

Humanitarian engineering programme: conceptual challenges

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ABSTRACT: Colorado School of Mines (CSM) in Golden, USA, has created a minor programme in humanitarian engineering. Numerous challenges have surfaced as the programme is being developed. The first and most basic challenge was to define the terminology *humanitarian* engineering and understand the possible implications of the name. One of the early criticisms of the Humanitarian Engineering programme at the proposal stage was the question: *Is not all engineering humanitarian?* The authors believe that specific considerations and awareness are required of the humanitarian engineer that are not generally included and developed within traditional engineering education. An investigation of past humanitarian and humanitarian engineering efforts has revealed that social and cultural constraints are at least as (and perhaps more) important as the technical constraints. The balance of this paper is aimed at supporting these arguments.

INTRODUCTION

The National Academy of Engineers report, *The Engineer of 2020*, calls for educators to prepare engineers for the future *who are broadly educated, who see themselves as global citizens, who can be leaders in business and public service, and who are ethically grounded* [1]. An entire chapter in the report addresses societal, global and professional contexts of engineering. Along with the requirement for firm technical knowledge and skills, the engineer of today and the future must respond to society.

ABET 2000 requires engineering schools to provide a means for students to attain the following:

- *An understanding of professional and ethical responsibility;*
- *The broad education necessary to understand the importance of engineering solutions in a global, economic, environmental and social context;*
- *A knowledge of contemporary issues* [2].

Cooperation with the liberal arts, social science, or humanities sections of universities with the engineering sections is essential to attain the goals. Numerous universities throughout the world work to provide students with a social or cultural context for their engineering education. Examples include the University of Manitoba, Canada [3], Monash University, Australia [4], the University of Porto, Portugal [5], Nihon University, Japan [6], and the University of São Paulo, Brazil [7]. Some universities have taken an additional step, such as Worcester Polytechnic Institute in the UK, which offers a degree programme in Liberal Arts and Engineering [8]. Katehi and Ross, and Lyman summarise the challenge to integrate non-technical skills with technical competences for engineering students [9][10]. Working together in an interdisciplinary

environment is essential. At Colorado School of Mines (CSM) in Golden, USA, educators have developed a minor programme in humanitarian engineering as part of their solution to the challenge of forming an engineer for our times. In this article, the authors describe this programme and some of the challenges that have been encountered in the development of this programme.

HUMANITARIAN ENGINEERING AT THE CSM

Colorado School of Mines (CSM) is one of nine universities participating in the Engineering Schools of the West Initiative (ESWI), generously sponsored by the William and Flora Hewlett Foundation. The goal of the Engineering Schools of the West Initiative is to improve the quality of undergraduate education in engineering and increase the number of engineering graduates. The major objective of the CSM project under the ESWI is to create a minor programme in humanitarian engineering. The long-term goals of this Humanitarian Engineering programme are to:

- Create a culture of acceptance, and a value of community and international service activities at the CSM;
- Increase the number of CSM engineering graduates who enter occupations that have a community or international service emphasis;
- Increase the recruitment of women and minority students to the engineering programme at the CSM;
- Increase the number of engineering students who enter internships in community or international service;
- Enhance the social and cultural sensitivity of engineering graduates;
- Attract students with strong aptitudes in mathematics and science, and also a strong interest in working with people (these might not have otherwise considered engineering as a career) [11].

Progress towards these goals, especially in the area of gender diversity, has been made [12][13]. The programme allows students to gain a minor in humanitarian engineering by the completion of a set of liberal arts and humanities classes, a set of humanitarian-designated engineering classes, and a year-long capstone humanitarian engineering senior design project [14][15].

CHALLENGES IN THE ACCEPTANCE OF THE HUMANITARIAN ENGINEERING PROGRAMME

Numerous challenges have surfaced as the programme is being developed. The first and most basic challenge was to define the terminology *humanitarian engineering*. A team of faculty from the CSM Division of Liberal Arts and International Studies, the Division of Engineering and the Engineering Physics Department have developed a working definition and continue to be engaged in further characterising the *humanitarian engineer*:

- *Humanitarian*: to promote the present and future wellbeing for the direct benefit of underserved populations;
- *Engineering*: design under physical, political, cultural, ethical, legal, environmental and economic constraints;
- *Humanitarian Engineering*: design under constraints to directly improve the wellbeing of underserved populations.

The term humanitarian engineering incorporates many of the concepts contained within sustainable development, although sustainable development has broader connotations. There is a new movement to include engineering in sustainable development, as is evidenced at many conferences and a recent book edited by Mulder [16].

Indeed, the multi-departmental faculty team has remained actively engaged in trying to understand the terminology from a historical and societal context. Numerous books and articles have been studied and discussed that provide a history of humanitarianism [17][18]. In addition, the documentation of the experiences of the late Frederick Cuny provides one of the best examples of the modern humanitarian engineer [19]. After his initial experiences as a relief supply pilot, Cuny became absorbed in using his skills and leadership towards helping people in crisis, wherever that might be in the world. He eventually disappeared in Chechnya in August 1995 while trying to help the refugees displaced by the civil war there [20].

In his book, Cuny identified three environments of operation for the humanitarian engineer [19]. The first is *response to emergency*. The words *humanitarian aid* connotes to many a response to help refugees displaced by a natural disaster or armed conflict. However, he also referred to *developmental response* to help meet the basic human needs of the underserved. He also cited *transitional response*, which is an effort he recognised in between the emergency and developmental responses. Cuny claimed that an effective design in emergency response could enhance the progress of the refugee towards an efficient developmental path.

Although it is not the authors' intention to provide a practicum for students in emergency response projects, as this is clearly a task for professionals, it has become clear that if one is working in developmental response, a certain level of trust is

developed between the humanitarian engineer and the people he/she is working to help. In the event of an emergency, the engineer will likely be called upon to render assistance [21]. Therefore, the student humanitarian engineer should be prepared, at least through coursework, to face emergency response-type challenges.

Much of what is written about the history of humanitarianism is depressing. At best, there have been failures in delivering aid. At worst, the aid benefits only the wealthy or the unscrupulous [18]. In addition, sustainable development is hard work; it requires significant time, awareness, patience, strong will, knowledge of a foreign language, plus knowledge of the social, cultural and political climate. In addition, the rewards system for faculty to be involved with these types of activities are not generally in place, nor is there appropriate infrastructure within the university to carry on this type of work. One can easily get discouraged and feel isolated or that it is hopeless to have any positive impact.

However, there is reason to be optimistic. For example, Hawken describes the millions of organisations throughout the world where people from all walks of life are working towards a better world [22]. Collaborative opportunities with Non-Governmental Organisations (NGOs) exist to aid the university faculty and students in a project's realisation. Undoubtedly, mistakes will be made, but in the process, people will learn to communicate with one another, yielding renewed hope for a better world.

One of the early criticisms of the Humanitarian Engineering programme that was asked during the proposal phase within the University's Undergraduate Council is encapsulated in the question, *Is not all engineering humanitarian?* This is an important question that has required an education in the history of humanitarianism and engineering to achieve a practical understanding. General faculty acceptance of the idea may indeed hinge on the ability to answer this question.

Historically, engineers have developed infrastructural systems and machines to meet a broad range of needs for the industrialised local human society in which they lived [23]. In fact, there is growing concern about the specialised engineer working within a compartmentalised environment creating technology with little consideration for the impact on humanity as a whole [24]. Within a globalised world, this type of compartmentalisation will not likely contribute to sustainable solutions for our increasingly complex, interdisciplinary problems. Additionally, the humanitarian engineer who works to directly meet basic human needs will necessarily encounter issues of social justice and human rights. Most engineering education is inadequate to prepare students for this type of environment. There are no ethical guidelines to aid the engineer working within this environment. Indeed, significant work remains to prepare students who wish to pursue a career as humanitarian engineers.

CONCLUSIONS AND FUTURE DIRECTIONS

The goals of the Humanitarian Engineering minor programme at Colorado School of Mines have been established and are presented above. The formation of this unique minor programme has resulted in unanticipated challenges that in turn have led to interesting questions. The definition and public recognition of the name, humanitarian engineering, connotes

an emergency response, but also includes latitude for sustainable development work and, indeed, the transitional work that may occur between these two activities.

With regard to the question, *Is all of engineering humanitarian?*, the answer is no as the word *humanitarian* refers to one who works towards improving the lives of underserved populations in need of emergency or developmental assistance. The field of engineering is much broader than this. As much as we might like to believe this were the case, there is nothing within the ethical code of engineering that guarantees that justice prevails or that human rights are maintained.

In preparation for the future, the faculty from both the Liberal Arts/Social Sciences and Engineering departments involved with the Humanitarian Engineering programme will seek to develop coursework that helps to prepare students for the emergency response situation, as it is likely that they will be called upon to provide assistance to a disaster.

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