changes of the entire degree course, the subject is no longer offered. However, this does not mean the opportunity for humanitarian engineering has ceased. In 2010, a group of 9 students decided to undertake a visit to the same village as a totally extracurricular activity that was not associated with an enrolled subject, to continue the experience under their own efforts.

In late 2010, a group of students associated with the PNG site visits decided to take it upon themselves to form a new student club to continue and broaden the activity. In September 2010, the Melbourne University Community Development Club held its inaugural meeting as an affiliated club of the University of Melbourne Student Union. One of the aims of the club was to broaden the disciplinary basis of the students undertaking the activities. In June 2011, another 10 current and recently graduated students from 7 different disciplines (Arts, Music, International Development, Nursing, Science, Environmental Politics, and Engineering) participated in the 4th visit to have a unique cultural and knowledge exchange opportunity.

Preparing for field based humanitarian engineering learning

Engaging in an activity that involves an overseas site visit requires careful planning. This section briefly reviews the preparatory requirements for undertaking humanitarian projects, especially in remote areas and/or developing countries.

It is likely that the Occupational Health and Safety laws within your state and institution assign some of the responsibility of the health and safety of students you supervise to you. A comprehensive risk identification, rating, and control strategy should be developed in conjunction with people knowledgeable of local conditions and the type of activity contemplated. One basic risk control strategy deployed by the University of Melbourne when undertaking fieldwork in remote areas is to require one of the group to have workplace first aid training. Pre-departure training for the group should include dealing with the most significant health and safety risks.

Local knowledge is very important in having an effective field based learning activity. It is likely that access to sites, information, and local stakeholders will all be required for both learning and safety reasons. In my case, I was able to meet with a local liaison person before leaving Melbourne who was then able to meet our group in country and who alerted his network of colleagues of our travel arrangements. They aided our progress through airports and transit accommodation. At the fieldwork location the liaison person helped organise meetings with local people, guides, and translators and assisted in arranging accommodation.

Although not related to this particular project there are very relevant training opportunities for people who wish to lead humanitarian engineering learning. Two excellent courses are conducted by RedR Australia (RedR 2011) that are directed mainly to emergency relief operations, but are also very relevant to more general development activities. Essentials of Humanitarian Practice is a six day course that covers issues ranging from minimum standards and indicators for human habitation to

dealing with the media. A second course, Personal Security and Communications, is more relevant if the proposed activity is in an area where there are higher risks to personal safety that may be reflected in higher Department of Foreign Affairs and Trade (DFAT) travel alert levels. This course deals mainly with understanding the risks in unfamiliar environments and developing individual and team based strategies for controlling those risks.

DFAT maintains the Smart Traveller website which publishes travel advisories and allows traveller's registration. Bulk registration is available by liaising directly with DFAT.

Since it is likely that you will be visiting a location where cultural norms are quite different to those understood by you and your students. Providing the opportunity for the travellers to meet and discuss appropriate behaviour with several people who are well versed in the culture of the destination may mean the difference between achieving good collaboration or a hostile reception.

Conclusion

The important lessons from this case study are many. One of the most important is to listen to what might inspire and motivate students and use this to help design learning experiences. Based on the student reflective journals it is apparent that students are prepared to put in significant effort to the point where many declared an ongoing interest to continue contribution after the subject was completed. While the challenges of mounting a humanitarian engineering project in a developing country are large, they are matched by even larger rewards for the participants and will generate support from open-minded people in what are otherwise risk averse institutions.

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