

Student involvement in water development/treatment in rural settings

STEPHEN E. SILLIMAN & LLOYD H. KETCHUM JR

University of Notre Dame, Notre Dame, Indiana 46556, USA

e-mail: silliman.1@nd.edu

Abstract The Department of Civil Engineering and Geological Sciences at the University of Notre Dame has a rich history of involving students in a variety of projects designed to enhance their understanding and appreciation of problems associated with developing and maintaining high quality drinking water supplies. These projects have included: design of wetlands for treatment, design of wellhead protection for rural settings, international distance learning, and water supply/treatment studies in Haiti, Mexico and the Czech Republic. These educational efforts are paying significant dividends in terms of the overall educational experience of the students and the awareness of these young engineers of the challenges faced in both high and low technology settings.

INTRODUCTION

The undergraduate and graduate education of civil engineers within the United States has, for some time, become increasingly focused on the use of sophisticated computer resources with less reliance on physical measurement and “hands-on” experience. Over the past decade, however, it has been recognized that this heavy reliance on numerical skills does not necessarily produce engineers who are capable of providing creative solutions to water supply/water treatment problems, particularly those faced in small communities and/or in small communities in developing countries.

Within the Department of Civil Engineering and Geological Sciences (CE/GEOS) at the University of Notre Dame, a series of activities are used to introduce civil engineering students (undergraduate and graduate) to application of their engineering skills in the areas of water treatment and water supply. These activities are used to balance the heavy (and important) emphasis on conceptual understanding and numerical skills. They also help to develop understanding of the conceptual and numerical skills through application to practical problems.

These activities take one of three forms. First, during the academic year, CE/GEOS attempts to offer unique course and research options. Second, during the summer period, CE/GEOS invites the highest quality undergraduate engineers from across the United States to take part in an eight week research programme. Finally CE/GEOS pursues active research activities involving graduate students.

This paper outlines some of the projects which have been pursued in this effort to introduce these young engineers to the engineering challenges to be faced in water treatment/water supply.

PROJECTS DURING THE ACADEMIC YEAR

Development of opportunities appropriate for undergraduates to pursue during the academic year have included:

Distance learning Using two video cameras and microphones attached to one lap top and one desk top computer, CE/GEOS recently completed a semester long course in which a faculty member in Israel lectured in real time to students in residence at Notre Dame. Using a variety of teaching tools, this course ran quite smoothly and was the pilot study for educational interchanges planned with the National University of Benin.

Hand-pump testing Notre Dame undergraduate students have established a hand-pump testing facility in CE/GEOS. This facility has enabled students to analyse and redesign home-made hand pump cylinders for use in developing countries. This work has immediate application as some of these cylinders are now in use in Togo, Africa.

Wellhead protection CE/GEOS has pursued a number of projects related to wellhead protection for small public water systems in the United States and the introduction of this concept to developing countries. Much of this work can be completed *via* computer modelling which can be fully understood by senior engineering undergraduates who have the skills to pursue, through a senior research project, the analysis of alternative strategies.

PROJECTS APPROPRIATE TO SUMMER RESEARCH

Notre Dame has pursued a number of undergraduate projects which are more appropriate for summer research in which the student has the freedom to travel out of the country or to work at a remote facility on a daily basis. Examples include:

The Elkhart Environmental Center (EEC) The EEC is an innovative teaching and research centre based on the capping of a landfill and conversion of the landfill region into an environmental education centre. Developed by the City of Elkhart, Indiana, the EEC has a decade long history of development in cooperation with CE/GEOS. A number of summer research projects have been pursued at the EEC.

As an example, students have worked with the EEC in the design and construction of four artificial wetlands. Built for a variety of purposes (wetlands research, stormwater treatment, and treatment of the domestic waste from the education centre at the EEC), these wetlands involved a variety of design considerations including hydraulic analysis of flow, analysis of nutrient removal, stability analysis of the embankments, and selection of vegetation for planting in the wetlands.

Hand pump project (Haiti) Summer student projects can also involve international travel. CE/GEOS has been actively working in Haiti to drill water wells and repair hand pumps. We have recently begun including students in trips to Haiti, including a trip to the remote village of St. Michel where the students contributed directly to ten days of driller's training.

Research in Tijuana, Mexico A second international trip involved a summer student studying with a research group at El Colegio de la Frontera Norte (COLEF). The student conducted pilot scale studies on composting of waste solids from a biotower which was one component of a domestic wastewater treatment system. This system was designed such that it required little energy, could be operated by less skilled operators, and produced an effluent suitable for urban irrigation.

GRADUATE LEVEL RESEARCH

A number of graduate level research projects have been pursued. Two examples are:

On-site treatment plant A doctoral student conducted studies for treatment of rural wastewater at the Elkhart Wastewater Treatment Plant (which is used regularly as a teaching/research facility by Notre Dame) using 100 m³, 4 m³, and 3 l pilot biological treatment units and constructed wetlands. The system proved simple to operate, used no chemicals and little energy, and the wetlands provided for pathogen reduction and disposal of the waste solids.

Czech Republic A graduate student, supported by an 18-month Fulbright Award, currently is conducting research with the Prague Institute of Chemical Technology. They are investigating the feasibility of biologically leaching heavy metals from their municipal waste treatment plant residues to allow beneficial use on crop lands. These metal-contaminated residues now must be placed in scarce landfill space.

BENEFITS

Through these projects, a number of benefits are realized by the students, by CE/GEOS, and by those cooperating with these projects. The students have the opportunity to experience applications of their engineering education to real problems in both first- and third-world settings. Such experience can encourage students to pursue higher levels of education and/or to pursue alternative, developing-country projects following graduation. CE/GEOS gains, through these programmes, the opportunity to work with some of the brightest undergraduate and graduate engineers in the country. CE/GEOS has an active record of publication and development of new, interesting projects based on these programmes. Finally, those cooperating with these projects (e.g. the City of Elkhart, the community of Tijuana, Mexico, and the community of St. Michel, Haiti) gain through these efforts as innovative, high-quality projects are completed at minimal cost.

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